The path-to-purchase is paved with digital opportunities: An inventory of shopper-oriented retail technologies

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The path-to-purchase is paved with digital opportunities:

An inventory of innovative retail technologies

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The path-to-purchase is paved with digital opportunities: An inventory of innovative retail technologies

Abstract

This study focuses on innovative ways to digitally instrument the servicescape in bricks-and-mortar retailing. In the present digital era, technological developments allow for augmenting the shopping experience and capturing moments-of-truth along the shopper's path-to-purchase. This article provides an encompassing inventory of cutting-edge retail technologies resulting from a systematic screening of three secondary data sources, over 2008-2014: (1) the academic marketing literature, (2) retailing related scientific ICT publications, and (3) related business practices (e.g., publications from retail labs and R&D departments). An affinity diagram approach allows for clustering the retail technologies from an HCI perspective and categorizing the technologies in terms of the type of customer value that they offer, and the stage in the path-to-purchase they mainly pertain to. This in-depth analysis results in a comprehensive inventory of innovative retail technologies that allows for verifying the suitability of new technologies for targeted in-store shopper marketing objectives (cf. www.retail-tech.org to consult the resulting online repository, using faceted search). The results of the analyses indicate that the majority of the inventoried technologies provide utilitarian value, whereas few offer hedonic benefits. Moreover, at present the earlier stages of the path-to-purchase appear to be the most instrumented. The article concludes with a research agenda.

Keywords

Retail technology, path-to-purchase, customer value, smart retailing, shopper marketing

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1. Introduction

While online retail sales still represent a minority of the total sales across all channels, their growth rates are exceedingly outperforming those of bricks-and-mortar stores, year after year (U.S. Census Bureau, 2016). The continuing and explosive rise of e-commerce of about 20 percent on average each year sharply contrasts with the rather stable situation in traditional retailing (Deloitte, 2011). As a result, many researchers devote their attention to online shopping which is hot and 'on', as if bricks-and-mortar shopping is 'off' and on its demise. However, despite the many merits of electronic and mobile commerce, it is unlikely that traditional retail settings will disappear; rather both channels will complement each other in satisfying shopper needs (Zhang et al., 2010). Nevertheless, a proper strategic response is necessary in order for offline retailing to sustain its role.

One of the main drivers of these changes in multichannel shopping behavior, and consequently also in optimizing shopper marketing actions, is technology (Shankar et al., 2011). Technology has always played a role as the primary enabler of change in the evolution of retailing (Hopping, 2000). Today, as bricks-and-mortar retailers are preparing for battle with online merchants, there are several areas they can draw upon in order to gain a competitive advantage (IBM, 2012). This article sheds light on the fairly underexplored topic of the promising role of technology for traditional retailers to survive in today's fierce multichannel competition. Indeed, as Bodhani (2012, p. 46) suggests '[…] rather than diminishing the traditional shopping experience, techniques that have been the preserve of the online shop are to some extent now informing the new in-store retail technology'. In this vein, Pantano & Timmermans (2014) introduced the concept of 'smart retailing', referring to the use of technology in retail to improve the quality of shopping experiences. In this smart retailing scenario, technologies are considered as '[…] enablers of innovation and improvements in consumers' quality of life' (Pantano & Timmermans, 2014, p.103). Or how a digital infusion in physical retailing may serve well, switching the old-school retail stores from 'off' back to 'on'.

From barcodes, over in-store kiosks, ATMs, and self-scanning, to virtual fitting rooms, the technological possibilities for retailers to optimize their in-store experience offering are vast and continuously increasing. After providing an appropriate theoretical background for this study (cf. Section 2), this paper's first empirical aim is to compose a multi-disciplinary inventory of these kinds of advanced retail technologies, drawing from academic marketing and IT literature as well as from developments in the field (cf. Section 4), made available via web appendix A as well as via an easily accessible online repository of that data. The URL www.retail-tech.org allows for faceted search of the inventory.

However, as Pantano and Timmermans (2014, p. 101) note, 'the idea of smartness goes beyond the concept of application of new technologies'. Since technology in retailing is and should remain a means to an end rather than an end in se, the most important objective of this article is to add to this inventory in terms of when these technologies entail potential for augmenting the shopping experience and eventually also the retailer's bottom line. History has shown that trying to capitalize on technological trends without appropriate business model evolution is a pitfall for many businesses (Rayna & Striukova, 2016). Clearly, 'technology *can* play a role in enhancing the shopping experience' but 'consumers are not interested in technology for its own sake' (Burke, 2002, p. 426-427). This study contributes to elaborating on the conditions when it *will* enhance the offline shopping experience, by evaluating (1) at what stage of the customer's path-to-purchase the technology is likely to add value, and (2) what type of consumer value the technology foremost entails. Section 5 offers a summary of this exercise, guided by affinity diagram clustering methodology, and supported by inter-rater reliability evaluations. All this information is made available through an online repository offering *faceted* search, thus allowing for directed search for technologies that are suitable for a given context and set of expectations (cf. www.retail-tech.org). After conducting and discussing a deep analysis of the current situation in retail technologies (cf. Section 6), a research agenda is compiled with specific avenues for future research on shopper marketing and advanced technologies for smart retailing, at the intersection of both the marketing and the IT bodies of research, conclude this paper (cf. Section 7). As such, this paper serves as a starting point for smart retailing research.

2. Theoretical background

2.1 Fighting fire with fire: Offline retailing digitally trading-up

Bricks-and-mortar retailers face an erosion of their sales productivity as they struggle to redefine their role in a multichannel world. In order to avoid that consumers shift their purchases even more online, they do need to find a way to create a differentiating value proposition that exploits the physical store advantages in a more compelling way (IBM, 2012; Rapp et al., 2015; Pantano & Viassone, 2015).

Trying to make the difference in terms of price may no longer be the best idea. The current trend of retailers shifting their focus towards prices, especially in recent times of economic crisis, has led to a predominantly price-based competition, undermining the retailer's profitability and resulting in 'commoditization' of retail outlets (Corstjens & Corstjens, 1995; Rigby & Vishwanah, 2006). Moreover, online shops have an operational cost-advantage over traditional retailers (cf. cost savings on physical store space, frontline employees, stock management and so on). Furthermore, the Internet offers an unprecedented price transparency that only rarely identifies the offline player as being the cheapest. So, price competition is a battle that traditional retailers can hardly win against their online counterparts.

Another potentially relevant basis to differentiate physical service encounters from online shopping trips is the face-to-face interaction with friendly, knowledgeable sales people (cf. SERVQUAL – e.g., Parasuraman, Zeithaml, & Berry, 1988). However, with the advent of technology infusion in service encounters, retailers have moved from traditional interpersonal service encounters to non-interpersonal service encounters where consumers can often perform the service themselves through 'self-service technologies' (cf. Hilton et al., 2013; Meuter et al., 2000). As such, the ubiquity and sophistication of new information and self-service technologies have fundamentally altered and are continuing to alter the way in which retail organizations interact with their customers (Froehle & Roth, 2004; Pantano and Timmermans, 2014).

As a result, '[…] retailers increasingly realize the benefits of utilizing the store itself as a means of marketing, i.e., the concept of shopper marketing,' (Ligas & Chaudhuri, 2012: 2). Shankar et al. (2011) suggest two unique characteristics that physical retailers can still exploit in their quest of creating a competitive advantage over online channels by means of 'shopper marketing', namely in-store atmospherics on the one hand and in-store merchandising innovations on the other hand. First, as Eroglu et al. (2001) note, online retailing is deprived of certain sensory appeals, contributing to a higher perceived purchase risk (Lee and Tan, 2003). Second, regarding in-store merchandizing, Shankar et al. (2011) and Newell (2013) suggest 'technology utilization' as a promising weapon in face of the stiff competition from online players that allows offline retailers to ride the waves of the digital revolution that is currently shaking up the retailing landscape. After all, as Kukka et al. (2014, p. 29) note, 'people ever more blend their online and offline worlds into a single reality'. It is now up to the physical retailer to follow-up on this evolution by assuming its reinvented role in the smart cityscape, reaping the rewards of the convergence between the physical and virtual shopping environment (Kent et al., 2015).

2.2 The strategic role of advanced technologies in retailing

On an operational level, the use of technologies in retailing is obvious (Newell, 2013; Efendioglu, 2015). Finne and Sivonen (2008) confirm cost efficiency as a priority focus for retailers in implementing technologies. The current advances in technologies are however also able to enhance both consumers' shopping experience and retailers' performance as they enable business competitive advantages (Pantano, 2014; Pantano & Di Pietro, 2012; Zhu et al., 2013). Particularly advanced technologies, like virtual and augmented reality, RFID, biometric technology, and 3D scanning entail strategic potential as they provide retailers constantly with real-time feedback about customers, that can inspire better informed marketing strategies (Renko & Druzijanic, 2014; Pantano & Naccarato, 2010). The strategic importance of investing in such emerging smart retail technologies is outlined in annual reports of pioneering retailers (see, for example, MetroGroup, 2014a; Tesco PLC, 2014). Innovative retail technologies moreover also directly modify customer behaviour in the store by enhancing consumers' shopping experience and increasing satisfaction (Pantano & Naccarato, 2010; Bharadwaj, Walker, & Hofstede, 2009), and by improving the in-store service and increasing store appeal (Newsom, Collier, & Olsen, 2009; Liljiander et al., 2006). A wide array of previous studies has focused in particular on self-service technologies in this regard (cf. e.g., Weijters et al., 2007; Nilsson, 2007; Fisher et al., 2009).

Nevertheless, investments in retail technologies do not always provide the expected returns (Sethuraman & Parasuraman, 2005). Several studies illustrate how the current retailer strategies towards using advanced technologies at the point-of-sale do not capture their full potential in meeting and exceeding customer expectations (Pantano & Viassone, 2012). Varadarajan and colleagues (2010, p. 105) contend that '[…] a retailer with superior insights into the potential of a new interactive technology (relative to its competitors) and/or complementary resources may be able to effectively leverage the fullest potential of a generic technology, and thereby achieve a competitive advantage'. The present paper contributes to the generation of exactly those insights that may leverage advanced technologies for smart retailing to become the basis of a competitive advantage, by examining what kind of customer value they provide and at what stage of the shopper's path-to-purchase they tend to be most relevant.

2.3 Retail technology as a source of customer value

This study directly responds to Burke's (2002, p. 427) suggestion that '[…] it is not the technology per se but how it is used to create value for customers that will determine success'. So, to use technological innovations as the cornerstone of a successful business strategy, retailers are to leverage technology in function of specific types of customer value (Padgett & Mulvey, 2007). Customer value is a cornerstone in the marketing literature. One of the most generally accepted definitions of customer value is the one by Zeithaml (1988, p. 14): "the consumer's overall assessment of the utility of a product based on perception of what is received and what is given". In retailing, customer value tends to be considered as a multidimensional construct. An offering can save consumers time and money (i.e., the 'cost' side of the value equation), and/or it can provide consumers with benefits (i.e., 'added' value). Basically, two distinct albeit not per se mutually exclusive types of value are common in academic literature, namely functional versus hedonic value (cf. Babin, Darden, & Griffin, 1994), referring respectively to the utilitarian and experiential benefits that an offering provides (i.e., does it help the shopper to achieve his goal or is it pleasant?).

2.4 Retail technology along every stage in the path-to-purchase

Shankar et al. (2011, p. 29) define shopper marketing as 'the planning and execution of all marketing activities that influence a shopper along, and beyond, the entire path-to-purchase from the point at which the motivation to shop first emerges through to purchase, consumption, repurchase, and recommendation'. As such, shopper marketing targets the shopper while (s)he is in a shopping mode (i.e., in an active decision mode, ready to make a choice) by influencing triggers in the shopping cycle (Shankar et al., 2011). This paper focuses on the role of advanced retail technologies as triggers in the shopping cycle, thereby building on Pantano and Naccarato's (2010) suggestion that advanced technologies might influence the customer shopping experience by affecting the different stages in the path-to-purchase.

In general, a full shopping cycle consists of 5 stages; (1) the *need recognition* stage, (2) the *information search* stage, (3) the stage where the customer *evaluates alternatives* in his/her consideration set, (4) the *actual purchase* stage, and (5) the *post-purchase* stage (Hoyer, MacInnis, & Pieters, 2012). Advanced retail technologies can address one or more of these stages (Pantano & Naccarato, 2010). For instance, in the *need recognition* stage, a technology '[…] can inform consumers about the new arrivals in the stores, and suggest them the products capable to stimulate the emerging of new needs' (Pantano & Naccarato, 2010, p.203; Pantano, 2016), whereas in the *information search* stage, '[…] technologies become a useful tool for consumers to achieve fast and detailed information about products in the store' (Pantano & Naccarato, 2010, p.203).

Where manufacturers and retailers traditionally focused on increasing brand equity and sales by influencing shoppers early in the shopping cycle (i.e., often before they even enter the store), shopper marketing takes on a different approach by emphasizing that '[…]

marketing activities should be relevant to shoppers' needs as they emerge over the entire shopping cycle' (Shankar, 2011, p. 27). Since retailers are both in close proximity to shoppers and in control of the in-store environment, traditionally '[…] they are better able to influence the shopper near the end of the shopper cycle' (Shankar, 2011, p. 30). With the increasing adoption of digital technologies by physical retailers, technological aspects become ever more important elements in customers' encounters, and this at different touch points along the customer journey. Recent qualitative, sequential incidence research by Stein and Ramaseshan (2016), based on 34 customer journey narratives, deduced in this regard for example a relative presence of technology along the path-to-purchase as follows: about 45 percent pre-purchase, 36 percent in the purchase stage, and 19 percent post-purchase.

2.5 Defining the scope of 'retail technologies' in this study

Technology in retail can encompass different environments such as point-of-sale, online or supply chain (Renko & Druzijanic, 2014). The focus in this study is on technology at the point-of-sale, since a substantial part of the purchase decisions are cue-prompted or unplanned and triggered in the store (Neff, 2008). In particular, this study predominantly examines self-service technologies or technology-mediated customer contact, where '[…] the human customer service representative component of the service encounter is entirely replaced by technology' (Froehle & Roth, 2004, p. 3). Moreover, the present study focuses on customer-oriented technologies, or technologies with which the customer interacts, rather than on behind-the-scenes (back-end) technologies such as RFID in function of supply chain management (Renko & Durzijanic, 2014). So, the emphasis is on how IT can serve as pillar of the 'customer intimacy' strategy in retailing (rather than the 'operational excellence' strategy, cf. Efendioglu, 2015).

Pantano and Viassone (2014) classify the most recent retail technologies in three categories according to their technical characteristics: (1) *touch screen displays/in-store totems* (e.g., ATMs or virtual garment fitting systems enabled by 3D body scanning systems; Choi & Cho, 2012), (2) *mobile applications* (e.g., product comparison apps on the shopper's own mobile phone; Rudolph & Emrich, 2009; Bennet & Savani, 2011) , and (3) *hybrid in-store systems* that users can move around with in the store only (e.g., RFID recommendation systems, Wong et al., 2012; intelligent shopping trolleys, Black, Clemmensen, & Skov, 2009). Given this paper's focus on in-store shopper marketing, the empirical part (i.e., composing the inventory of retail technologies) centers on Pantano and Viassone's (2014) first and third category of technologies. As such, this study discards purely mobile applications that bear no link to the in-store shopping experience, and can thus function on a stand-alone basis. This delineation is in line with Shankar's (2011, p. 33) classification of social and mobile media as being largely 'out-of-store activities'. Both generic and proprietary technologies qualify for potential inclusion in this study's inventory (cf. Varadarajan et al., 2010).

2.6 Adoption and maturity of retail technologies

Retailers are usually not perceived as pioneers with innovative technologies (Hopping, 2000; Pederzoli, 2015). As Pantano and Viassone (2014, p. 43) note: 'Despite the large number of technologies for points of sale and the potential benefits emerging from the introduction of these advanced systems, still only a limited number of retailers adopted them'. Factors that tend to discourage retailers to adopt technology-based innovations are uncertainty of consumer acceptance, an obsolescence risk, huge monetary investments, and rather long term and difficult to measure returns on investments (Evans, 2011; Alkemade & Suurs, 2012; Pantano, Lazzolino, & Miggliano, 2013; Zhu et al., 2013; Pantano & Di Pietro, 2012). Without detailing on drivers of technology adoption in retailing (cf. Pantano, 2014; and

Pantano & Viassone, 2014, for more information), retail sectors or formats seem to differ in terms of which technologies they tend to embrace. Table 1 provides an overview of Pantano's (2014) findings in this regard.

Table 1. Technology diffusion in retailing industries *(Source: adapted from Pantano, 2014)*

Retail industry/format	Technology	Number of adopters	Amount of investment	Role of technology
Fashion	Digital signage	Medium	Medium *(mainly in hardware)*	Informative (providing shoppers with information)
Groceries and (large) department stores	Self-service technologies	High	Medium *(mainly in hardware)*	Providing new services to shoppers
(large) Department stores	mobile apps	High	Low *(mainly in software)*	Providing new services to shoppers
Small and frequently ad-hoc new retailers	Ubiquitous computing	Low	Low *(mainly in software)*	Creating new services for shoppers, reducing staff, managing data

Carr (2003, p. 41) contends that '[…] as information technology's power and ubiquity have grown, its strategic importance has diminished'. However, in retailing, IT's potential is still not exploited to the full extent. The pace of change is accelerating, causing competitive advantage to erode ever quicker (IBM, 2012). Although many retailers believe IT strategy and investments should be a top priority, only one in five (18%) indicates to be presently ahead of the curve (Deloitte, 2011). However, retail executives do recognize the importance of incorporating emerging technologies into the next-generation stores as their intentions toward future investments indicate (Deloitte, 2011).

3. Research objectives

This study provides a systematic overview and inventory of digital retail technologies, tailored for retailers to make informed decisions about what technologies to select given their specific goals and situation. As such, this research contributes to educate retailers in terms of when and with what objective the many existing retail technologies can serve for shopper marketing purposes. 'In order to stay ahead, retailers must bring the best of this digital technology into the store environment' (Newell, 2013, p. 37), but how does one select 'the best' technology? To this end, this study combines both marketing literature and literature from computer science to inform readers beyond the currently available body of knowledge on this subject. To optimize the managerial relevance of this retail technologies inventory, a classification of the existing technological possibilities and innovations is performed from a marketing perspective, bearing in mind (1) the stage in the shopping cycle in which they are most powerful to be of influence and (2) the type(s) of customer value that they contribute to. These insights are essential in order for retailers to leverage advanced retail technologies to become the basis of a competitive advantage.

Starting from this study's scope of retail technologies, the paper also aims to provide a finer overview of how to group the inventoried technologies into clusters based on the perspective of the consumer (or "user") of these technologies. We map technologies by characteristics and knowledge prevalent in the human-computer interaction (HCI) domain. HCI can be situated at the intersection of computer- and behavioral sciences and aims to optimize the user experience when interacting with digital systems. As such, HCI is also applicable for the shopper-oriented retail technologies in this paper. Taking on a HCI lens, a further elaboration of the existing but fairly broad-based schemes, such as the one of Pantano and Viassone (2014) for example, is a second objective of this paper. A more fine-grained technical clustering allows for identifying which underlying technologies/platforms and stakeholder interactions seem to be dominating in a given situation. Studying what common grounds they share, enables to detect potential drivers for success as well as barriers, inspiring further developments in the (academic) IT discipline.

An online repository of the resulting inventory of retail technologies is composed that is searchable according to these three above mentioned facets (i.e., customer value type it offers, stage in the shopping cycle is matters most, and HCI cluster). This repository intends to create awareness among both scholars and retail managers of the existing retail technologies and, more importantly, their strategic potential. Finally, a research agenda is composed in order to further guide academic interest in the domain of smart retailing.

To sum up, the following research questions are central in this study:

RQ1: *What is the current state-of-art in terms of retail technologies?*

RQ2: *What type of customer value can these retail technologies offer?*

RQ3: *At which stage of the customer journey do these retail technologies matter most?*

RQ4: *Can we cluster these retail technologies from an HCI perspective?*

RQ5: *What are research priorities to further advance the knowledge on smart retailing?*

4. Research methodology

In order to compile a comprehensive inventory of technological advancements in retailing, this study consults publications that stem from the intersection of marketing science and computer science, as well as practitioner reports. In particular, three sources of information have been systematically screened: (1) publications in the field of ICT for retailing as presented in the digital library of the Association for Computing Machinery (ACM, see paragraph 4.1), (2) publications in the marketing discipline (cf. paragraph 4.2), and (3) working papers and vulgarizing publications available from applied retail labs, retail R&D

departments and related newsletters (cf. paragraph 4.3). This literature review covers 7 years of relevant research, with data collection starting from the beginning of 2008 up to December 2014. The idea behind this specific timeframe comes from Foster (1986) and Johnston (2013). In essence, Foster (1986) discovered that supplanting an old technology by a new one generally takes between 5 and 15 years. Now, thirty years later, due to the sheer volume of new technology releases, the pace of technological innovation even seems to further increase (Johnston, 2013). Therefore a timeframe of seven years seems to be ideally suited for the intended research purposes. Starting from this retail technologies inventory, a team of researchers in the area of human-computer interaction (HCI) as well as a team of marketing scholars have clustered the technologies by means of an affinity diagramming approach (cf. Paragraph 4.4).

4.1 Academic literature review: IT in Retailing

In the first place, we consulted the Association for Computing Machinery (ACM, 2014) Digital Library, which is the largest scientific computing association world-wide that provides a vast digital library. On top of offering cutting-edge publications, this computing society also includes conferences and workshops. The review of this literature consists in particular of a systematical screening of the ACM Digital Library, for the timeframe 2008-2014. The search basis consists of the following keywords: *"retail" OR "supermarket" OR "grocery"*. A relevancy screening on the resulting hits (cf. scope definition in Section 2.5) subsequently took place in a stepwise basis, first by assessing the title, and second by examining the abstract. Search output beyond this study's scope is discarded for further analysis. In summary, this literature review resulted in an output of 47 papers dealing with a total of 53 technologies retrieved from 20 ACM sources.

4.2 Academic literature review: Marketing

The next step in this systematic screening was reviewing the academic marketing literature. In order to find relevant papers in the marketing domain about new in-store technologies, the 52nd edition of Anne Harzing's (2014) Academic Journal Quality Guide served as a guide in finding journals with an appropriate standard in different domains. More specifically, all the journals in the domain of 'Marketing', 'General Management & Strategy', and 'Innovation' incorporated in the Association of Business School (ABS) were screened for the period 2008-2014 (i.e., same timespan as for the computing discipline search). Together, these 3 domains contain 107 ABS recognized journals. After completing this protocol driven methodology of searching according to a pre-defined strategy, the literature review in the marketing discipline continued with a 'snowballing technique' searching to capture published output that might have escaped our first review round (cf. e.g., Ravasi and Stigliani, 2012; Greenhalgh and Peacock, 2005). In particular, we supplemented the composition of our inventory in two ways. First, two additional special issues dedicated to the use of technologies in retail were screened (i.e., International Journal of Electronic Commerce 18(4) and Journal of Retail and Consumer Services 17(3)). The keywords in these searches were: *'technology AND retail' OR 'computing AND retail' OR 'supermarket AND technology' OR 'grocery AND technology'*. If no output resulted with the above-mentioned keywords, the search term *'technology'* was used stand-alone. The resulting hits were again screened for relevancy. Second, as she is considered an authority in the research domain of technology-based retail settings, all publications of Eleonora Pantano were screened, and forward as well as backward snowballing was applied on these publications. This research resulted in total in the identification of 22 additional technologies retrieved from 13 papers published over 8 journals.

One reason for the - in comparison to the results from the ACM database - limited search results from the marketing literature, is that a lot of technologies are still in too early stages of

IT development to allow for conducting field research (e.g., experimental field studies in real stores, with real shoppers).

4.3 Review of practitioner publications and developments in the field

A final source of input for composing the envisioned inventory of retail technologies consists of publications and best practices by practitioners in the field as well as by shopper labs. First, several online newsletters in the retail domain (i.e., retailtech.nl, retaildetail.be, retailwire.com, marketingonline.be, retailwatching.nl, gondola.be, bcgperspectives.com, retailanalysis.com, retailnews.nl, essentialretail.com, retailtechnologylab.be and retail-business-review.com) as well as newsletters provided by trade fairs for retail technologies (e.g., EuroCIS) were screened. The keywords in these searches were *'technology AND retail' OR 'innovation AND retail' OR 'digital AND retail'* and the resulting hits were again screened for relevancy. Second, a screening of industry living/shopper labs renowned for their achievements in the field of retail technology (e.g., SAP Future Retail Center, IBM, HP, Intel, Lowe's Innovation Lab) was performed. However, probably due to data confidentiality and non-disclosure agreements, the results of this search were meager. There is only sufficient information available from the Philips Shopper Lab and Lowe's Innovation Lab. Finally, the website of Innovation Boulevard, a project of Belgian digital communication company Digitopia, as well as the website of the academic Innovative Retail Laboratory (IRL), run by the German Research Center for Artificial Intelligence (DFKI GmbH), were screened to further substantiate the inventory of retail technologies. These searches resulted in an output of 90 technologies within 12 sources.

Summarizing the overall literature review in search of retail technologies (cf. Section 4.1 – 4.3), the resulting inventory contains a total of 165 technologies that are retained, stemming from 20 ACM sources, 8 marketing journals and 12 practitioner sources. However, it should be noted that within the total of 165 inventoried technologies, some instances may in fact be considered applications of a same underlying technology. For instance, several of the inventoried technologies are based on facial recognition technology (e.g., OptimEyes, cf. Retail Business Review, 2013; Facial Detection, cf. EssentialRetail, 2013; FaceDeals, cf. Harrison, Mennecke, & Peters, 2014). Our online repository provides a complete searchable overview of these 165 technologies, including a brief explanation, the discipline of retrieval, and further classification information.

4.4 Affinity diagram clustering

We used an affinity diagramming approach to find appropriate clusters of technologies in order to further improve the organization of the 165 in-store technologies. This method, introduced in the 1960s by Jiro Kawakita, is a powerful tool for collaborative qualitative data analysis (Harboe et al., 2012). Affinity diagramming is commonly used to address research questions that at first sight seem hard to structure due to the lack of a generally accepted classification scheme, which is clearly the case in the present research. Constructing an affinity diagram starts with recording each technology on paper notes, and organizing these into groups/clusters according to intuitive relationships, such as for example similarity, dependence and proximity between technologies (Moggridge & Atkinson, 2007). Next, based on resemblances and differences between the clusters, mergers and reorganizations take place to arrive at a parsimonious, actionable affinity diagram scheme. The affinity diagramming was conducted by an interdisciplinary team, bringing experience in marketing, computer science, economics and user experience to the table. This strengthens the value of the clusters that are uncovered, encompassing the agreement of multiple viewpoints of different types of experts. Sections 5.1 and 5.2 further elaborate on the specific clusters that were uncovered.

5 Results

5.1 Retail technologies clustering from a Human-Computer Interaction perspective

Let us start by retaking Pantano and Viassone's (2014) framework consisting of three categories (i.e., 'fixed' touch screen displays/in-store totems, mobile applications, and hybrid systems), of which the first and third are relevant, given this study's scope (cf. Section 2.5). Of the 165 inventoried technologies, a majority of around 55.15% (i.e., 91 of the 165 technologies) pertain to the hybrid class, implying a combination of both in-store fixtures and mobile aspects. Some examples are the Mobile Productlens (IRL, 2014), or the Lambent Shopping Trolley (Kalnikaite et al., 2011). The remaining 74 technologies pertain to the class of fixed touch screen displays or in-store totems and comprise examples such as the Monopulse System of RFID-equipped Fitting Rooms (Parada et al., 2013), or Kahl's (2013) ACES application for Electronic Shelf Labels. This dual classification into fixed versus hybrid retail technologies is open for further elaboration to enrich our insights from a HCI-perspective, which is one of this study's objectives.

Two HCI scholars involved in this study conducted an affinity diagram clustering technique on the inventory of 165 retail technologies, resulting in ten overarching clusters in which these technologies can be aggregated. Natural relationships that underlie these ten resulting clusters draw on technical characteristics as well as user-benefits. Moreover, this affinity diagram incorporates the fact that there are three parties that interact: the customer, the retailer and the product. Technologies can exist on all three levels. For example, product augmentation is possible using augmented reality techniques such as Layar or Junaio (Olsson, & Salo, 2012). Technologies on the level of the retail environment entail either the more 'ambient' (often lighting related; cf. Philips, 2014) technologies, or smart retail 'furniture' comprising technologies like electronic price tags, the Smart Cheese Counter and smart shelves (cf. IRL, 2014). Technologies in support of payment form a separate cluster (e.g., Wallet phone; Swilley, 2010). Then, there are five clusters of technologies that relate more closely to the customer and technology-provided user benefits in the shopper's personal decision making process, namely (1) a cluster of 'context-aware data pool technologies' like the Digital Grocery Shopping List (Heinrichs, Schreiber, & Schöning, 2011), (2) the cluster of 'product finding technologies' (e.g., SoloFind; Wiethoff & Broll, 2011), (3) 'personal product assistants' such as the IRL SmartCart and the Mobile Productlens (IRL, 2014), (4) 'product decision support systems', comprising technologies such as the Ecofriends app (Tholander et al., 2012) or the Digital sommelier (IRL, 2014), and finally (5) price comparison technologies (e.g., Bargain Finder app; Karpischek, Geron, & Michahelles, 2011).

5.2 *Retail technologies clustering from a marketing perspective*

The inventoried technologies were also clustered from a marketing perspective. Section 5.2.1 starts by mapping the 165 inventoried technologies in terms of the stage in the path-to purchase they pertain to. Subsequently, a classification in terms of the type of customer value that the inventoried technologies offer is discussed in section 5.2.2. Finally, section 5.2.3 summarizes the marketing clustering results by confronting the path-to-purchase and the customer value type classifications.

5.2.1 Mapping advanced retail technologies in terms of the path-to-purchase

Three independent raters classified the 165 inventoried technologies into one of the five stages in the shopper's path-to-purchase. Based on Perreault and Leigh's (1989) formula for nominal data stemming from qualitative judgments, an inter-rater reliability score of 87.47% was obtained (i.e., 31 inter-rater disagreements on the total of 165 technologies that were classified in one of the five stages in the customer journey). A commonly experienced difficulty in the independent raters' classifications was the unique allocation of a technology to either the 'information search' stage or the 'evaluating alternatives' stage. Many of the information providing technologies also aid shoppers – directly or indirectly – in the stage of comparing alternatives in their consideration set. In such cases, the raters opted for the stage farthest in the shopper's path-to-purchase, namely the stage of evaluating alternatives.

Whereas the digitalization of shopping lists (e.g., Digital Grocery List by Heinrichs et al., 2011) may aid in need recognition, translating natural language into SKUs known in store data warehouses or in-store information kiosks (e.g., RFID-Based Smart Shopping Assistant by Chen et al., 2014) may help in searching external information upon request. In order to evaluate alternatives, smart shopping trolleys equipped with touch screens (e.g., Lambent Shopping Trolley by Kalnikaite et al., 2011) are an example of how technology at the point of sale can help shoppers in succeeding their mission. The actual purchasing stage can be technology-supported by means of near field communication technology (e.g., Pre-paid https-based mobile NFC payment, by Park et al., 2012) or even biometric identification systems (e.g., Biometric Authentication technology by Clodfelter, 2010). After the purchase, shoppers can easily share reviews with their friends and relatives via numerous apps (e.g., Taggle, cf. Retail Business Review, 2011) and social media platforms.

5.2.2 Mapping innovative retail technologies in terms of customer value

In line with previous studies on retail technologies from a consumer's point of view (cf. e.g., Renko and Druzijanic, 2014), technology is able to provide three broad types of consumer value, namely (1) *saving 'costs or energy'* (e.g., price comparison apps; smart shopping trolleys to navigate efficiently through the store and as such save time and effort), as well as in terms of (2) *offering utilitarian benefits* (e.g., in-store information kiosks to compare products and optimize one's choice, smart fitting rooms with RFID-enabled touch screens that recommend suited accessories to the dress the consumer may be trying on), and (3) *providing hedonic benefits* (e.g., lighting technologies drawing attention to certain products or reacting to consumers' movements and behaviors, apps to share pictures of a potential purchase to get social feedback in the process).

Each of these three broad value types can be split-up into a more fine-grained view. First, cost or energy savings can occur in three ways: (1) saving time or effort for the shopper at home, (2) in-store, or by (3) offering monetary savings. Second, functional benefits can be disentangled into (1) product information and comparisons in function of choice optimization by mobile phones, or (2) by in-store aid, (3) personalized recommendations, and (4) customization in function of optimizing one's choice. Third, the retailer can offer hedonic benefits by (1) inspiring or educating the shopper, (2) providing aesthetics or a nice ambient store atmosphere, (3) offering social value in terms of connecting people, or (4) generating a playful dimension in the shopping experience. On this finer-grained level, in total 11 alternative value types can be established.

Again, three independent marketing scholars classified the 165 technologies, using table 2 as a classification guideline. In case a technology provides multiple types of customer value, the value type highest on the hierarchical customer value ladder was chosen. For instance, Philips' (2014) Smart Lights Solution System offers both cost savings and shopping convenience (namely by providing in-store navigation and targeted coupons) as well as the functional benefit of personalized recommendations (namely by providing targeted information such as recipes or matching products). Since the functional benefit of personalized recommendation is considered highest on the customer value type ladder, the technology is classified under this value type. The inter-rater reliability of these classifications equals 90.18% (based on 28 disagreements).

Table 2. Customer value type classification guidelines

Customer value type		Classification guidelines	Exemplar illustrations
Cost reduction (Cost)	***a. convenience at home***	- Saving time or effort for the shopper at home - Shopping lists	*Amazon Dash*: provides a service to facilitate the composition of shopping lists at home
	b. convenience in-store	- Saving time or effort for the shopper in-store - In-store navigation or product finding - Convenience in payment - Personalized check-out services (e.g., saving personal data/recognizing the customer with a smart interface so that an extended log-in procedure can be avoided)	*The Product Finder*: provides in-store navigation by helping consumers find the articles they are looking for, thereby saving time and effort for the shopper in-store *Uniqul*: uses facial recognition to make payment at the checkout counter more convenient
	c. money	- Offering monetary savings - Price comparison apps - Personalized coupons/promotions	*LiveCompare*: provides an app to improve interstore grocery price comparisons *FaceDeals*: sends personalized coupons to consumers
Utilitarian benefits (Function)	***d. product information and comparison by mobile phone***	- Product comparison in function of optimizing one's choice by means of mobile phones - Information pull - NOT: receiving coupons (=c), local event information (=g), price comparison apps (=c), etc. by mobile phones	*Mobile Shopping Assistant*: provides information about products scanned by consumers by means a mobile device
	e. product information and comparison by in-store fixtures	- Product comparison in function of optimizing one's choice by aid of in-store fixtures - Information pull	*Cereal Assistant*: shows information about the products taken from the shelf
	f. personalized recommendation	- Using customer profile or in-store location information to push or pull customized information	*IRL SmartCart*: takes into account previous purchases in order to display personalized product recommendations
	g. customization	- Adapting to the consumer - Providing answers to questions such as 'how do I look in this product, what color suits me best, what are my sizes,…?' - Producing or displaying customized products	*Augmented Reality Makeup Mirror*: simulates how makeup products look on a shopper's face *Soap App*: allows to create and order customized soap
Hedonic benefits (Fun)	***h. inspiration/education***	- Inspiring or educating the shopper - Providing attention to certain products (e.g., via lighting) - Information push	*OLED*: turns objects such as mannequins or coat hangers into light sources to highlight and promote certain products
	i. aesthetics	- Providing aesthetics or a nice ambient atmosphere - Not focused on one particular product	*Swarm*: produces variable lighting and communicates messages, images, text, colors or a specific mood
	j. social	- Offering social value in terms of connecting people - Sharing and reviewing products via social media	*Mobile Mirror*: allows customers to share pictures and video via social media and to receive feedback on items they are considering to buy
	k. play	- Generating a playful dimension in the shopping experience	*Shopping Cart Game*: offers a shopping cart game to let toddlers participate in the shopping process

An example of a disagreement is that of Melià-Seguí et al.'s (2013) RFID enabled racks with contextual media detecting which garment is being examined by a customer and showing photographs and videos of that garment being worn by a model. Two raters interpreted this technology as offering the shopper with the functional benefit of product information and comparison, facilitated by an in-store fixture (namely the RFID enabled racks with contextual media, providing information on how the garment looks on a model). The other rater, however, classified this technology as offering the shopper with the functional benefit of providing personalized recommendations (namely by providing customized product information in response to a consumer's interest in a specific garment). A discussion between the three raters led to the classification in line with the former's interpretation. In this way, all 28 value disagreements have been resolved in order to allocate each of the technologies to a single type of value.

Note that upon aggregating the eleven value dimensions into the three overarching value dimensions, the reliability amounts to 92.93% (i.e., 15 disagreements). As such, the reliability of the technology classifications along both dimensions (i.e., value and path-to-purchase) largely surpasses Nunally's (1978) cut-off value for exploratory purposes (i.e., 70%), demonstrating the trustworthiness of the technology classifications.

5.2.3 Confronting the path-to-purchase and the customer value type clustering results

Table 3 represents the integrated technology clustering by three marketing scholars, documenting the inventoried 165 advanced retail technologies in terms of the stage in the shopper's path-to-purchase where they prevail (i.e., horizontal dimension), and in terms of the type of customer value they offer (i.e., vertical dimension). Table 3 furthermore provides an overview of the number and percentage of technologies classified under each stage of the path-to-purchase and each customer value type. A more in-depth discussion of these numbers is provided in section 6.

Table 3. The marketing affinity diagram clustering result

		NEED RECOGNITION 31 (18.79%)[1]	INFORMATION SEARCH 38 (23.03%)	EVALUATING ALTERNATIVES 38 (23.03%)	PURCHASE 56 (33.94%)	POST-PURCHASE 2 (1.21%)
COST/ENERGY REDUCTION 55 (33.34%)	***Convenience at home*** 6 (3.64%)	A Grocery Product Retrieval System; Intelligent Shopping List; Digital Grocery List; Amazon Dash	Store View	GuerillAR	/	/
	Convenience in-store 41 (24.85%)	/	/	/	UbiPay; Wallet Phone; Biometric Authentication Technology; IBM Personal Shopping Assistant; PIRAmIDE – BlindShopping; Robot Shopping Cart; NCR Personalized Self-Checkout; Smart Cart Application; Pre-Paid https-based Mobile NFC Payment; Bitcoins; PayPal's API; Starbucks' Square Wallet; RFID enabled POS; ProFI – Product Finding Assistant; Indoor Positioning by Wifi Fingerprinting; StoreMode; 360 Degrees Scanner; Mirco-Store Self-Service Systems; RFID-Based Smart Shopping Assistant; Smart Lights Solution Systems; Mobile Payment; Easy Checkout; Product Finder; Smart Cart; Zero-Effort Payments (ZEP); Uniqul; Interactive Touchpoint; Meijers's Find-It; Stop & Shop Supermarket's Scan it! Application; OSHbot; Qless; Instore E-Commerce; Touch&Go; Sainsbury's App; A Smartphone Application for Visually Impaired Persons; Smart Shelves; Enhanced Mobile Payment Options; Toshiba TCxAmplify; Digital Money; Retail Site Intelligence	/
	Money 8 (4.85%)	Plot Plugin; FaceDeals	/	LiveCompare; SurfaceWare; Bargain Finder App; Ubira; eBay's RedLaser Comparison Shopping App	Mobile Commerce Application – Tilly's; Store Mode for Kohl's Mobile App	/
UTILITARIAN BENEFITS 83 (50.31%)	***Product information and comparison by mobile phone*** 18 (10.91%)	/	CAST – a context-aware shopping trolley; Mobile Shopping Assistant; Layar; Junaio; Google Goggles; ShopSavvy; The Ecofriends Application; Cobra; Atierre's NFC-enabled Price Tags and Digital Signs; Signature Mobile App; Mobile App Nutritional Balance; Mobile Productlens; I-Space; Endless Aisle App	Screen Codes; Retail Interactive Fashion Experience; Mobile Shopping Assistant; HarvestMark; Image Search App	Window QR & Augmented Reality Codes	/
	Product information and comparison by in-store fixtures 21 (12.73%)	/	Must-D; Solofind; Adiverse – Interactive Digital Shopping Walls; I-PrOS™; ACES – Application and Controlling Framework for Electronic Shelf Labels; RFID-enabled Smart Shelves; RFID enabled Racks with Contextual Media; Digital Sommelier; A	Mobile & Functional Lambent Display; Lambent Shopping Trolley; Mobile Sales Assistants; Cereal Assistant; Smart Cheese Counter; Interactive Digital Signage Shopping Experience	/	/

			Mobile AR System to Browse Physical Reality; Browsable Physical Space with Clicking Solution; Touchscreen Tablet Computer for Grocery Carts; Tablet Shopping Experience; Shelfbucks			
	Personalized recommendation 25 (15.15%)	Ubiquitous Market Platform; OptimEyes; Facial Detection; RFID-enabled Personal Shopclub Ring; Beacon Technology; Miraview; Product Experience Wall; Touchless Large Interactive Displays; ShopBeacon	Virtual Shopping Assistant; Interactive terminal for Cooking Recipes; Myhmv; IBM Shopping Application; Smart Retail Environment; Gamestop	RFID – cellphone; weShop Mobile Application; Monopulse System (RFID) – Fitting Room Application; RFID enabled Interactive Fitting Rooms; Smart Dressing Room; Cross-Selling & Recommendation Tool; AR-assisted Mobile Grocery Shopping Application	IRL SmartCart; Smarter Checkout Solution	/
	Customization 19 (11.52%)	Tracking Biometrics; Futuristic Smart Mirror by Panasonic	Clark's Feet Measurement Technology	Color-Match; Smart Mirror for Optical Products; RFID-enabled Magic Mirror; Scanning Computer and Mirror (SCAM) System; Soap App; The Box; Holoroom; Body Scanning; Augmented Reality Makeup Mirror; 3D Mirror Measuring Bra Size; Oak Fitting Room; Intel MemoMi Memory Mirror	Smart Mirror; 3D Printing Service; Eye Candy Vending Machine; 3D Printing	/
HEDONIC BENEFITS 27 (16.36%)	***Inspiration/education*** 12 (7.27%)	Dynamic Digital Menu Board; Shelf Vision Refrigerator; Reactive Spotlight; Dynamic Balustrade; Holographic Display; Instore LED Wall; Magic Mirror; Digital Shopping Window	Intelligent Shop Window; OLED; Look	/	Interactive 'Coming Soon' Wall	/
	Aesthetics 4 (2.42%)	Lightung; Easytool; Interface	Swarm	/	/	/
	Social 6 (3.64%)	Clothes Racks with Online Buzz; FourSquare	/	Mobile Mirror; Lacoste's Augmented Reality App	/	Nedap twittering Mirror; Taggle
	Play 5 (3.03%)	Engaging Digital Window Display	/	/	Shopping Cart Game; Wanagogo Kids Corner; Augmented Reality for Halloween; Bloomingdale's Clothing To-Go Window	/

[1] Note: The numbers and percentages mentioned in the row- and column headings of this tables are interpreted as in the following example. A total of 31 technologies or 18.79% of the 165 technologies were classified as pertaining to the 'need recognition' stage.

5.3 *An Online Retail Technology Repository with Faceted Search*

The complete list of results of our analysis has been serialized as a collection of structured data records and made available through an interactive online repository at www.retail-tech.org. Our aim with this online repository is to support both exploration and directed search of possible solutions based on either a specific customer value type, a stage in the path-to-purchase cycle, a preferred technology cluster, or a combination of these. For this purpose the Exhibit framework (Huynh, Karger & Miller, 2007) was used, which allows to publish structured data on the web and provides a faceted search facility (see Yee, Swearingen & Hearst, 2003; Hearst, 2009). The faceted search exploits the orthogonal categories that appear in the metadata of the structured data for finding resources (solutions) that adhere a set of given characteristics. In the current implementation, three primary facets are used (i.e., value type, path-to-purchase, and cluster). However, additional facets (e.g., discipline, year, etc.) can be easily supported when even more fine-grained control over search is required. An additional benefit of this approach is extensibility. When new technologies become available, their data records can be added to the online repository and included in the search results without any further effort.

6. Conclusion and discussion

This study provides an interdisciplinary inventory of retail technologies, gathered from the academic fields of computing and marketing, as well as from business practice. A classification of the technologies along the stages in the shopper's path-to-purchase shows that all five stages are (or can) to some extent (be) digitally instrumented in the servicescape. The most technology-supported stage in the customer journey is that of the actual purchase, comprising many in-store payment and navigation technologies. Moreover, the earlier stages of the shopping cycle (i.e., before the purchase decision is made), comprise in total 64.85% of the 165 inventoried technologies (cf. Table 3). As such, the strategic potential of retail technology is high, since according to Shankar (2011, p. 30), retailers traditionally are better at influencing the shopper near the end of the customer journey. The technologies inventoried in this paper include instruments to also digitally equip the retailer for targeting the shopper earlier on. Remarkably underrepresented however, is the post-purchase stage, with only 2 out of 165 technologies serving to target the shopper at that stage (cf. Table 3). This void entails opportunities for IT and retailing to join forces in order to develop suitable technology-support to close the customer journey loop. Managers can benefit from digital support to capture insights in post-purchase behavior and leverage them to encourage repurchase and word-of-mouth intentions (Shankar, 2011).

Regarding the value of retail technologies, it is efficiency in-store (i.e., time saving technologies) that tops the list with 41 out of 165 technologies with this purpose (cf. Table 3). This finding is in line with Pantano and Viassone's (2014) finding that retailers tend to focus on the utilitarian benefits of technologies, and seem to neglect the proposal of recreational tools for improving the shopping experience per se. The hedonic benefit providing technologies cluster comprises a meager 16.36% (i.e., 27 of the total of 165 technologies), whereas utilitarian benefit providing techs comprise 50.31% (or 83 technologies) and cost/time-saving technologies 33.34% (i.e., 55 technologies). The reasons for this finding are twofold. First, the retail technologies in the present study to a large extent focus on applications in grocery retailing, which is the utilitarian retail context par excellence. When doing grocery shopping, consumers tend to be 'on a mission', striving to complete the purchase of their shopping list as efficiently as possible (Geuens et al., 2001). From that respect, technologies that aid in saving time, money, and contributing in optimizing one's product choice are indeed the ones that serve shoppers' goals in such supermarket contexts best (Geuens et al., 2003). After all, many shoppers are not looking for hedonic distractions upon doing grocery shopping. Second, the bulk of functional benefit- and cost-/time-saving technologies also reflects retailers' main preoccupation with operational efficiency matters (e.g., Finne & Sivonen, 2008).

7. Limitations, research and managerial implications

7.1 Extending the present inventory of retail technologies

Notwithstanding the comprehensive nature of the literature review in this study, the use of rather generic search terms such as 'retail' and 'technology', may have resulted in the fact that some technological advancements in shopping are not captured in this inventory. Furthermore, the inventory of 165 technologies could be further enriched by examining additional industry labs (such as SAP The Future Retail Center, IBM, HP, Intel; cf. Narayanaswami et al., 2011). The restriction that the present study however faced is the lack of disclosure of such lab findings. Another source of additional inspiration to complement this study's inventory are real-life 'stores of the future', like Metro Group's Real Future Store (Metro Group, 2014b) or Globus Warenhaus (IRL, 2014), although the latter implements innovations stemming from cradle IRL, that have been incorporated in this paper. The innovations are vast and evolve continuously and so does the information that is spread about them. This paper does not claim to present an exhaustive overview but is nevertheless, to the best of our knowledge, the first attempt to integrate findings from the intersection of the marketing and the computing discipline, providing a state-of-the art and outlook for the future, in academic and business practice terms.

Choosing is losing, so the saying goes. In respect to the scope delineation of retail technologies in this paper (cf. Section 2.5) some interesting related fields are left open to be explored in future studies. One significant example is that of the booming rise of mobile marketing and location-based advertising in retail settings (e.g., Tin et al., 2016; Kim & Lee, 2015). Entire special issues are devoted to this matter and new studies appear in many marketing journals on a continuous basis. Consulting the Appstore for example, points out that there are a wide amount of apps on offer upon searching for ‘shopping’ (i.e., 2163 hits), or ‘retail’ (i.e., 1190 hits), or ‘price’ (i.e., 2171 hits; all as of September 2014). Such mobile shopping applications for smartphones are sometimes called ‘mobile shopping assistants’, and have been subject to research in the field of ubiquitous and pervasive computing for many years (Karpischek et al., 2011). The mobile apps in this paper’s inventory all meet the criterion of serving as one of the multiple components in the digital system of optimizing the shopping process while not on a stand-alone basis.

Besides the notable scholarly interest in mobile marketing, the extant marketing research on effects of user-generated content, and in particular (online) product reviews, is also vast. Since this type of (typically) post-purchase behavior most often occurs via social media online, which falls outside this study’s scope on retail technologies as being out-of-store (Shankar, 2011), part of the digital instrumentation of shoppers’ post-purchase behavior may be lacking in this article’s inventory (cf. only 2 technologies aimed at this stage of the path-to-purchase are retained). This finding however entails fruitful opportunities for future research.

Furthermore, whereas the above mentioned scope extensions would still focus on the value of technology from a consumer perspective, the same documentation of the inventoried technologies can take place from a retailer perspective (cf. Pantano & Viassone, 2014). Another axis along which the present research can relevantly be extended is to examine how such digital augmentations of the consumer’s shopping experience can also capture moments-of-truth along the shopper’s path-to-purchase (cf. e.g., Johnston, 2015). For example, Smart RFID-equipped Shelves can sense consumer-product interactions, and as such peek into the retailer’s black box of which traditionally only product in- and outflows have been documented. This real-time information could inform and optimize shopper marketing actions at the point-of-sales (cf. Willems et al., 2014). Another illustration is that of Tesco's OptimEyes technology (N.A. - Retail Business Review, 2013) or wearable technology like Apple's SmartWatch (Cavus & Munyavi, 2016), allowing the retailer to interact with customers in a context-aware manner, and addresses shoppers while accounting for their socio-demographic as well as situational characteristics such as mood (Pucinelli, Deshpande, & Isen, 2007). In a similar approach to how the inventory in the present study has been documented in terms of customer value and stage in the path-to-purchase, documentation could be provided in terms of marketing intelligence capabilities (cf. analogy to webshop metrics) to feed retail shopper marketing strategy development (e.g., a dashboard of particular retail KPIs). Beyond organizational challenges resulting from these revolutionary changes in knowledge management (cf. e.g., Pantano & Timmermans, 2014; Rohrbeck, Battistella, & Huizingh, 2015; Vecchiato, 2015), another facet that merits further research attention pertains to challenges in terms of selling activities, such as the study of how to motivate and engage salespersons upon implementing smart retail technologies (cf. Pantano & Timmermans, 2014; Yurova et al., 2016). After all, ICT triggers the need for new knowledge and specialized skills (Gallouj et al., 2015), particularly in a traditionally 'low technology' sector such as the retail industry (Pederzoli, 2016).

7.2 Empirical further research opportunities on retail technologies

Besides extending the current inventory exercise to a wider scope, empirical research opportunities inspired by the knowledge generated in the present study are also numerous. As Ray et al. (2005, p. 626) state, '[…] while a number of case studies do highlight the critical role of IT in customer service (Elam & Morrison, 1993; El Sawy & Bowles, 1997), empirical research examining the link between IT and customer service performance has been lacking'.

For the stages in the customer journey that are well-instrumented (e.g., info search – 38 of 165 technologies, cf. Table 3), marketing scholars can start to examine which technology customers prefer to interact with in order to satisfy their needs in that particular stage of the shopper pathway, to ultimately also further advance IT fine-tunings in that direction. The same goes for customer value. Where 19 out of the 165 technologies are aimed at customization, marketing researchers can study drivers of customer adoption of such popular systems, making use of well-established models like the Technology Acceptance Model (TAM; Davis, Bagozzi, & Warshaw, 1989; Pantano & Di Pietro, 2012) or the (extended) Unified Theory of Acceptance and Use of Technology (UTAUT 2; Venkatesh, Thong and Xu, 2012) to empirically examine how shoppers (users) evaluate 'perceived usefulness' and 'fun or pleasure derived from using a technology' (Venkatesh et al., 2012, p. 161), for example. Pioneering examples in this direction include (1) Kourouthanassis, Giaglis, and Vrechopoulos' (2007) research on user experience evaluations of pervasive retailing, (2) the study by Evanschitzky et al. (2015) on consumer trials, continued usage and benefit perceptions of personal shopping assistants, and (3) Gurtner, Reinhardt & Soyez' (2015) TAM test of mobile business applications for ageing consumers.

To this end, the development of user scenarios may be a first necessary step, particularly for evaluating adoption of technologies that are not yet commercially or widely available and which as such may not yet enjoy sufficient familiarity among consumers (Pederzoli, 2016). Furthermore, return on investment in technology needs to be examined by quantifying the benefits that can be gained in terms of – among others – customer satisfaction (as one of the drivers of service firms' financial performance, cf. e.g., Heskett & Schlesinger, 1994) via an enhanced shopping experience (Pantano & Naccarato, 2010). Moderator analysis is warranted to set the boundaries for generalization of the findings resulting from such quantitative studies (e.g., including consumer characteristics, such as technology readiness; retail sector characteristics, such as level of self-service and technology-mediation, think/feel - high/low-involvement products, etc…).

Furthermore, additional IT developments to further instrument the post-purchase stage in the customer journey, and to add to the offering of hedonic value to shoppers, could be inspired by advances in other industries (cf. Pantano, 2014), such as the game industry (e.g., haptic technologies, augmented reality scenarios, multimodal interaction; cf. e.g., Poncin et al., 2015), the education sector (e.g., digital storytelling, collaborative 3D environments), and tourism and hospitality (e.g., ubiquitous computing and improved connectivity for data interchange).

7.3 Managerial implications

The managerial relevance of the present study lies in the insights that are provided on (1) what technologies exist for retailers to consider (cf. RQ1),, (2) what type of customer value they mainly offer (cf. RQ2),, and (3) in what stage of the customer journey are they most likely to be effective (cf. RQ3). The fact that the main emphasis of retail technologies currently still appears to be on functional benefits and cost/time savings, may over time erode the differentiating potential of such technologies, inducing retailers to move a step up on the hierarchical customer value ladder (e.g., hedonic value providing technologies). Furthermore, given retailers’ traditional excellence in influencing shoppers nearby the end of the path-to-purchase, this technologies inventory provides inspiration on how technology can be used to also leverage retail power to trigger shopper responses earlier on in their shopper pathway. Or how the shopper’s path-to-purchase indeed is - and will become ever more - paved with digital opportunities.

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References pertaining to the search results of the literature review in the computing, marketing literature and practice, retained to compose the final inventory of 165 retail technologies, are included in web appendix B.

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