



A model of online shopping cart abandonment: evidence from e-tail clickstream data

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Abstract

This research investigates online consumer behavior in an e-commerce context with a focus on consumer online shopping cart use and subsequent cart abandonment. A model rooted in the Uses and Gratifications Theory, the Unified Theory of Acceptance and Use of Technology, and the concept of the purchase funnel is developed to explain the predicted relationships. Empirical findings based on clickstream data show that returning to an existing cart increases the subsequent cart use and decreases cart abandonment. Conversely, viewing clearance pages and viewing a large number of product reviews increases both cart use and cart abandonment. Browsing product pages decreases cart use, and increases cart abandonment. The moderating role of smartphone-based shopping is also examined, with the moderating effects primarily occurring early in the purchase funnel affecting cart use, and influencing cart abandonment to a smaller degree. Theoretical contributions and managerial implications for digital marketers are provided.

Keywords Online consumer behavior · E-commerce · Shopping cart use · Shopping cart abandonment · Clickstream data

Introduction

A known managerial problem concerning marketers and retailers is the alarmingly high rate of online shopping cart abandonment, defined as consumers' placement of item(s) in their online shopping cart without making a purchase of any item(s) during that online shopping session (Kukar-Kinney & Close, 2010, p. 240). Industry studies show that more than 80% of online shopping carts are abandoned worldwide (Statista,

2020), leading to billions of unrealized sales dollars. Such high abandonment rates raise two important questions for marketers. First, beyond a transactional purchase, what drives consumers to place items in an online shopping cart? Furthermore, why does shopping cart abandonment occur?

Previous research has separately investigated the motivations for placing items in the cart (Close & Kukar-Kinney, 2010) and perceptual determinants of online cart abandonment (Cho et al., 2006; Huang et al., 2018; Kukar-Kinney &

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Close, 2010; Moore & Mathews, 2008, Oliver & Shor, 2003; Rajamma et al., 2009; Rubin et al., 2020; Song, 2019; Xu & Huang, 2015). However, there is an under-addressed need to consider both stages of the online purchase funnel: (1) consumers' cart use, which we define as the frequency (i.e., number) of items that consumers place into their cart during a current shopping session, *and* (2) cart abandonment, which refers to when consumers decide to leave the shopping session without purchasing the item(s) placed in the cart as opposed to completing the transaction by purchasing the item(s) placed into the cart during the online shopping session.

Studying cart use is critical for many reasons. First, placing one or more items in an online shopping cart is a necessary condition for abandonment, as consumers cannot abandon a cart if there are not items in it. Second, extensive cart use (i.e., a large number of items placed in the cart) may signal a higher purchase commitment, directly affecting the subsequent decision to purchase the item(s) or abandon the cart. Third, factors that influence consumers' decision to use the cart may also affect cart abandonment later in the online purchase process. Fourth, although e-tailers and marketers can collect information on online shopping behavior using clickstream data, they are unable to measure shoppers' motivations directly. While motivations for cart use have been theorized (e.g., Cho et al., 2006; Huang et al., 2018), scholars have not conceptually determined which *online behaviors* are associated with consumers' cart use and abandonment. Therefore, the primary goal of this research is to investigate, from a motivational lens, how consumers' behaviors while shopping online influence both their cart use and abandonment. To accomplish this goal, we use consumer shopping clickstream data from a large European multinational retailer specializing in sportswear, clothing, footwear and home products.

We make two key contributions to the marketing literature. As the first contribution, we develop and empirically test a theory-based conceptual model that explicitly includes cart use and cart abandonment. We test this model with actual online consumer behavior data, going beyond past work that examined behavioral intentions. The conceptual model builds on past work that studied how motivations affect consumers' intentions to use online shopping carts. Specifically, we develop the model through integrating aspects of the Uses and Gratifications Theory and the Unified Theory of Acceptance and Use of Technology. Collectively, these theories help explain reasons or motivators associated with a customer placing items in their online cart (i.e., their cart use), and also what variables are associated with a consumer abandoning the cart and therefore not making a purchase during that online shopping session.

Overall, we contribute to previous research that has not considered a holistic understanding of how both cart use and abandonment are related elements in a consumer's overall online shopping journey. In particular, in earlier stages of

the purchase process, we contend that the relationship between specific behaviors (e.g., returning to an existing cart, reading customer reviews) and cart use represent an important first step in shopping online that may signal purchase involvement. Our research is also the first to show the similarities and differences between how specific clickstream behaviors affect cart use and cart abandonment. For example, while the number of product reviews read positively influences one's cart use as indicated by an increased number of items placed in a cart, it also increases cart abandonment, rather than vice versa. This is important to recognize because previous literature has not considered how specific behaviors may bolster online shopping at an earlier stage in the purchase process (i.e., cart use), but at the same time impede purchase completion at later stages of the purchase process (i.e., cart abandonment).

A second intended contribution is to identify the moderating role of smartphone-based shopping, as the role of mobile shopping may influence consumers' cart use. Shopping using mobile devices compared to fixed devices offers unique benefits that can affect the shopping experience (Haider et al., 2020; Wagner et al., 2020). As such, consumer online cart behaviors likely vary depending on the device used for shopping. The study of mobile shopping is also important from an economic perspective. Forecasts show that by the end of 2024, mobile shopping will total \$488 billion, 44% of the total U.S. e-commerce market (Meola, 2020).

Next, we discuss the relevant literature, the theoretical background, and develop a conceptual model. We then follow with an overview of methods, results, and a discussion. In the discussion, we offer managerial implications including possible ways to reduce initial cart abandonment and retarget consumers to recover abandoned carts in order to help facilitate e-commerce sales.

Literature review, theoretical background, and conceptual framework

Synthesis of online shopping cart literature and research gap

An online cart refers to a virtual space where consumers can select, view, and hold items on retail websites before potential purchase. We synthesize literature on online shopping cart abandonment, along with how the current research fills the research gap, in Table 1. Overall, Table 1 brings attention to the novelty of this research in that it is the first work to address all of the following components: it investigates both cart use and abandonment, considers the role of shopping on a smartphone, and tests a cohesive online cart model with behavioral clickstream data rather than consumer-reported intentions or motivations regarding the use and/or abandonment of their online shopping cart.

Table 1 Online shopping cart abandonment literature and literature gap

Article	Method	Cart Use	Mobile Device	Click-stream Data	Focus and Key Findings
<i>The current research</i>	Field study	✓	✓	✓	Behavioral aspects of online abandonment representing purchase, economic control, organization, and information motivations. Drivers of greater cart use include: having an existing cart, number of sold-out items seen, visiting clearance page, number of product reviews accessed, and using a smartphone. Number of products seen reduces cart use. Shopping on a smartphone (vs. other devices) moderates these relationships. Predictors of higher cart abandonment are: visiting clearance page, removing items from the cart, number of products and customer reviews seen. Having an existing cart and extensive cart use reduce abandonment.
Li et al. (2021)	Field experiment	–	✓	✓	Retargeting in electronic cart abandonment. Examines causal effectiveness of retargeting abandoned carts. E-commerce cart retargeting ads bring “double-edged” incremental effects on purchasing. A cart retargeting ad sent late has a positive incremental effect; an ad sent early brings a negative effect. Effects are amplified with an above average price and larger quantity of products.
Rubin et al. (2020)	Experiment	–	–	–	Role of consumers’ temporal framing in online shopping cart abandonment. An abstract mindset will lead to a positive intention to purchase products in a cart. Peripheral features in the product description moderate this effect. With positive peripheral attributes, the negative effect of abstract mindsets on abandonment is reduced. Involvement moderates the path from construal to number of product features.
Song (2019)	Survey	–	–	–	Product categorization in online cart abandonment. Price, symbolic value, perceived importance, and purchase frequency impact abandonment through motivations for shopping activities (e.g., product inspection).
Huang et al. (2018)	Survey	–	✓	–	Conflicts, ambivalence and hesitation in mobile cart abandonment. Consumers experience tension between completing or not completing a shopping task while considering making a purchase. Conflicts about product attributes determine emotional ambivalence. Ambivalence leads to hesitation and abandonment.
Xu & Huang (2015)	Survey	–	–	–	Determinants of cart abandonment in China. Results replicate the role of organization and research motive on abandonment and the role of concern about costs from Kukar-Kinney and Close (2010).
Close et al. (2012)	Conceptual	✓	–	–	Consumer electronic shopping behavior. Conceptually, cart abandonment, frequency of online buying, and decisions to buy from a land-based retailer depend on: cost concern, entertainment value, organizational intent, taking advantage of a price promotion, current purchase intent, cart use, and privacy/security concerns.
Kukar-Kinney and Close (2010)	Survey	✓	–	–	Determinants of cart abandonment. Determinants include: entertainment value, use of the cart as a research and organizational tool, concern about costs, and waiting for a sale or price reduction.
Close and Kukar-Kinney (2010)	Survey	✓	–	–	Hedonic and utilitarian motivations in online cart use. Cart use is explained by current purchase intent, taking advantage of price promotion, entertainment purposes, organizational intent, and research and information search. Frequency of online shopping cart use then leads to frequency of online buying.
Rajamma et al. (2009)	Survey	–	–	–	Factors leading to propensity to abandon a cart during the transaction completion stage. Perceived transaction inconvenience is a driver of abandonment. Consumer perception of waiting time, risk also drive cart abandonment. As perceived waiting time increases, incidence of shopping cart abandonment decreases.
Moore and Mathews (2008)	Qualitative	–	–	–	Online shopping cart abandonment syndrome. Perceived performance risk via extrinsic cues (e.g., price) determine performance evaluation, while company’s reputation explains frequently abandoned carts.
Cho et al. (2006)	Survey	–	–	–	Shopping cart hesitation and abandonment. Three types of online shopping hesitation are overall hesitation, shopping cart abandonment, and hesitation at the final payment stage.
Oliver and Shor (2003)	Experiment	–	–	–	Role of promotion codes. The effect of digital redemption of promotion codes on online purchase abandonment is studied. When a consumer does not have a coupon code, it is perceived as inequality, driving noncompletion intentions of a hypothetical purchase as a proxy for cart abandonment.

As depicted in Table 1, the research on cart abandonment has primarily focused on its drivers, but has not also examined the extent of consumers' cart use or the number of items placed in a cart during a specific shopping session in the first place. For instance, research by Oliver and Shor (2003) finds that having to enter a digital promotion code increases non-completion purchase intentions as a proxy for cart abandonment, while Moore and Mathews (2008) determine that a company's reputation is a reason behind frequent cart abandonment. Likewise, completing an online purchase can be inconvenient; Rajamma et al. (2009) find that perceived greater transaction inconvenience increases cart abandonment.

In addition, Kukar-Kinney and Close (2010) identify several key drivers to abandonment, including for example, using a cart as a research and organizational tool and a concern about total costs. They suggest cognitive and behavioral reasons for abandonment from the perspective of online cart use motivations. Following this work, Xu and Huang (2015) explore factors influencing online cart abandonment in China and determine that motivations for research and organization increase abandonment, supporting the generalizability of findings by Kukar-Kinney and Close (2010). Cho et al. (2006) also consider purchase hesitation as a type of cart abandonment. Overall, these works study cart use or abandonment independently of each other. In addition, and despite research that demonstrates mobile devices affect online shopping experiences (e.g., Haider et al., 2020), this body of research has not considered how mobile devices affect cart use and abandonment. One exception is research by Huang et al. (2018), which explains that consumers may abandon their carts in the mobile channel due to emotional ambivalence and hesitation at checkout.

Table 1 further shows that previous research has primarily depended on consumer surveys, with self-reported measures of perceptions and motivations used as predictors. In particular, no work has addressed how factors jointly affect cart use and abandonment with behavioral clickstream data. Clickstream data refer to the electronic record of consumer Internet usage collected by Web servers or third-party services used to track page views and clicks using cookies (Bucklin & Sismeiro, 2009). They provide information on how consumers navigate web pages in their own environment without artificial interruptions, offering an accurate, natural, and detailed view of online consumer behavior (Bucklin & Sismeiro, 2009). In marketing, clickstream data have been used to explore a variety of online consumer behavior topics, including online search and browsing behavior (Bucklin & Sismeiro, 2003; Huang et al., 2009), consumer choice models (Moe, 2006), online shopper segmentation (Moe, 2003), consumer decision process and buying behavior (Shi & Zhang, 2014), online consumer journey (Li et al., 2020), channel conversion (Li & Kannan, 2014), and online advertising (Chatterjee et al., 2003). Nonetheless, research has not

applied behavioral data to jointly study cart use and abandonment. While Li et al. (2021) use behavioral data, they find contrasting effects of retargeting ads of previously abandoned carts depending on the timing of the ad: a retargeting ad sent one to three days after cart abandonment has a positive incremental effect, while an ad sent within 30 min to an hour has a negative effect on purchasing. Products that are above average price and of larger quantity amplify the effects (Li et al., 2021). However, their work does not address the initial drivers of cart use or abandonment. We now introduce the theoretical background used to inform the conceptual model.

Theoretical background

Uses and gratifications theory The proposed conceptual model of online shopping cart use and abandonment is primarily rooted in the Uses and Gratifications Theory (UGT), which explains how consumers seek the use of a specific medium to satisfy their needs (Blumler, 1979). Assumptions of this theory are that consumers are active media users, goal-directed, aware of their needs, and can select the appropriate outlet to gratify those needs. In UGT, various motivations exist for a specific media use including: entertainment, interaction, identity, information (McQuail, 1987), economic control (Wolin & Korgaonkar, 2003), and diversion (O'Donohoe, 1994). Originating from mass communication, UGT has been applied to a wide-range of disciplines and topics, including marketing and e-commerce. The existing online cart literature has linked UGT uses with motivations for online cart use. For instance, an information motivation may lead consumers to use the cart as a research tool to organize product and pricing information; an economic control motivation may encourage consumers to place items in the cart because they are on sale; and a diversion motivation may encourage consumers to use the cart for entertainment (Close & Kukar-Kinney, 2010). Based on e-commerce research (Wolin & Korgaonkar, 2003), the key uses considered as motivators of placing items in an online cart and abandonment in the present research are economic control, information search, and organization. Drawing from UGT, and overviewed next, we propose that consumers' online shopping behaviors ranging from browsing to completing the transaction can be used to discern their uses and gratifications at various stages of the online purchase funnel.

We integrate UGT (Blumler, 1979) into the conceptual reasoning for why consumers behave in a certain way on a retail website, and how the UGT motivations could drive online cart behaviors both at earlier stages of a purchase process when a consumer is deciding on items to place into the cart, and at later stages when deciding whether to purchase the item(s) or abandon the cart. In their path to purchase, consumers have traditionally been thought to move through

awareness, interest, desire, and action stages of the purchase funnel. In today's information-rich online shopping environment, the path to purchasing has become more nuanced, including not only the stages leading up to a purchase such as "needs/wants", and "willing to purchase", but also the post-purchase stages, such as "consumes", "satisfied", "loyal", and "advocates" (Batra & Keller, 2016). Since we focus on cart use and abandonment, the funnel stages up to "willing to purchase" (i.e., purchase or cart abandonment) are relevant. The further one is in the purchase funnel, the more their focus shifts from product evaluation to purchase decision.

Unified theory of acceptance and use of technology In addition to UGT and the purchase funnel concept, it is necessary to also draw upon aspects of the Unified Theory of Acceptance and Use of Technology. The Unified Theory of Acceptance and Use of Technology (UTAUT) studies the acceptance, adoption, and use of technology (Venkatesh et al., 2012). In particular, UTAUT explains which factors drive the use of specific technologies and why (Venkatesh et al., 2012). Under the umbrella of UTAUT is the Technology Acceptance Model (TAM) framework which has been applied to explain mobile device use when shopping (Hubert et al., 2017). Consistent with both UTAUT and TAM, Hubert et al. (2017) demonstrate that consumers with prior positive smartphone experiences are more likely to use their smartphone for mobile-commerce activities. In a later section, we turn back to UTAUT, UGT, and the concept of the purchase funnel to develop hypotheses with respect to the moderating role of smartphone-based shopping.

Literature review and conceptual model

Figure 1 depicts the conceptual model of the behavioral determinants for consumer online cart use and abandonment. The model accounts for motivations shown in previous research (Close & Kukar-Kinney, 2010; Kukar-Kinney & Close, 2010; Wolin & Korgaonkar, 2003) as being associated with online cart use and/or abandonment including motivations regarding purchase, economic control, organization, research and information, and convenience. For instance, Close and Kukar-Kinney (2010) find that a consumers' desire to take advantage of price promotions and an organizational intent increase the number of items placed in a cart. Similarly, Kukar-Kinney and Close (2010) and Xu and Huang (2015) demonstrate antecedents to cart abandonment including using an online shopping cart as a research and organizational tool.

In the hypotheses development, we focus on clickstream shopping behaviors that we argue correspond with the underlying motivations previously shown to be drivers of cart use and/or abandonment. There are important differences between the proposed model and previous research. First, we focus on actual online shopping behaviors versus perceived

motivations to behave in specific ways. Hence, UGT theory not only focuses on perceived motivations, but also considers goal-directed behaviors that individuals choose to engage in (Ko et al., 2005). According to Zhang and Zhang (2013), prior UGT research has relied heavily on self-reported behaviors, and there is a need to study and verify UGT with behavioral data. To that end, previous research has not determined how underlying motivations may behaviorally manifest themselves and subsequently affect consumer cart use and abandonment. Second, our research adds to previously considered motivations. For instance, we distinguish between specific types of research and information motivations (i.e., retailer-provided and consumer-provided information). Below, we discuss each of the hypotheses in the model.

Returning to an existing shopping cart Extant work demonstrates that goal directed motivations, such as purchase intent, increase online cart use (Close & Kukar-Kinney, 2010; Close et al., 2012). In goal-directed purchase circumstances, if items in the cart are not immediately purchased, consumers may use the cart to hold items for a potential future purchase. Per UGT, a goal-oriented purchase motivation should encourage consumers to satisfy the underlying need by completing the purchase. Indeed, previous research demonstrates that having a purchase motivation decreases the likelihood of cart abandonment (Oliver & Shor, 2003; Xu & Huang, 2015; Huang et al., 2018).

Applying this work to cart use behavior, and from a UGT lens, the instance of *starting an online shopping session with an existing cart* is when consumers return to a cart containing items added during a previous shopping session, which we contend is a behavior that reflects a purchase motivation. Close and Kukar-Kinney (2010) demonstrate that online shoppers' purchase motivation increases the frequency of cart use. We suggest that a consumer's return to an existing cart signals an enduring interest in the product(s) and a current purchase motivation. Specifically, this behavior signifies the goal of satisfying one's needs by purchasing. Further, returning to the site with an existing cart signals that the customer may have moved further down the purchase funnel and is closer to making a purchase decision. It is also likely that after returning to an existing cart, consumers' desire to satisfy their needs will lead to more shopping, including adding additional items to the cart. Thus, we expect that consumers who return to an existing cart are both more likely to place additional items in their cart and to follow through with a purchase compared to those without items in an existing cart. Specifically, we posit:

H1a Starting an online shopping session with an existing cart is associated with higher online shopping cart use.

H1b Starting an online shopping session with an existing cart is associated with lower online shopping cart abandonment.

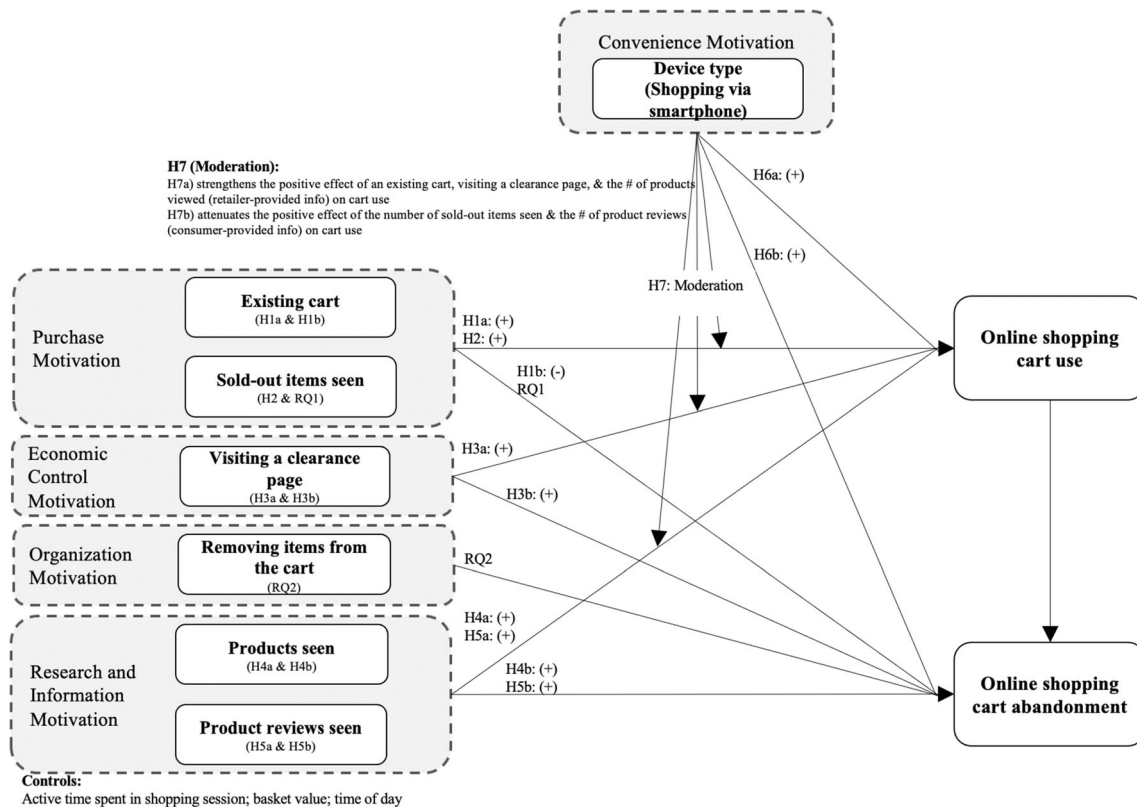


Fig. 1 Uses and gratifications theory based model of online shopping cart use and cart abandonment

Encountering a sold-out product An additional behavior that should reflect a purchase motivation is *encountering a sold-out product*, which refers to when a consumer is exposed to a product(s) that is no longer in stock and cannot be immediately purchased. On the one hand, if a consumer encounters a sold-out product, such an encounter may increase the perceived desirability of the item and create a greater purchase motivation and decision urgency. Increasing the perceived urgency of a potential purchase is consistent with research that demonstrates how signaling a product restriction in the form of limited quantity influences consumers' perceived deal value and consequently increases purchase intent (Inman et al., 1997). Consumers perceive products that are not readily available as more valuable (Cialdini, 2001), especially if this is due to a high demand versus supply (Castro et al., 2013). One could extend this reasoning to products encountered while shopping online and propose that seeing a sold-out product will encourage the consumer to become more purchase-driven in order to not miss out on other purchase opportunities. In turn, the consumer will more likely add items into the cart and follow through with a purchase during the shopping session. This reasoning is consistent with research showing that scarcity appeal advertising leads to enhanced value perception, which in turn increases purchase intent (Eisend, 2008) and with work that demonstrates how a lack of product availability triggers

purchase intent (Steinhart et al., 2013). The associated UGT motivation is a purchase motivation, which is manifested when a consumer seeks a product they desire to buy, but it is sold-out and cannot be purchased during that online shopping session. Due to consumer purchase motivation triggered by the product unavailability, they may place other substitute items in the cart and purchase them to fulfill this motivation.

However, on the other hand, one could argue that seeing sold out products could contribute to cart abandonment. Seeing a sold-out item may entail finding a stock-out based substitution (Anupindi et al., 1998). Even if such a substitution is found at the same retailer, the consumer may be more reluctant to complete the purchase. Alternatively, the substitution item that is ultimately purchased may not be from the same retailer. The stock-out literature (e.g., Breugelmans et al., 2006; Campo et al., 2000, 2004; Sloot et al., 2005) suggests that when a product is not available, it can lead to store switching. In the current setting, this would manifest itself in an increased probability of cart abandonment. Thus, while theory and literature would suggest that seeing sold-out products increases the number of items a customer considers and puts in a cart, it is unclear if seeing sold-out products would increase or decrease cart abandonment because it is also possible to obtain a substitute item from other retail sites. As such, while we expect exposure to sold-out products to

increase cart use (H2), the nature of the relationship between seeing sold-out items and cart abandonment is unclear. Hence, we do not propose a directional hypothesis for this relationship, but pose a research question (RQ1):

H2 Seeing sold-out products is associated with higher online shopping cart use.

RQ1 How does seeing sold-out products affect online shopping cart abandonment?

Visiting a clearance page The next motivation relates to the UGT motivation of economic control (Wolin & Korgaonkar, 2003). Research demonstrates that a price savings motivation, as a form of economic control, influences cart use (Close & Kukar-Kinney, 2010). Similarly, Oliver and Shor (2003) demonstrate that consumers seek price discounts, and not having a discount code leads to non-completion of the online transaction. For instance, some retail websites offer conditional promotions (e.g., 15% off purchases up to \$1000) or threshold free shipping policies (e.g., free shipping on orders \$35+). For such promotions, consumers could place items into their carts and merge orders in order to qualify for promotional conditions (Kukar-Kinney et al., 2016). These types of incentives provide customers a higher level of economic control through price savings. Based on previous work, we suggest that behaviors rooted in an economic control motivation relate to a consumer's desire to save money. One type of behavior that we contend reflects a price savings motivation is a consumer's *visit of the clearance section of a retail website*, or an instance in which a consumer is exposed to a section of a shopping website that shows product(s) on clearance sale that will no longer exist in the future. In light of this consideration per UGT, a visit to the clearance section of a website is proposed to indicate an economic control motivation, which in turn encourages consumer's cart use in the form of placing additional (clearance) items into their cart. Further, consistent with Batra and Keller (2016), a price savings motivation should be important early in the purchase funnel, particularly in the awareness and interest stages.

A potential tradeoff for the behavior of visiting a clearance section of a shopping website is a limited assortment of clearance items. Clearance items tend to include left-over, end-of-season, and less in demand products (Smith & Achabal, 1998). Therefore, when a consumer reaches the purchase decision stage, items that were initially placed into the cart, motivated in part because the item was on clearance, may not seem as desirable anymore, and other characteristics may become more salient. In particular, conflicting cues such as a low price coupled with a perceived lack of quality or popularity may lead to a negative evaluation (Miyazaki et al., 2005) and evoke hesitation when finalizing the purchase. When making

these types of purchase decisions, hesitation can increase cart abandonment (Huang et al., 2018). Consequently, we propose that visiting a clearance section of an e-commerce site will be associated with an increase in both cart use and cart abandonment:

H3a Visiting a clearance section of a shopping website is associated with an increase in online shopping cart use.

H3b Visiting a clearance section of a shopping website is associated with an increase in online shopping cart abandonment.

Removing items from the cart In e-commerce, an organization motivation, which refers to using the cart as a wish-list, a bookmark, and as a way to compare items, is associated with a decrease in cart abandonment (Kukar-Kinney & Close, 2010). From a UGT and purchase funnel lens, behaviors related to an organization motivation are goal-driven and help facilitate online purchase behavior. For instance, consumers can organize and compare attributes for items of interest with an online cart. We focus on a particular type of organizational behavior, *removing items from the cart*, defined as an instance when a consumer removes an item(s) that was previously added to the cart. As such, removing items could represent a step in the organization process. However, since removing items from a cart by nature requires placing one or more items in their cart to start with, we do not evaluate the effect of item removal on cart use, but instead focus on investigating how removing items affects cart abandonment. The UGT-based rationale would suggest that removing items from the cart as an expression of organization motivation will lead to lower cart abandonment. However, item removal can also indicate purchase uncertainty and hesitation, with hesitation at check-out being associated with higher cart abandonment (Huang et al., 2018). Tang and Lin (2019) show that purchase hesitation and subsequent cart abandonment are largely due to perceptions of uncertainty. Aforementioned, Cho et al. (2006) also consider purchase hesitation as a type of cart abandonment. Applied to our work, removing items from a cart could be seen as a behavioral indicator of overall uncertainty and hesitation to complete a purchase, thus leading to higher cart abandonment. In light of work that suggests organization-based behaviors could in some instances increase cart abandonment, but in other instances decrease cart abandonment, we do not propose a directional hypothesis but instead pose a research question (RQ2):

RQ2 How does removing items from the cart affect online shopping cart abandonment?

Browsing product pages and customer reviews Another UGT motivation is information search (McQuail, 1987). UGT can

help explain how motivations to obtain information may influence consumer shopping cart behaviors. We propose that consumer behavior in the form of *browsing a large number of product pages*, defined as the number of times a consumer views products and corresponding product information, and *browsing a large number of customer product reviews*, defined as the number of times a consumer reads online reviews for products, reflect an information search motivation. To establish generalizability of the effects across different types of information search, we differentiate between search of retailer-provided information and search of consumer-provided information. *Retailer-provided information* involves marketer- or brand-generated content (Chen & Xie, 2008) and refers to product information provided on the retailer's website, such as a product description, images, and pricing. Such information is typically factual in nature and descriptive of product features. Browsing retail product pages is an example of a retailer-provided information search. In contrast, *consumer-provided information* falls into the category of user-generated content (Chen & Xie, 2008) and refers to any information about the product and purchase experience provided by other consumers, such as customer reviews. Such information tends to be more subjective and describes the customer's experience when purchasing the product of interest. Browsing customer reviews represents a form of consumer-provided information research.

Focusing on the search of retailer-provided information, we posit that the more extensive the consumers' browsing of product webpages is, the more products of interest they may encounter, and consequently, place into the cart for further consideration. Specifically, based on Batra and Keller (2016), we propose that gathering information through multiple product pages should occur early in the purchase funnel and should encourage consumers to further consider various products by placing them into the cart. During this stage, consumers consider, search, and learn about different product options. As such, extensive browsing of product pages will increase the consumer's consideration of products, and consequently, their cart use.

However, at the same time, an exposure to a large number of product options may have a negative effect on the consumer's progression further down the purchase funnel. Huang et al. (2018) show that consumers who are ambivalent about making a purchase may have a motivation to put items in a shopping cart as a research tool and consequently abandon the cart to a greater extent. Such findings support the notion that an information search motivation increases both the chances of placing item(s) in an online cart and the chances of cart abandonment. Theoretically, such behavior could be further explained by choice overload in that, especially when shopping online, there can simply be too many choices which in turn overwhelms the consumer, resulting in cart abandonment. Work by Scheibehenne et al. (2010) supports the notion that too many choices result in loss of sales. As such, we predict:

H4a Retailer-provided information search (i.e., browsing a large number of product pages) is associated with an increase in online shopping cart use.

H4b Retailer-provided information search (i.e., browsing a large number of product pages) is associated with an increase in online shopping cart abandonment.

Similar to retailer-provided information search, and based on Batra and Keller (2016), *consumer-provided information search*, such as browsing customer reviews, can serve as an indicator of an additional type of product information search, signifying customer interest in the products and a higher likelihood of their further consideration. Thus, reading customer reviews should also enhance the number of items a customer puts in their cart, hence, their cart use.

However, we expect that consumers will increase their rate of online cart abandonment after reading customer reviews. We theorize that a reason for this effect is that cart use and abandonment occur at different stages of the purchase process. Putting one or more items in one's cart occurs during the earlier stages (such as awareness, interest, or consideration stages), while cart abandonment is closer to the end stage (willingness to purchase stage). Previous work demonstrated that user-generated content (in our research, customer reviews) has a strong impact on consumers' purchase decision (Jang et al., 2012). Further, reading a large number of customer reviews increases information overload and may result in conflicting information, so consumers might experience ambivalence and hence avoid making a choice (Scheibehenne et al., 2010), resulting in greater cart abandonment (Huang et al., 2018). For instance, Maslowska et al. (2017) show that the volume of reviews lowers the probability of purchase; they speculate that this effect is driven by a high cognitive overload from too many reviews. As such, consumer-provided information search in the form of reading customer reviews should be associated with an increase in cart abandonment. We predict that:

H5a Consumer-provided information search (i.e., reading customer reviews) is associated with an increase in online shopping cart use.

H5b Consumer-provided information search (i.e., reading customer reviews) is associated with an increase in online shopping cart abandonment.

Smartphone-based shopping When shopping online, consumers can use either a mobile device, such as a smartphone, or other devices, such as a personal computer. Shopping on a smartphone may be indicative of a desire for convenience, an established motivation in e-commerce (Evanschitzky et al., 2004; Szymanski & Hise, 2000). In an online shopping context, we define *smartphone-based shopping* as a behavior that

reflects a convenience motivation. As previously mentioned, UTAUT helps explain consumers' use of technology (Venkatesh et al., 2012). According to UTAUT, mobile device usefulness positively affects consumer intentions to use smartphones for shopping (Hubert et al., 2017). In this context, usefulness refers to smartphones being more convenient than other devices such as personal computers (Hubert et al., 2017). Coupled with research emphasizing that consumers often search for product-related information before making a purchase, additional research shows that while smartphones are better used to obtain product characteristics, they make it difficult to complete a purchase (Bhatnagar & Papatla, 2019). Applied to our work, this suggests that compared to devices such as personal computers, smartphones could increase cart use because of their perceived usefulness (Natarajan et al., 2018) early in the purchase process.

While browsing and placing products into the cart on a smartphone is convenient, there are concerns that it could impede consumers from moving from product consideration to purchase using a smartphone. For instance, Oliver and Shor (2003) demonstrate that when required to enter a promotion code, consumers less often complete online transactions due to the inconvenience of locating and entering the code. Related, Rajamma et al. (2009) find that the inconvenience of an online transaction drives an increase in cart abandonment. Making a purchase also often requires a disclosure of sensitive information such as contact information and a credit card number. Further, concerns about security of payment information may also arise. Previous research also indicates that consumer perceptions of a technology's intrusiveness of their personal privacy can negatively affect behavioral reactions such as retail patronage (Inman & Nikolova, 2017). In addition, given the "on the go" nature of the mobile phone usage and the ease of adding items to the cart from one's smartphone, consumers may want to take more time to fully consider the purchase before completing the order. Such reasoning is also consistent with De Haan et al. (2018) who find that mobile devices are more frequently used early in the purchase funnel. As such, we propose that shopping on a smartphone is positively related with consumer cart use, but negatively related with purchase completion, thus increasing cart abandonment.

H6a Shopping on a smartphone (vs. other devices) is associated with an increase in online shopping cart use.

H6b Shopping on a smartphone (vs. other devices) is associated with an increase in online shopping cart abandonment.

Smartphone-based shopping as a moderator Using a smartphone for shopping does not represent a consumer action on an e-commerce site, but rather a distinct tool a consumer

employs during their journey through the online purchase funnel. As such, shopping on a smartphone could influence various behaviors and intentions, and affect the relationships between the antecedents and the resulting shopping behaviors including cart use (Natarajan et al., 2018; Wang et al., 2015), exerting a moderating role. One pioneering work demonstrates that the type of mobile device used significantly affects perceived enjoyment, and moderates the effect of perceived usefulness and enjoyment on the intention to use mobile shopping applications, with the effects being stronger for larger devices (Natarajan et al., 2018). Research also shows that mobile devices affect the types of products purchased. They are best suited for habit-based purchases (Kaatz et al., 2019), and are not the best channel for new products (Wang et al., 2015). Taken together, this supports the notion that the device type used for shopping could affect the customer's path through the purchase funnel.

Consistent with research that shows mobile devices are used early in the purchase funnel (De Haan et al., 2018), we expect that smartphone usage will act as a moderator in the cart use stage of the funnel, thus affecting the impact of predictors on cart use, but will play a lesser or no role in the cart abandonment stage, which takes place later in the funnel. Thus, we propose the moderating effects of a smartphone on cart use, but not on cart abandonment.

Overall, a smartphone makes it easier for consumers to be productive early in the shopping process (Bhatnagar & Papatla, 2019). In particular, it is convenient to use a smartphone to view products and deals by clicking on different product pages or visiting clearance pages. Returning to an existing cart and recontinuing the shopping process is also convenient, which may further boost consumer cart use. Hence, we expect that smartphone shopping strengthens the positive effect of the number of product pages seen, having visited the clearance page, and having an existing cart on the extent of one's cart use.

In contrast to activities such as viewing basic product information or clearance pages or returning to an existing cart, which can all be easily performed on a smartphone, reading customers reviews is associated with the need to be more productive in order to move further down the purchase funnel and approach making a purchase decision. Even though smartphones often make it easier to view initial product-related information, they are inconvenient to complete a purchase because of their physical size (Bhatnagar & Papatla, 2019). In addition, mobile shopping benefits most from one-click journeys and mobile users' purchase decisions are mainly driven by affective and behavioral aspects rather than extended information search (Kaatz et al., 2019). An involved research process which focuses on customer-provided information, such as reading customer reviews, typically occurs further in the purchase funnel, and it is more difficult to conduct on a smartphone. As such, we suggest that shopping on a

smartphone (vs. other devices) will dampen the positive impact of reading customer reviews on cart use.

Seeing sold-out items on a smartphone also limits its ease of use, especially when consumers search for products they are familiar with or have habitually purchased but find that those items are out of stock. Recall that smartphones are suitable for habit-based purchases that do not require an extended information search (Kaatz et al., 2019) and are tools for reinforcing existing behaviors rather than learning new product information (Wang et al., 2015). Since a sold-out item of interest requires the consumer to conduct a more extensive search to locate an acceptable substitute (Anupindi et al., 1998), we propose that shopping on a smartphone (versus other devices) will also dampen the positive impact of seeing sold-out items on one's cart use. In sum, we propose the following moderating relationships:

H7 Shopping on a smartphone (vs. other devices):

- a) strengthens the relationship of: starting the session with an existing cart, having visited a clearance page, and the number of products viewed on online shopping cart use, and
- b) attenuates the relationship of the number of product reviews seen and of the sold-out items seen on online shopping cart use.

Next, we provide an overview of the method for testing the model with field data.

Method

We used field data, specifically consumer shopping clickstream data, from a large European multinational retailer specializing in sportswear, clothing, footwear and home products. The company has over 500 stores globally. The initial number of session observations was approximately one million, spanning sessions from across the world in the summer of 2018. However, many of the shoppers responsible for these shopping sessions did not have unique IDs, making it impossible to track them over multiple sessions. To ensure data quality before modelling, we removed these customers from further analysis, as our method of analysis based on a panel data structure requires us to attribute sessions to a specific customer. We also removed outliers using the 3 standard deviations from the mean method. This resulted in the sample of 179,473 unique customers with the number of shopping sessions ranging between 1 and 20 per customer. Device switching across sessions did not occur frequently in the data; of customers who used a smartphone in a given session, only 2% of them switched to an alternative device in a later session and 4% switched to a smartphone from one session to the other.

Measurement

Independent variables As a measure of the purchase-oriented goal behavior of returning to an existing cart, we use a dummy variable indicating whether the consumer started out the session with an existing shopping cart (1) or not (0). For the goal-oriented purchase motivation based on seeing sold-out products, we use a variable indicating the number of sold-out items encountered during the specific shopping session. A dummy variable is used to measure whether a consumer visited the clearance page during the specific shopping session (1) or not (0) as an expression of economic control motivation. A dummy variable is also used to measure whether a customer removed any items from the cart during the shopping session (1) or not (0) as an expression of organizational motivation. We use a dummy variable rather than a count of products removed, because the count is highly dependent on the number of items that are in the cart in the first place. For information search, we use the number of product pages visited as a measure of the retailer-provided information search and the number of product reviews seen as a measure of the consumer-provided search. Smartphone-based shopping, also referred to as device type, as an indicator of convenience motivation, is measured as a smartphone (1) or other devices (0) based on the device used during the shopping session.

Dependent variables The dependent variable *cart use* is measured with the number of items the customer added to their cart during the tracked session. Please note that this number does not include items that could have potentially already been in the customer's cart from a previous session. Since the number of previously added cart items is driven by past clickstream behaviors, not the behaviors tracked during the current shopping session, it would be inappropriate to estimate the effect of current clickstream behaviors on such a measure, due to the reverse temporal sequence. The dependent variable *online shopping cart abandonment* is measured with whether the cart was abandoned (i.e., left without purchasing any items) at the end of the tracked session (1) versus whether a purchase of any items was completed (0). Means, standard deviations and correlations for all variables are shown in Tables 2 and 3.

Accounting for endogeneity concerns

Device type used can be seen as an endogenous variable. Endogeneity in marketing models can lead to biased coefficient estimates (Germann et al., 2015; Rutz & Watson, 2019). Because consumers were not randomly assigned to the treatment (device type) but self-selected the treatment, users of different devices could vary systematically across the different

Table 2 Variables and descriptive statistics

Variables	Variable description	Mean	SD	Min	Max
Cart abandonment	If a customer abandoned the cart without purchase (1) or completed purchase (0) during the tracked session	0.42	0.49	0	1
Cart use	Number of items a customer added to their online shopping cart during the tracked session	3.188	0.563	0	102
Existing cart	If a customer had a product in their cart from a previous session (1) or not (0) at the start of the tracked session	0.289	0.453	0	1
Sold-out items	Number of times a sold-out item was seen by the customer during the tracked session	0.501	1.266	0	42
Clearance page	If a customer visited the clearance section of site (1) or not (0) during the tracked session	0.269	0.443	0	1
Cart removal	If a customer removed an item from the cart (1) or not (0) during the tracked session	0.177	0.381	0	1
Products seen	Number of products viewed during the tracked session	2.478	0.489	0	49
Product reviews	Number of product reviews accessed during the tracked session	0.150	0.794	0	34
Device type	If a smartphone device was used (1) or not (0) during the tracked session	0.375	0.484	0	1

Note: N = 179,473 customers

device type groups. To account for this potential self-selection bias (Gamefeld et al., 2013), we employ propensity score matching (PSM) and create an artificial control group. First, in a binary logistic regression we calculate each customer's propensity to use a particular device (smartphone vs. other devices) to enter a shopping session (see Table 4, panel B). Second, the matching procedure links each customer in the treatment condition with a statistical twin from the control group who did not enter a session using a particular device but has statistically the same propensity to use this device. For every customer who used smartphone, we find a match in the group who did not. Unmatched customers are removed. Outcomes of the matched sample are then compared. The matched sample (n = 78,232) is then used in further analysis. Table 4 provides additional details on the PSM analysis.

Following Mallapragada et al. (2016), we further account for endogeneity by adding a control variable measuring active

time spent in session, which takes into consideration only the active time spent on the website and disregards any idleness or inactivity. One limitation of De Haan et al. (2018) was the inability to include time of the day as control variable, as this factor can influence cart use and abandonment. Thus, we also control for time of the day. Time of day also serves as a proxy for unobserved variables, such as if the customer is at work or at home. Last, in the cart abandonment model, we also control for cart value.

Modeling online shopping cart use

Since the consumer response (i.e., cart use and/or abandonment) is observed at repeated times, as in longitudinal studies, the response at one session may be positively correlated with the response of another session. One can tie the two sessions together by assuming that the random effects are jointly normal and correlated. We model cart use using a

Table 3 Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Cart abandonment	1								
(2) Cart use	0.301***	1							
(3) Existing cart	-0.019***	0.015***	1						
(4) Sold-out items	0.063***	0.223***	-0.025***	1					
(5) Clearance page	-0.035***	0.069***	0.023***	-0.036***	1				
(6) Cart removal	0.091***	0.217***	0.123***	0.203***	0.135***	1			
(7) Products seen	0.082***	0.370***	-0.040***	0.555***	-0.077***	0.359***	1		
(8) Product reviews	0.036***	0.104***	-0.008***	0.207***	-0.021***	0.161***	0.375***	1	
(9) Device type	-0.054***	-0.008***	0.013***	-0.169***	-0.075***	-0.335***	-0.330***	-0.142***	1

*** p < 0.001 (two-sided)

Note: N = 179,473 customers

Table 4 Endogeneity testing**A. Results of matching procedure (n=179,473 customers)**

Sample Sizes:	Control	Treated
All	101,241	78,232
Matched	78,232	78,232
Unmatched	23,009	0
Discarded	0	0

B: Propensity score matching results: determinants of device type propensity

Exogenous Variable	Coefficients
Constant	0.051***
Existing cart	1.374***
Sold-out items	0.197***
Clearance page	2.315***
Cart removal	0.809***
Products seen	2.324***
Products reviews	0.866***

C: Propensity score matching results: means before and after matching

Mean Before Matching			Exogenous variable: Customer Behavior Before Treatment	Means After Matching			PRB ^a
Control Group (n=101,241)	Treatment Group (n=78,232)	Mean comparison ρ -value		Control Group (n=78,232)	Treatment Group (n=78,232)	Mean comparison ρ -value	
0.289	0.234	0.018	Existing cart	0.287	0.234	0.010	94%
0.501	0.532	0.112	Sold-out item	0.503	0.532	0.021	93%
0.269	0.213	0.132	Clearance page	0.271	0.213	0.010	97%
0.177	0.168	0.161	Cart removal	0.175	0.168	0.021	93%
2.478	2.216	0.027	Products seen	2.472	2.216	0.022	94%
0.150	0.148	0.111	Products review	0.143	0.148	0.021	96%
Average PRB							94.5%

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-sided)

^a In line with Garnefeld et al. (2013), we calculated the PRB (percentage reduction in bias) using a formula from Rosenbaum and Rubin (1983)

random effects for zero-inflated Poisson (ZIP) regression model because our dependent variable describes the frequency of cart use occurrence, which is discrete and non-negative but skewed, with a presence of a large number of zeros (Azoulay et al., 2010). This characteristic has made the Poisson model one of the core models to leverage in a situation when distributions of outcomes are highly skewed and zero-inflated. Lambert (1992) proposed an approach to model zero-inflation in count data in what is referred to as the ZIP model. The probability of being in a group can be estimated by information from covariates with a logit link. Specifically, we estimate the cart use (i.e., number of items in the cart) model by:

$$\text{Log } E(y_{it}|u_t) = \alpha + X'_{it}\beta + u_t \quad (1)$$

Where y_{it} is the observation for customer i in session t , and u_t is the random effect for session t . X'_{it} is the regressor matrix and β is vector of parameters.

Thus, the two distributions are:

$$y \sim \text{Pois}(\lambda)$$

and

$$u \sim N(0, \sigma^2)$$

The ZIP is asymmetric, more suitable for sparse event counts (or infrequent outcomes or counts with small means), usually positively skewed, used for positive integers and the distribution loads more extremely at zero. As the mean of the event count increases and the probability of zeros decreases, the distribution increasingly approaches normal distribution, and the ordinary least square regression may become suitable (Atkins & Gallop, 2007). Finally, the Poisson distribution is a one-parameter model. Its conditional mean is assumed to equal the conditional variance. This is a quite constrictive assumption. Count data in reality are frequently characterized

by over-dispersion (the variance exceeds the mean) and excessive zeros. Thus, a standard Poisson model is often insufficient for real count data because variability and zeros exceed what the Poisson model can predict.

Consistent with past research (Danaher et al., 2006; Sismeiro & Bucklin, 2004), we use the log-transformation of cart use (i.e., number of items added into cart), number of sold-out items, number of products seen, number of product reviews seen, and the control variables cart value and active seconds spent in session. This approach accommodates the right-skewed nature of the variables.

Modeling online shopping cart abandonment

As cart abandonment can only occur after a customer places at least one item in their cart, it is crucial to jointly investigate cart abandonment and cart use. Thus, we model cart abandonment using a random effects for a conditional logistic (CLGT) regression model. This modeling approach recognizes that the effects may be correlated and that there exists a sequential order of the events: first, the customer adds items to the cart (i.e., cart use), and then, the customer chooses to either abandon the cart or purchase the item(s) (i.e., cart abandonment).

Let Z_{it} stand for the independent variables - characteristics (i.e., cart use, existing cart, number of sold-out items, visiting clearance page, cart removal, number of products seen, number of product reviews seen, device type, and control variables) of consumer i in session t with the corresponding parameter vectors denoted by α . Let P_{it} be the probability that individual i in session t abandons the cart. The abandonment probability in the CLGT model is:

$$P_{it} = \exp(Z_{it}\alpha) / (1 + \exp(Z_{it}\alpha)) \quad (2)$$

We again accommodate the right-skewed nature of the variables by log-transforming cart use, number of sold-out items, number of products seen, number of product reviews seen, and control variables cart value and active seconds spent in session. We estimate both the random effects for zero-inflated Poisson and the CLGT models using STATA software (Bell et al., 2011).¹

¹ CMP analysis was conducted as a robustness check. The CMP model fit was substantially worse ($BIC = 20,333$; $\log\text{-likelihood} = -9383$) than the fit of the ZIP and CLGT models. While a majority of the coefficients was consistent, there were some changes. For cart use, a previously significant interaction between existing cart and device type became non-significant, while the main effect of clearance page became negative. For cart abandonment, visiting clearance page, cart removal, and number of products seen had a significant and negative effect. A possible reason for the changes is simultaneous, rather than sequential estimation. We argue that based on cart use being a condition that has to occur before cart can be abandoned, sequential modeling is more appropriate. Heteroskedasticity could also render CMP results to be inconsistent.

Results

Main effects on online shopping cart use

We begin with a discussion of the main effects on cart use. The results of the zero-inflated Poisson model for the impact on cart use are displayed in Table 5 and are discussed next. Model 1 includes only the control variables. In Model 2, we add the investigated direct effect variables. Model 3 includes all of the investigated variables including their interactions with device type (smartphone vs. other devices). Our analysis is guided by Yli-Renko and Janakiraman (2008). We first mean centered all variables and their interaction terms by subtracting the mean of each variable from all observations of that variable in the dataset such that the variable's new mean was zero (Aiken & West, 1991). Variance inflation factors were all below 2.5, indicating that multi-collinearity is not an issue. The comparison of all three models shows Model 3 as the best fit with the lowest BIC and log-likelihood values.

All main effects were significant, with all hypotheses, except H4a, supported. In support of H1a, starting the online shopping session with an existing cart is positively associated with additional cart use (.194, $p < .01$), with higher cart use when consumers already have a product in their cart on the first page of the session. The number of sold-out items encountered during the shopping session is also positively associated with cart use (.079, $p < .01$). Specifically, cart use is higher when consumers see a larger number of sold-out items, supporting H2. In addition, and in support of H3a, visiting clearance pages is positively associated with cart use (.021, $p < .01$).

Results indicate that the number of products seen is negatively associated with cart use (-.459, $p < .01$), which does not support H4a which predicted a positive relationship. Consumers who view a high (vs. low) number of products during their shopping session exhibit a lower cart use. Supporting H5a, the number of product reviews accessed is positively associated with cart use (.026, $p < .01$), such that higher cart use occurs when consumers access more product reviews. Last, the results demonstrate higher cart use when consumers shop on a smartphone (vs. other devices), supporting H6a (1.186, $p < .01$). Table 5 (Cart use: Model 3 column) presents these results along with the results for the online shopping cart abandonment model.

Main effects on online shopping cart abandonment

Next, we discuss the main effects on online shopping cart abandonment. Model 1 includes only the control variables. In Model 2, we add the examined direct effects variables, while Model 3 also controls for their possible interactions with device type (smartphone vs. other devices). We first centered the variables of the interaction terms (Aiken & West, 1991).

Table 5 Random effect models for zero-inflated poisson regression model results for # products in cart and random effects models for conditional logit model results for online shopping cart abandonment (standardized regression coefficients)

H	Variable	DV: Cart use			DV: Cart abandonment		
		Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Log(Cart use)						
	Log(Cart use) X Device type						
H1 a, b	Existing cart		0.196***(0.022)	0.194***(0.005)		-0.372*** (0.025)	-0.376*** (0.026) -0.015 (0.199) -0.634***(0.112)
H2 RQ1	Existing cart X Device type log(Sold-out items)		0.083***(0.001)	0.043***(0.174) 0.079***(0.009)		0.085(0.055)	-2.399(1.605) 0.085(0.056)
H3 a, b	Log(Sold-out items) X Device type Clearance page		0.029***(0.023)	0.693***(0.170) 0.021***(0.022)		0.422***(0.118)	-0.821(0.224) 0.409***(0.119)
RQ2	Clearance page X Device type Cart removal	N/A	N/A	0.190***(0.179) N/A		0.371***(0.106)	-1.294***(1.247) 0.370***(0.106) 1.193(1.781)
H4 a, b	Cart removal X Device type log(Products seen)	N/A	-0.453***(0.020)	N/A -0.459***(0.021)		0.672***(0.095)	0.685***(0.096)
H5 a, b	log(Products seen) X Device type log(Product reviews)		0.027***(0.013)	0.629***(0.134) 0.026***(0.013)		0.117***(0.072)	-0.354(0.836) 0.115***(0.072)
H6 a, b	log(Product reviews) X Device type Device type		0.069***(0.082)	-0.307***(0.129) 1.186***(0.005)		-1.184(0.537)	0.655(0.35) -2.292(1.074)
	Constant	-15.16***(0.029)	-6.916***(0.246)	-6.913***(0.247)	-9.52***(0.085)	-4.043***(1.119)	-4.100***(1.122)
	Control variable 1: log(Active sec spent)	1.144***(0.002)	0.487***(0.019)	0.486***(0.019)	0.629***(0.006)	0.391***(0.089)	0.396***(0.089)
	Control variable 2: Time variable (Dummies)	Included	Included	Included	Included	Included	Included
	Control variable 3: log(Cart value)	N/A	N/A	N/A	0.059*** (0.006)	-0.364*** (0.067)	-0.366*** (0.068)
	<i>BIC</i>	753,520.6	27,017.46	17,027.85	135,443.3	8981.414	3030.614
	<i>Log-likelihood</i>	-376,740.6	-9471.87	-8456.586	-67,698.01	-2743.623	-1440.757

p < .05, *p < .01 (two-sided); N = 78,232

Model comparisons show Model 3 has the best fit with lowest log-likelihood and BIC values.

Depicted in Table 5, and in support of H1b, having an existing cart has a negative relationship with cart abandonment ($-0.634, p < .01$). Consumers who started the shopping session with an existing cart are less likely to abandon their cart than other consumers. Recall that due to conflicting theoretical reasoning, we posed an exploratory research question 1 (RQ1) in lieu of a formal hypothesis for the role of the number of sold-out items seen on cart abandonment. This relationship is non-significant ($0.085, p > .05$). It is possible that the conceptually competing positive and negative effects of encountering a sold-out item cancelled each other out, leading to a non-significant overall effect. In support of H3b, the results indicate that visiting the clearance page is positively associated with cart abandonment ($.409, p < .01$). In addition, in response to research question 2 (RQ2), the results show that removing item(s) from the cart is positively associated with cart abandonment ($.370, p < .05$).

Supporting H5a and H5b, we find a positive association between both the number of products seen (H5a: $.685, p < .01$) and cart abandonment as well as between the number of product reviews accessed (H5b: $.115, p < .05$) and cart abandonment. Thus, customers who conduct a more extensive search of retailer-provided or consumer-provided information have a higher likelihood of cart abandonment. H6b hypothesized a positive association between smartphone-based shopping compared to other devices and cart abandonment. Interestingly, the results show shopping on a smartphone does not have a significant main effect on cart abandonment ($-2.292, p > .10$). Thus, H6b is not supported.

While not formally hypothesized, the model also controls for the effect of cart use on abandonment, as typically, consumers must use the cart in order to abandon it. In addition, more extensive cart use may indicate a higher purchase commitment. The results show that the more the customer uses the cart, the lower the subsequent cart abandonment ($-.376, p < .01$). These results are shown in the last column (Cart abandonment: Model 3) of Table 5. We also tested an alternative model in which cart use was not included as a predictor of cart abandonment. The direction and significance of the predicted relationships did not change; however, the fit of the model substantially worsened as indicated by an increase in both BIC and log-likelihood values. As such, the model reported here controls for the effect of cart use.

Moderating role of smartphone-based shopping on online shopping cart use

When evaluating the moderating role of smartphone-based shopping on cart use, we first discuss those variables for which smartphone shopping strengthens the relationship, followed by those for which it dampens it. H7a predicted that

shopping on a smartphone versus other devices strengthens the positive relationship between having an existing cart, visiting a clearance page, and number of products viewed and one's cart use. The interaction of device type and existing cart on cart use is positive and significant ($.043, p < .01$). As seen in Fig. 2a, having an existing cart has a more positive relationship with cart use when shopping on a smartphone (vs. other devices). The interaction of device type and visiting clearance page is also positive and significant ($.190, p < .01$). Figure 2b shows that visiting clearance page is more positively associated with cart use when shopping on a smartphone (vs. other devices). The results further indicate that number of products seen and device type positively interact to impact cart use ($.629, p < .01$). In response to an increased number of products seen, cart use increases to a greater degree for a smartphone (vs. other devices) (see Fig. 2c). These results jointly support H7a.

In contrast to H7a, H7b proposed that shopping on a smartphone (vs. other devices) weakens the positive relationship between both sold-out items seen and number of product reviews seen and cart use. The results instead suggest a positive interaction of device type and number of sold-out items on cart use ($.693, p < .01$). Figure 2d shows that cart use when seeing sold-out items is greater when shopping on a smartphone (vs. other devices). In addition, and as expected, the number of product reviews seen and device type exert a negative interaction ($-.307, p < .01$) on cart use. As seen in Fig. 2e, cart use when seeing an increased number of customer reviews is lower for consumers shopping on a smartphone (vs. other devices). These findings support H7b, for product reviews, but not for sold-out items. Finally, recall that moderating relationships on cart abandonment were not expected or formally proposed, but they were controlled for in the model. Only the interaction between device type and having visited a clearance page is significant ($-1.294, p < .001$), providing evidence for a less important role of device type on cart abandonment vs. cart use.

Discussion

Online shopping cart use and the moderating role of smartphone-based shopping

Overall, our findings show that a variety of behaviors explicated in UGT affect consumers' cart use during a specific online shopping session. For example, starting a session with an existing cart, seeing sold-out items, visiting a clearance page, and reading customer reviews positively affect cart use. On the one hand, returning to an existing cart and being exposed to sold-out items are both associated with a purchase goal orientation. On the other hand, visiting a clearance page is an expression of economic control motivation, while

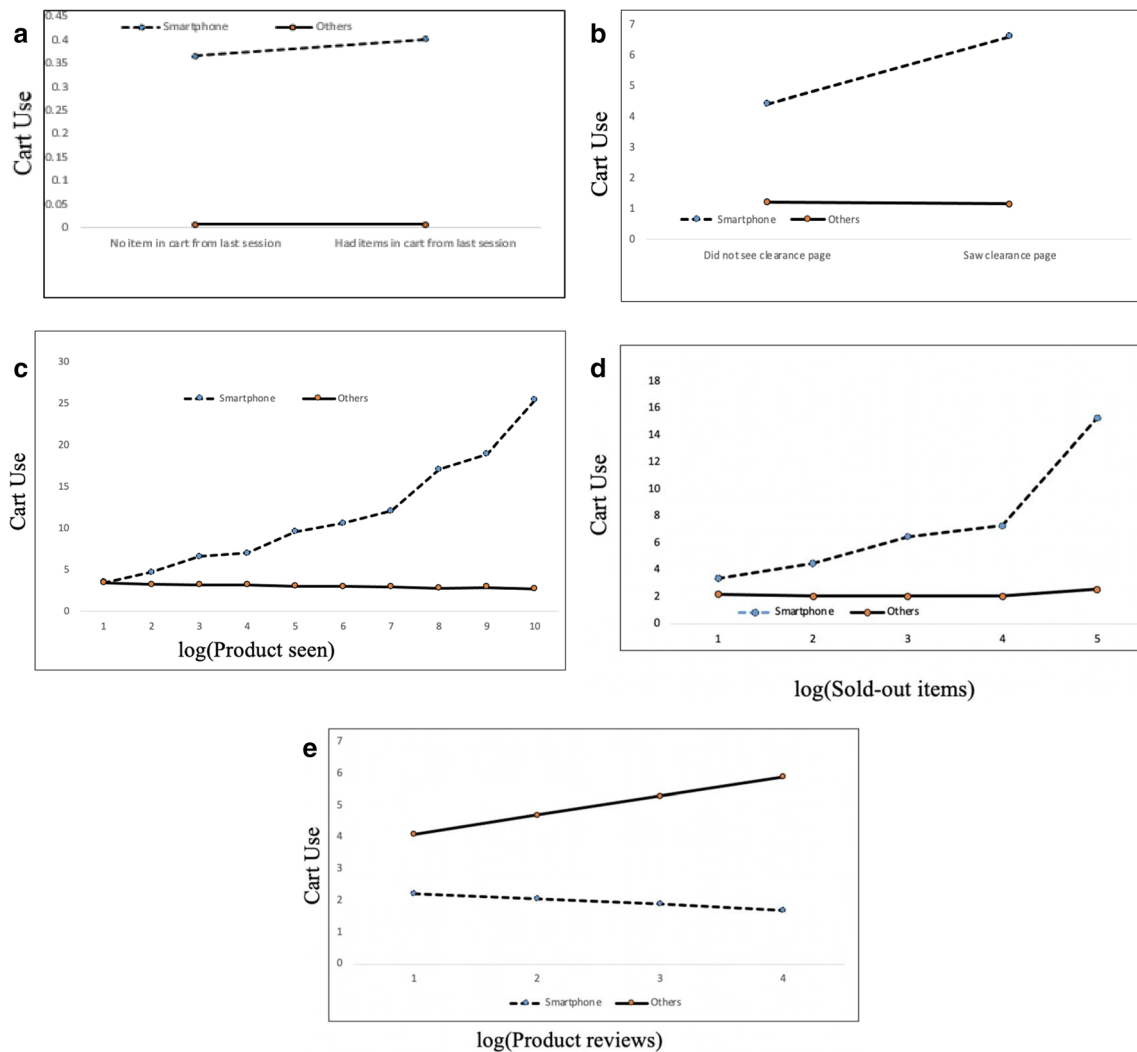


Fig. 2 **a** The effect of existing cart x device type on cart use. Cart use when starting a session with (vs. without) an existing cart is greater for consumers using a smartphone than other devices. **b** The effect of clearance page x device type on cart use. Cart use in response to visiting the clearance page is greater for consumers using a smartphone than other devices. **c** The effect of log (products seen) x device type on cart use. Cart use in response to an increased number of products seen is

greater for consumers using a smartphone than other devices. **d** The effect of log (sold-out items) x device type on cart use. Cart use in response to seeing sold-out items is greater for consumers using a smartphone than other devices. **e** The effect of log (product reviews) x device type on cart use. Cart use in response to seeing an increased number of customer reviews is lower for consumers using a smartphone than other devices.

consumer-provided information search signals higher involvement and is associated with a late state of the purchase funnel. In contrast, the findings indicate that viewing product pages is *not* associated with greater cart use. We speculate that browsing a large number of products may be more strongly associated with an entertainment motivation, a UGT shopping motive considered in previous research (Close & Kukar-Kinney, 2010). Since the goal of the entertainment motive is experiencing fun, placing items in a cart is not necessarily required.

Interestingly, the relationships between specific behaviors and cart use change when a smartphone is used for shopping. As seen in Fig. 2c, the proposed positive relationship between the number of product pages seen and cart use is observed for

smartphone-based shopping, but this relationship is flat or even negative for other devices. This finding can be explained by the perceived usefulness (Natarajan et al., 2018) of smartphones in early stages of the purchase funnel. This reasoning is further supported by the positive relationship between a smartphone use and cart use. Similar to the number of products seen, smartphone use *enhances* the positive relationship between an existing cart, visiting clearance pages, and seeing sold-out items on the one hand and cart use on the other hand. Engaging in these activities may be more convenient and triggers impulse cart use on a smartphone, boosting the number of items placed in the cart. Smartphones may also be superior for habitual purchases not requiring extensive search (Kaatz et al., 2019; Wang et al.,

2015). In contrast, smartphone use *decreases* the positive relationship between the product reviews seen and cart use. Reading many customer reviews may indicate an extensive search, which may be less productive on a smartphone.

Online shopping cart abandonment

Our findings show that in some cases, the behaviors that are associated with greater cart use, such as starting the shopping session with an existing cart, are also negatively associated with cart abandonment. Here, incenting these types of cart behaviors will simultaneously help retailers lower the rate of abandonment. In contrast, in other cases, the behaviors associated with greater cart use, such as seeing sold-out items, do not significantly affect cart abandonment.

In addition, some behaviors increase both cart use and cart abandonment. For instance, visiting a clearance section is positively related with both cart use and abandonment, likely because putting an item in a cart and cart abandonment occur at different stages of the purchase process (Batra & Keller, 2016), and because a consumer may decide not to purchase due to conflicting value cues (Miyazaki et al., 2005). Similarly, both retailer-provided information search (i.e., the number of products seen) and consumer-provided information search (i.e., the number of customer reviews accessed) are positively associated with cart abandonment. We propose that this may be due to information overload and choice ambiguity leading to hesitation (Huang et al., 2018) and choice avoidance (Maslowska et al., 2017; Scheibehenne et al., 2010). This is akin to research which demonstrates that assortment overload makes it difficult to discern which option is best, leading to a deferral (abandonment) of making a choice (Jessup et al., 2009).

Interestingly, seeing sold-out items and using a smartphone are not significantly related with cart abandonment. A possible explanation is that both of these behaviors are linked to early browsing stages of the purchase funnel (De Haan et al., 2018). Further, while seeing sold-out items may affect what or how many items consumers place into the cart, once the consumers proceed to the purchase decision stage, the focus shifts from out-of-stock items to the evaluation of items in the cart. Also, the inconvenience of purchasing on a smartphone may be less pronounced for habitual purchases, resulting in no relationship of smartphone use and cart abandonment above and beyond other website shopping behaviors and control variables.

Theoretical contributions and implications for marketing

This research makes several significant theoretical and managerial contributions. Drawing from UGT, UTAUT, and the concept of the purchase funnel, this is the first research to

theoretically and empirically examine both cart use and cart abandonment using clickstream data and to suggest conceptual links between consumer online shopping motivations and behavioral variables. Identification of relevant online behaviors not only makes a theoretical contribution to the online shopping cart literature, but also allows for more meaningful managerial contributions as online retailers can track customer browsing behavior, but not their shopping motivations. This contribution extends research that has separately investigated the motivations for online cart use (Close et al., 2012) and perceptual determinants of cart abandonment (Huang et al., 2018). By doing so, we uncover complexities associated with behaviors that have a differential relationship with cart use and cart abandonment. For example, *we empirically uncover a differential relationship of retailer-provided and consumer-provided information search with cart use and abandonment*. To encourage consumers to place more items in their cart, online retailers should make consumer reviews more visible. However, the results also suggest that exposure to too much information may create information overload that fosters choice deferral and consequently cart abandonment. Since reading a large number of customer reviews can result in information overload (Maslowska et al., 2017; Scheibehenne et al., 2010), retailers could simplify the consumer research process by providing easily navigable and searchable reviews.

Another contribution is the managerial implication based on the finding that *returning to an existing cart is positively associated with subsequent cart use and negatively with cart abandonment*. In particular, retailers should remind consumers of items left in the existing carts and encourage them to return to the cart. However, immediate retargeting should be avoided as it can negatively affect purchase completion (Li et al., 2021). Retailers could also incent customers to return to an existing cart by offering purchase incentives, such as free shipping.

In addition, managerial implications also stem from the results showing that *visiting a clearance page has a positive association with both cart use and cart abandonment*. To increase purchase behavior at the purchase decision stage of the purchase funnel, retailers should consider displaying messages that would increase purchase urgency and item desirability, such as time or quantity restrictions (Inman et al., 1997), and emphasizing other positive cues, such as the number of deals already sold (Kukar-Kinney & Xia, 2017). Another managerial implication is to use retargeting (Johnson et al., 2017; Sahni et al., 2019) as a way to remind customers of the clearance item(s) previously placed into the cart.

Another contribution is based on the findings which suggest that *consumers tend to use smartphones earlier in the purchase funnel*, when they are most convenient, especially while initially browsing products and clearance pages, *and to return to an existing cart*, which facilitates their further cart

use. However, when more extensive search is needed, smartphones are less convenient. To counter the latter, retailers should push additional information about the products searched through apps to maintain and increase the consumer interest in those products. To ease a consumer's search burden, they could also push information about complementary products and provide consumers with a short list of top suggestions to prevent information overload. They could also link consumer information from their smartphones to other devices, making it easier for consumers to continue their path to purchase on larger devices.

The results also provide *direction for how to respond to consumers who remove items from their cart to reduce cart abandonment*. Retailers could decrease purchase uncertainty and perceived financial risk of purchase by providing a generous return policy and offering free shipping, free return shipping and product warranties. Also, retailers could provide product substitution suggestions for the products removed from the cart.

Finally, the interaction between device type and having visited the clearance page on cart abandonment suggests that visiting (vs. not visiting) clearance pages on a smartphone may lead to lower cart abandonment relative to doing so on other devices, possibly because a clearance section makes it easier to conduct a simple search with a single focus (i.e., low price), suitable for smartphone use. An implication is that clearance items or deep promotions should be pushed through to phones via smartphone apps to encourage clearance page visits and purchases.

Limitations and future research

The contributions of this research need to be interpreted in light of its limitations. While clickstream data allow us to track consumers' actual online shopping behaviors, providing an advantage over most previous research using self-reported survey data, the nature of this type of data also represents important considerations. Foremost, clickstream data are limited to consumer website behaviors, and therefore, we are unable to measure and control for variables such as search engine advertising, email marketing, valence of reviews, as well as consumer characteristics. While past research suggests that consumers' online shopping behaviors are an external indicator of their underlying motivations, the correspondence between these motivations and online behaviors is imperfect, and the behaviors we captured may be narrower in scope than the proposed underlying motivation. For example, based on previous research, we suggest that smartphones are used primarily because of their convenience. However, online shopping convenience is broader than solely using a mobile device. Similarly, an economic control motivation could also be indicated by buying after receiving a price discount, in addition to visiting the clearance page. Therefore, in addition to factors

such as email marketing, future research should directly capture underlying motivations by matching clickstream data with self-reported shopping motivations. It would be also worthwhile to investigate consumers' individual differences, such as impulsive tendencies, as possible drivers of cart use and abandonment.

Other avenues to extend this work are in consideration of different types of analyses. For instance, scholars could examine theory-supported curvilinear relationships and examine if and how the nature of the relationships differs at different levels of the variables. As another avenue, more explicit modeling of dynamic effects across different sessions can add insights. For example, scholars can examine the time elapsed since the previous session, and whether the previous session resulted in a purchase or abandonment, if that data are available.

Also, this research differentiates between item removal (i.e., removing a specific item in a cart) and cart abandonment (i.e., abandoning the entire cart). Examining drivers of either single item or multiple item removal would also be an interesting research venue. In addition, the shopping behaviors captured in the present work are specific to one retailer. Finally, the study did not account for product presentation type which can make a difference in consumer perception (Roggeveen et al., 2015); scholars may continue this research and test if products presented in a dynamic (vs. static) fashion are more likely to be placed in a cart or subsequently abandoned. Therefore, future research in cart use and abandonment is encouraged.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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