Augmented reality in retailing: a review of features, applications and value

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Abstract

Purpose – The purpose of this paper is to review augmented reality (AR) within retailing by identifying, outlining and discussing definitions of AR, applications of AR that are relevant for retailers, and the value AR provides for retailers and consumers.
Design/methodology/approach – The paper is based on a review of AR research within the business-oriented literature and an overview of current AR applications within retailing.
Findings – Based on previous literature, the paper presents a synthesised definition of AR, its main elements and how it differs from virtual reality. Furthermore, it reviews and provides examples of three major types of AR applications in retailing: online web based, in-store and mobile app based. Finally, the paper identifies the specific value that AR applications may provide for consumers and retailers.
Originality/value – The paper contributes an overview of a relatively recent but rapidly emerging theme that has not yet been sufficiently reviewed. It outlines areas for further research and thus provides value for both researchers and retail practitioners.

Keywords Retailing, Augmented reality, Literature review
Paper type Literature review

Introduction

Retail is an integral part of society. Today, technological changes and the widespread use of digital technologies are transforming retailing and the shopping experience (Spears, 2014; Hagberg *et al.,* 2016) and are helping to keep retail stores alive (Berman, 2019). Interactive technologies (Huang, 2019; Javornik, 2016a, b; Poushneh, 2018) and the increased use of the internet and e-commerce (Barlow *et al.*, 2004) have garnered attention from consumers and retailers (Pantano and Laria, 2012) in the past few decades. These technologies have significant implications for traditional forms of retail (Hagberg *et al.*, 2017) and are modifying the way consumers engage in the shopping process (Yadav and Pavlou, 2014). Through high connectivity and interactivity (Huang, 2019; Berman, 2019; Yim and Park, 2019), these technologies can enhance the shopping experience (Javornik, 2016a, b; Poushneh, 2018) and store atmospherics by helping to create a buying context that increases consumers' willingness to buy (Poncin and Mimoun, 2014). Thus, the point of sale becomes a new immersive place where digital technologies merge with traditional elements and provide a highly personalised and interactive environment (Berman, 2019; Pantano *et al.*, 2018; Pantano and Laria, 2012; Pantano and Servidio, 2012; Pantano and Timmermans, 2014). Consumers can interact more profoundly with products. On the other hand, by improving the in-store shopping experience, retailers can have a positive impression on consumers and attract new categories of consumers.

Augmented reality (AR) is one of several digital technologies that could be considered useful in developing the new concept of retail stores where traditional and digital store elements co-exist. Along with other interactive technologies, such as virtual reality (VR) and

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mixed reality, AR is shaping a new environment (space) where physical and augmented/virtual objects/elements are integrated in different ways (Flavián *et al.*, 2019).

Retailing is considered one of the sectors with the greatest possibilities to implement AR (Cruz *et al.*, 2018). As highlighted by Javornik (2016a, b), the AR industry is estimated to reach $56.8bn globally by 2020, and in the retail market, it is expected to reach almost $7.9bn globally by 2023 (MarketsandMarkets, 2018)[1]. These global data support the positive expectations of the future of this technology. AR has the potential to modify the shopping experience (Watson *et al.*, 2018). Increases in online shopping (Barlow *et al.*, 2004), smartphone use and the adoption of connected devices are major factors driving the growth of AR in retail markets by encouraging retailers to adopt AR. Thus, retailers are increasingly embracing AR applications as a tool for creating immersive customer experiences (Flavián *et al.*, 2019; Watson *et al.*, 2018).

In the last few years, academics and practitioners have focussed on several possible ways that the shopping experience can be enhanced and store environments can become more attractive for consumers (Pantano, 2010). It is important to understand the role of digital technologies, particularly AR, within the point of sale as an emerging opportunity for physical stores that will contribute to defining the future of retailing (Grewal *et al.*, 2017).

The early studies on AR were primarily conducted in the computer science and engineering areas to define the main technological characteristics of AR (Azuma, 1997; Azuma *et al.*, 2001). However, over time, scholars' attention has also turned to the retail sector, and we are currently witnessing a growing number of studies within business in general and retailing in particular (Kang, 2014; Jaekel, 2016; Yim *et al.*, 2017; Pantano *et al.*, 2017; Pantano and Gandini, 2017, 2018; Scholz and Duffy, 2018). There is a need for a review of this emerging literature. Thus, the purpose of this paper is to review AR in retailing within business-oriented research. The paper addresses the following three research questions:

RQ1. What are the main features of AR?

RQ2. What AR applications are relevant for retailers?

RQ3. What kind of value may AR provide for consumers and retailers?

The paper is organised as follows. The next section will describe the method of the literature review. This will be followed by three sections discussing previous research in relation to each of the research questions focussing first on definitions of AR, second on applications of AR in retail settings and third on AR's value for retailers and consumers. Finally, concluding observations will be provided, and opportunities for further research and implications for scholars and practitioners will be identified.

Method and materials

The literature review was conducted in four steps: literature search, screening and initial assessment, review and analysis of the literature and writing up and reporting of the results. The first and second steps were conducted between November 2017 and December 2018 through an iterative process that included business/retail-oriented studies from 2001 to 2018. In the first step, literature in the Scopus database was searched. The use of the Scopus database is justified by its indexing approximately 70 per cent more sources than other databases, such as Web of Science (Brzezinski, 2015). This ensured more coverage of the literature analysed (Harzing and Alakangas, 2016). The literature search was limited to published articles and scientific book chapters edited in English within academic journals (Green and Hall, 1984). The reason behind this choice is connected to the quality resulting from the peer review process offered by academic journals and scientific books, whereas the quality of books, conference papers and non-academic material is less ensured (Lucarelli and Berg, 2011).

The literature search was conducted by using the keyword "augmented reality" combined with the disciplinary area of business management. This was followed by a search for the keyword "augmented reality" combined with the keyword "retail*" to include papers and book chapters that were within other disciplinary areas but related to the empirical field of retailing in some way.

A second step consisted of a screening and initial assessment of the literature, which was conducted by reading the abstracts and assessing their relevance for the topic at hand. This process was guided by the three research questions.

The third step consisted of a review of all selected papers and an analysis based on the three research questions:

RQ1. What are the main features of AR?

RQ2. What AR applications are relevant for retailers?

RQ3. What kind of value may AR provide for consumers and retailers?

The review and analysis were conducted by using a table in which the papers were in the rows, the three research questions were in the columns, and relevant information from each paper was included in the matrix. After the table was filled in, analyses were conducted by categorising the results based on different themes and topics that emerged from the literature in relation to each research question. Additional relevant literature identified through the reviewed papers was also included (e.g. Sutherland, 1968; Milgram *et al.*, 1994; Drascic and Milgram, 1996; Azuma, 1997; Caudell and Mizell, 1992). To complement the material on practical applications found in the research papers, another review was conducted. This review was performed considering industry reports (e.g. Goldman Sachs, 2016; Ericsson Consumerlab, 2017; MarketsandMarkets, 2018), company websites and newspaper articles to identify the major types of AR applications and specific examples from retail companies. This review was based on examples that we came across in our monitoring of different examples through such sources. Thus, considering that AR applications are continuously introduced within retailing, the intention of this review of examples is not to be terminal or exhaustive but rather to illustrate the variety of applications currently present in retailing.

The fourth step consisted of compiling and writing up the results of the review. The findings are presented based on the three research questions to provide structure and clarity for the reader. The three findings sections present and discuss the literature and are followed by a concluding discussion.

What are the main features of AR?

Origin and development

The term AR dates back in the literature to the 1940s, but the term only became widespread in the 1980s, when engineer Thomas Caudell used it to describe a new technology useful for assembling and installing electronic cables in aeroplanes (Caudell and Mizell, 1992). The first applications of this technology were applied in the military, industrial and medical sectors (Hwangbo *et al.*, 2017). In particular, in a brief historical excursus, the first AR system appeared in the 1950s, a product of Morton Heilig. In 1962, this cinematographer created and patented a simulator called Sensorama, with visuals, sounds, vibrations and smells. Then, in 1968, Ivan Sutherland created an AR system using an optical see-through head mounted display (Daponte *et al.*, 2014). In the mid-1970s, Myron Krueger introduced the interaction between a user and a virtual object (Levin, 2006). Following these events, Caudell and Mizell (1992) coined the term AR in relation to the development of an AR system that helped workers assemble wires and cables for an aircraft. With AR, users could have an experience in which real and virtual elements coexisted in the same place. Thus, AR combines the real and virtual

by permitting an interaction in real time and displaying elements in three dimensions (3D) (Azuma, 1997; Azuma *et al.*, 2001; Reinwald *et al.*, 2014). Integrating real-world and virtual elements enhances a specific reality (Poushneh and Vasquez-Parraga, 2017) and, in a store environment increases the customer experience (Flavián *et al.*, 2019).

In the new millennium, the growth of AR has been rapid thanks to several applications inside mobile devices (e.g. smartphones, tablets and glasses) with sensors. Additionally, the number of fields of application has been growing rapidly. If AR was originally developed for military, industrial and medical applications, its use later expanded into other areas such as commerce, retailing and games (Hwangbo *et al.*, 2017). AR developers' increasing attention to users' needs and desires has also increased the quality of AR applications (Poushneh and Vasquez-Parraga, 2017). An important goal regarding the evolution of AR applications has been to define and create platforms that are able to merge both physical and virtual worlds into one and to permit users to overlay and interact with virtual objects in their real-life contexts (Ramadan and Farah, 2017; Carmignani and Furht, 2011).

Definitions of AR

Azuma (1997) proposed the first definition of AR by identifying the three main elements that characterise it: the combination of real and virtual elements, real-time interaction and the reproduction of content/elements in 3D. Building on Azuma' definition of AR and its three features, over time, several other authors attempted to define AR. The main contributions from the business management area are displayed in Table I to identify the main features underlined by these authors.

The above definitions are all linked by the same features identified by Azuma (1997). Some of these definitions emphasise the technoogical aspects of AR, such as those by Carmignani and Furht (2011), Sood (2012), Ukwuani and Bashir (2017), Olsson *et al.* (2013), Hwanlgbo *et al.* (2017), Pantano *et al.* (2017), Lee and Leonas (2018) and Watson *et al.* (2018). Several authors emphasise the enhancement of the user experience, such as Scholz and Smith (2016), Javornik (2016a, b), Grewal *et al.* (2017), Poushneh and Vasquez-Parraga (2017), Rese *et al.* (2017), Yim *et al.* (2017), Brengman *et al.* (2018), Poushneh (2018) and Watson *et al.* (2018). Overall, these definitions convey that the natural environment is the main feature of AR, which, in combination with sensory digital/virtual contents (e.g. information, video, graphics and images), generates an augmented real environment (ARE). An ARE could be defined as a new interactive and smart place where people can enhance their relationships, interactions and living through an augmented experience (AE). An AE is the main result of the application of AR during the shopping process in retail settings.

Combining this plethora of definitions and the main features identified in Table I, our definition of AR is as follows: AR is technology-enabled augmented content that combines with the real environment to develop an ARE where people can have an AE.

Based on these definitions, to identify the components of AR, three main elements are considered in, as shown in Table II.

AR vs VR

The use of AR is principally based on the reproduction of 3D images of virtual objects. It is similar to VR, but it is important to underline their main differences. AR is principally characterised by the superposition of virtual elements generated by a computer on users' real and physical environment (Cho and Schwarz, 2010; Drascic and Milgram, 1996), but even if the purposes of AR and VR are similar (i.e. to enhance the consumer experience), they address these aims in different ways. AR consists of reproducing virtual objects in the real environment, while in VR, the reproduction of the object is developed by devices that users have to wear, such as smart glasses (Milgram *et al.*, 1994). More specifically, VR is defined as a realistic 3D environment developed by a computer (Burdea and Coiffet, 2003) and

Authors	Definition of AR	Prevalent elements
Carmignani and Furht (2011)	AR is defined as a real-time direct or indirect view of a physical environment that has been augmented by adding virtual computer-generated information	Real time Physical environment Virtual information
Sood (2012)	AR converges the physical world with virtual objects, augmenting the view of the physical world with streams of information from the Web	Physical world Virtual objects
Ukwuani and Bashir (2017)	AR is aimed at improving and enhancing the way we perceive our surroundings by combining technologies such as computing, sensing and display technologies	Enhanced surroundings Combined technology
Olsson *et al.* (2013)	AR is a technique that combines real and computer-generated digital information into the user's view of the physical real world in such a way that they appear as one environment	Combination of real and digital information Physical world Real world
Scholz and Smith (2016)	AR seems to be an ideal technology for forging deeper relationships, as it fuses and entangles branded content with consumers' own environments and bodies	Ideal technology Forging relationships
Javornik (2016a, b)	AR is an interactive technology that modifies physical surroundings with superimposed virtual elements. The user can add textual information, images, videos or other virtual items to the person's viewing of the physical environment	Interactive technology Physical surroundings Virtual elements
Grewal *et al.* (2017)	AR is one of the emerging applications that will define the future of retailing	Emerging application Future of retailing
Hwangbo *et al.* (2017)	AR refers to the computer graphic technology that visualizes things that exist in the natural environment by combining computer-generated sensory inputs such as sound, video, graphics, or GPS data from the physical, real world environment	Computer graphic technology Natural environment Sensory input
Pantano *et al.* (2017)	AR is a real-time view of the physical world augmented with virtual computer-generated information	Real time view of the physical world Virtual information
Poushneh and Vasquez-Parraga (2017)	AR is a series of technologies that integrate real world and virtual information, enhancing a specific reality	Real world Virtual information
Rese *et al.* (2017)	AR integrates computer-generated objects with the real environment and allows real-time interactions	Real environment Real time interactions
Yim *et al.* (2017)	AR is defined as the superposition of virtual objects on the real environment of the user	Virtual objects Real environment
Brengman *et al.* (2018)	AR allows for the digital overlay of content to the user's real environment	Digital content Real environment
Lee and Leonas (2018)	It brings virtual and artificial objects into a real environment	Virtual and artificial objects Real environment
Poushneh (2018)	AR is an interactive technology that generates three-dimensional virtual content and then maps it onto the user's reality	Interactive technology Virtual content
Watson *et al.* (2018)	AR layers virtual elements over physical environments, and blends virtual worlds with reality. AR is a system to have these properties: combines real and virtual objects in a real environment; runs interactively and in real time; registers (aligns) real and virtual objects with each other	Virtual elements Physical environment Interactivity Real time

Source: Authors' data elaboration

Table I.
Definitions of AR

composed only of virtual elements (Milgram *et al.*, 1994). The main differences and similarities between AR and VR are underlined in Table III, where similarities are indicated with the letter S and differences with the letter D.

Considering the differences between AR and VR, the positive effects generated by AR are more appropriate for brick-and-mortar stores because through AR, consumers have the

	Elements of AR	Description
Technology	Augmented content (AC)	This component is constituted by technology-enabled content reproduced in three-dimension (3D) such as pictures, objects, video, information, text
Context	Augmented real environment (ARE)	This component is related to the real environment where users are immersed and in which the content is integrated
User experience	Augmented experience (AE)	This component is related to the possibility of enabling users to enrich their experience by interacting with a virtual element in real time and physical space by enhancing their perception

Table II.
Elements of AR

Source: Authors' data elaboration

Elements of AR	Differences and similarities		AR	VR
Technology	Reproduction in 3D	D	Objects	Environment
	Superposition	D	Virtual elements in real environment	Virtual element in virtual environment
	Need for electronic tool	D	No need to see	Yes need to see
	Computer based	S	Yes	Yes
Context	Kind of reality	D	Natural reality	Synthetic reality
User experience	Goal	S	To enhance consumer experience	To enhance consumer experience

Table III.
AR vs VR

Source: Authors' data elaboration

opportunity, for example, to test several products/clothes without physically trying them (Verhagen *et al.*, 2014; Yim *et al.*, 2017). In this context, AR is more realistic than VR for different reasons. AR permits the overlap of virtual elements in the real and physical worlds in which a user is immersed (Hwangbo *et al.*, 2017), whereas with VR, the user is completely immersed in a virtual world with virtual objects. In this way, VR presents a stark difference to AR because in VR, a synthetic reality is generated by a computer (Pantano *et al.*, 2017; Burdea and Coiffet, 2003) and is composed only of virtual objects (Milgram *et al.*, 1994). However, it is interesting to note that techniques used to develop AR applications come from techniques used in developing VR (Rese *et al.*, 2017; Azuma, 1997). Moreover, AR is considered similar to VR in supporting the goal of enriching users' experience (Yim *et al.*, 2017).

What AR applications are relevant for retailers?

In the last few years, a high number of retailers (principally in the beauty and apparel sectors) have introduced different kinds of AR applications in order to enhance the customer shopping experience (Flavián *et al.*, 2019). Through an analysis based on company reports, company website information and documents elaborated by a consulting research company (e.g. Goldman Sachs, 2016; Ericsson Consumerlab, 2017; MarketsandMarkets, 2018), three major AR applications used by companies were identified: online web based, in-store and mobile app, as shown in Table IV. These examples are more permanent features of AR applications and primarily concern beauty and apparel sectors but also other retail sector like toys (LEGO), furniture (IKEA and Wayfair), interior decoration (Dulux) and grocery retailing (Yihaodian and Coop Italia).

Online web-based applications

Online web-based applications permit customers to have an immersive shopping experience while comfortably seated in front of their computer. Via webcam, this kind of

Type of application	Brand	Short description
Online web based	Benefit Cosmetics	Brow Try-on
	CoverGirl	Try it: Virtual Makeover Tool
	DeBeers	Forvermark Fitting
	Estee Lauder	Facebook Messenger Chatbox
	Ray-Ban	Ray-Ban Virtual Mirror
	Yihaodian	Virtual Store
In-store	Adidas	Smart Fitting Room
	Burberry	AR Mirror
	Burberry Beauty	Burberry Beauty Box
	Coop Italia	Augmented Label
	GAP	Smart Fitting room
	Lego	AR Kiosk
	L'Oréal	AR Mirror
	Mac Cosmetics	Virtual Mirror
	Nike	AR Display
	Rebecca Minkoff	AR Mirror
	Sephora	AR Mirror
	Shiseido	Makeup Mirror "TeleBeauty"
	Topshop	AR Fitting Room
	Uniqlo	Smart AR Mirror
	Zara	AR Dispaly
Mobile app	BMW	BMW i Visualiser
	Converse	The Sampler
	Dulux	Dulux Visualizer
	IKEA	IKEA Place
	L'Oreal	L'Oréal ModiFace
	Lego	Lego AR Studio
	Rimmel	Rimmel Get the Look
	Sephora	Sephora Virtual Artist
	Swarovski	AR Smartphone Filters
	Wayfair	Wayfair Reality App
	Zara	Zara AR Studio Collection

Source: Authors' data elaboration based on industry reports, company websites and newspaper articles

Table IV. Types of AR applications and examples

AR scans and tracks customers' bodies and movements to allow customers to try on various virtual clothes as they would in a real fitting room (Kang, 2014). The computer screen becomes an AR mirror through which customers can immediately see how clothes look in real time and adjust the size and colour of clothing items just by using hand gestures. AR permits consumers to better visualise their appearance (Berman, 2019). For example, the Ray-Ban Virtual Mirror is one of the first online web-based AR applications developed in the retail setting, and it is accessible through the company's' international website. Potential customers can try on several kinds of sunglasses and find the most suitable ones for their face (Pantano *et al.*, 2017). Thanks to the computer camera, which becomes a virtual mirror, several beauty companies (e.g. Benefit Cosmetics, CoverGirl, Estee Lauder) offer their customers a new makeup experience, enabling customers to become almost like real makeup artists.

In-store applications

Recently, retailers have been increasingly interested in using various AR applications in the shopping process to bring life to the point of sale by personalising the in-store experience through AR (Berman, 2019). Sometimes a monitor and video could be sufficient to engage people and enhance the shopping experience in a more digitalised retail store.

AR in-store applications are based on projection-based AR interfaces that are able to offer consumers an enhanced and more immersive and interactive experience (Huang, 2019; Yim and Park, 2019). Several big companies, such as L'Oréal and Sephora, have introduced AR mirrors in their stores to enable customers to experience virtual facial makeup (Berman, 2019; Yim *et al.*, 2017; Jaekel, 2016). Other companies, such as Nike and Adidas, have used AR applications to enrich the experience of their customers during the shopping process (Yim *et al.*, 2017).

Several AR in-store applications are principally based on a dressing room, which allows users to try on clothes virtually in front of an "augmented mirror" by reducing the time in which a user has to decide whether the clothing fits. In this way, customers are able to try on more clothes in less time (Erra and Colonnese, 2015). Furthermore, virtual mirrors allow customers to take a picture of their clothes from any angle and compare them with other clothes or share their impressions with other people through the social application (Berman, 2019; Pantano and Gandini, 2017, 2018) installed inside the virtual mirror. These applications give customers a new and interactive way to try on clothes without removing any items they are wearing. The applications also enable customers to create outfits by mixing and matching a broad range of clothing from retailers' inventory (Kim *et al.*, 2017; Poushneh, 2018; Fretwell, 2011) and enhance users' perception of the real world in real time (Lee and Leonas, 2018; Yuen *et al.*, 2013; Yaoyuneyong *et al.*, 2014). This type of in-store application also allows customers to check the size and colour of the clothes they are wearing before purchasing (Hwangbo *et al.*, 2017). In this way, customers can obtain information about their body shape in relation to the clothes they want to buy. This AR in-store application has the power to offer many of the same benefits that only traditional retailing provided in the past (Lee and Leonas, 2018).

Mobile applications

Mobile augmented reality (MAR) applications are a relatively recent phenomenon in the research literature but are increasingly common applications within retailing (Scholz and Duffy, 2018). Through a handheld device (e.g. smartphone, camera and tablet), MAR applications permit users to explore the surrounding area (Dacko, 2017). Leading companies, such as IKEA, Wayfair and Sephora, have introduced specific mobile AR apps to permit consumers to try products on their bodies or in specific spaces in the home or elsewhere (Scholz and Duffy, 2018). By using a smartphone camera, users can integrate physical and augmented elements, interact with digital content and find and evaluate products in novel ways.

One of the most significant applications developed in recent years is the IKEA mobile app that permits users to see a specific room (e.g. living room, kitchen and bedroom) and to add virtual content from IKEA. Users can then evaluate the content relative to where in the home it is expected to be placed (Lee and Leonas, 2018; Rese *et al.*, 2014). Other companies, such as Ray-Ban and Sephora (Scholz and Duffy, 2018), have introduced self-augmentation applications to increase user interaction with the brand and increase customer satisfaction through more information, interaction and utility (Poushneh and Vasquez-Parraga, 2017).

What kind of value may AR provide for consumers and retailers?

AR can contribute to enriching the retail setting both online and in and physical stores by generating different value for consumers and retailers (e.g. Pantano *et al.*, 2017; Scholz and Duffy, 2018).

Value for consumers

AR enables consumers and potential users to interact with products and touch them in an augmented way (Brengman *et al.*, 2018) by increasing product tangibility (Vonkeman *et al.*, 2017)

and purchase confidence (Pantano, 2014, 2016). AR helps customers see how products fit them personally (Rese *et al.*, 2014; Lu and Smith, 2007; Olsson *et al.*, 2013) by adding different degrees of information (e.g. digital and interactive images, videos). When they touch an object, customers' intention to buy the object increases, as do their willingness to pay a higher price and their general willingness to buy. Customers' interaction and full immersion in the retail context is facilitated by more information (Yaoyuneyong *et al.*, 2014). Examples range from information on product assembly, product content and how the product works to more general entertainment elements. AR enables customers to become co-designers of what they want to buy. Through AE, it is possible to create a deeper level of customer satisfaction and engagement (Javornik, 2016a, b) and modify customer decision making. AR creates a "space of fantasy", as highlighted by Scholz and Duffy (2018), where customers interact with others. The shopping experience becomes more intuitive and sensitive when customer satisfaction is enhanced (Dacko, 2017). AR applications offer more dynamic 3D animation during the online shopping process compared to traditional e-commerce (Pantano *et al.*, 2017; Li *et al.*, 2013; Lee and Park, 2014). Overall, several benefits and types of value for consumers can be achieved through AR in the retail environment, as highlighted in Table V.

Value for retailers

Meanwhile, AR gives retailers possibilities to achieve several goals in their advertising and marketing strategy and to stimulate customers to come to their shopping space (online and/or offline), increase brand awareness and customer loyalty, and create an AE in an immersive experiential environment. In particular, AR applications enable retailers to reshape or redesign retail space by promoting a different mode of customer perceptions and sense making and by using several elements related to the five senses. Retailers can use AR to provide customers with virtual try-on opportunities to help them find the most suitable products for their needs (Brengman *et al.*, 2018). AR has become an excellent opportunity for promoting retail stores and increasing customer attendance. Its advantages for retailers are related to increased speed for obtaining information about consumer behaviour and consequently improvement in service at the point of sale with positive influences on the consumer shopping experience (Flavián *et al.*, 2019; Dacko, 2017; Pantano and Naccarato, 2010). Through AR, retailers have possibilities to increase sales volumes with mobile, web-based and in-store applications by offering a personalised pre-purchase evaluation (Dacko, 2017). As underlined by Scholz and Smith (2016), AR is important for retailers as a means of generating a memorable customer experience and creating consumer engagement (Bonetti *et al.*, 2018). Table VI shows the main benefits retailers can obtain from using AR in their retail strategy.

Concluding discussion

The purpose of this paper was to conduct a review of AR in retailing within business-oriented research. It has reviewed and discussed the features of AR through

Values for consumer	
Interaction	More interaction with products and brand
Experience	Augmented shopping experience, intuitive and sensitive
Engagement	Involvement in creating personal products
Information	Get more kind of information regarding products, instruction for use and about companies
Entertainment and creativity	Create personal products or personalise them
Satisfaction	High level of satisfaction

Source: Authors' data elaborations

Table V.
AR value for consumers

Value for retailers	
Advertising	Creative and interactive advertising
Experience	Experiential environment
Attracting	Customers online and offline
Sales	Increase sale volume
Environment (online and offline)	Smart and easy to use
Brand awareness and customer loyalty	Increase BA and CL
Information	Get more information regarding customers behaviour

Table VI.
AR value for retailers

Source: Authors' data elaborations

analysing its origins and development, definitions and elements as well as how it differs from VR (Table VII). It has described and discussed different types of AR applications relevant for retailers with specific examples in three major areas: online-based, in-store and mobile apps (Table VII). It has also described and discussed the value of AR for consumers and retailers (Table VII).

From this review, it is clear that AR may provide retailers with several opportunities to enhance the store experience for consumers and potential users to interact with products and touch them in an augmented way (Brengman *et al.*, 2018), to increase consumer engagement (Javornik, 2016a, b), to enhance product tangibility (Vonkeman *et al.*, 2017) and to increase willingness to buy. Thus, increased interest in AR in retailing among researchers and practitioners is most likely to continue. However, AR is still in the budding stages for retailers and business-oriented research, and there is a great scope for further development.

Research limitations and future research

While this paper contributes an overview of a relatively recent but rapidly emerging theme that has so far not been sufficiently reviewed, the limitations should also be acknowledged. As an overview, the paper does not provide an in-depth understanding of various aspects of AR and its applications within retailing that empirical research would provide; the paper provides more of a snapshot of AR's present state rather than a thorough understanding of its development over time or a more systematic literature review using quantitative methods. However, despite these limitations, the paper raises important issues for future research. First, based on our identified elements of AR, which consist of technology, context and the user experience, it was found that given AR's origin and initial development, much progress has occurred in technological aspects among practitioners and in the research literature. Less is known about user experiences and the contexts in which AR is used. These are fruitful arenas to further explore empirically for retailers and consumer- and business-oriented retail research. Specifically, we think that such research should address the implications of AR in terms of its effects on retailing, its integration within retailing and the value it provides (cf. Hagberg *et al.*, 2017). Second, we think that further empirical research should combine in-depth case studies of AR applications within retailing with cross-case analyses that are able to compare different types of retailers and situations in order to understand the conditions under which AR is more or less suited to the context of retailing and to what extent the potential values of AR are also realized in practice. Third and finally, we believe that such comparisons should be complemented with longitudinal studies that are able to provide insight into the development of AR over time. Like any other technology-related phenomena in retailing, there may be major differences over time depending on the maturity of the technology and its usage, which among other things means that the value provided by such technologies are different when they are introduced and if/when they become part of everyday life. Overall, we believe that AR will call for and provide several opportunities for retailing research in the

AR	Key points	Relevant literatures		
Features	Origin and development	Azuma (1997), Azuma *et al.* (2001), Carmignani and Furht (2011), Caudell and Mizell (1992), Daponte *et al.* (2014), Flavián *et al.* (2019), Levin (2006), Hwangbo *et al.* (2017), Poushneh and Vasquez-Parraga (2017), Ramadan and Farah (2017) and Reinwald *et al.* (2014)		
	Definitions and elements	Emphasis on technological aspects Carmignani and Furht (2011), Hwangbo *et al.* (2017), Lee and Leonas (2018), Olsson *et al.* (2013), Pantano *et al.* (2017), Sood (2012), Ukwuani and Bashir (2017) and Watson *et al.* (2018)	Emphasis on user experience Brengman *et al.* (2018), Grewal *et al.* (2017), Javornik (2016a, b), Poushneh and Vasquez-Parraga (2017), Poushneh (2018), Scholz and Smith (2016), Watson *et al.* (2018) and Yim *et al.* (2017)	
		Technology Azuma (1997), Poushneh and Vasquez-Parraga (2017), and Yim *et al.* (2017)	Context Scholz and Smith (2016) and Ukwuani and Bashir (2017)	User experience Dacko (2017), Daponte *et al.* (2014), Rese *et al.* (2017) and Schmalstieg and Hollerer (2016)
	AR vs VR	Azuma (1997), Burdea and Coiffet (2003), Cho and Schwarz (2010), Drascic and Milgram (1996), Hwangbo *et al.* (2017), Milgram *et al.* (1994), Rese *et al.* (2017), Verhagen *et al.* (2014) and Yim *et al.* (2017)		
Applications	Online based	Berman (2019), Kang (2014), Li *et al.* (2015) and Pantano *et al.* (2017)		
	In-store	Berman (2019), Chung *et al.* (2016), Erra and Colonnese (2015), Fretwell (2011), Hwangbo *et al.* (2017), Huang (2019), Jaekel (2016), Kim *et al.* (2017), Lee and Leonas (2018), Yuen *et al.* (2013), Pantano and Gandini (2017, 2018), Poushneh (2018), Yaoyuneyong *et al.* (2014), Yim *et al.* (2017) and Yim and Park (2019)		
	Mobile app	Cruz *et al.* (2018), Dacko (2017), Lee and Leonas (2018), Poushneh and Vasquez-Parraga (2017), Rese *et al.* (2014, 2017), Scholz and Duffy (2018) and Yim *et al.* (2017)		
Values	For consumers	Brengman *et al.* (2018), Hilken *et al.* (2017), Javornik (2016a, b), Lee and Park (2014), Li *et al.* (2013), Lu and Smith (2007), Olsson *et al.* (2013), Pantano *et al.* (2017), Pantano (2014, 2016), Rese *et al.* (2014), Scholz and Duffy (2018), Dacko (2017), Vonkeman *et al.* (2017) and Yaoyuneyong *et al.* (2014)		
	For retailers	Bonetti *et al.* (2018), Brengman *et al.* (2018), Dacko (2017), Flavián *et al.* (2019), Pantano and Naccarato (2010) and Scholz and Smith (2016)		

Source: Authors' data elaborations

Table VII. Summary of AR features, applications, values and the relevant literature

coming years and will require different approaches and combinations of approaches including qualitative and quantitative empirical studies as well as additional reviews that may summarise and synthesise the results of these studies.

Practical implications

Several practical implications can be drawn from this review. First, one main feature that distinguishes AR from VR is that it combines virtual and physical elements. Thus, AR is particularly suitable for the ongoing hybridisation within retailing that is blurring the digital and physical domains rather than treating them as separate (Hagberg *et al.*, 2016; Grewal *et al.*, 2017); thus, it constitutes an opportunity for retailers in such an emerging landscape. Second, AR may provide opportunities for multiple applications that could be used and combined in different types of settings, including physical stores, consumers' homes or other places in which consumers are on the move. Third, the review outlined a variety of values that may be adjusted to specific situations suitable for different retailers. Rather than a "one size fits all" solution, AR provide opportunities for a variety and

multiplicity of applications of value and thus for many forms of differentiation in an increasingly competitive retail landscape.

Note

1. MarketsandMarkets™ is a private research company that offers B2B research on 30,000 high-growth emerging opportunities and threats that will impact 70 to 80 per cent of companies' revenues worldwide. The "Knowledgestore" platform developed by MarketsandMarkets™ is an intelligence market research platform that connects over 200,000 markets, and it is useful for better understanding issues such as market sizing and forecasts of niche markets.

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Further reading

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