

Immersive Technologies in Retail: Practices of Augmented and Virtual Reality

Costas Boletsis^a and Amela Karahasanovic^b
SINTEF Digital, Forskningsveien 1, 0373 Oslo, Norway

Keywords: Augmented Reality, Customer Engagement, Retail, Shopping, Virtual Reality.

Abstract: In this work, we examine the value that immersive technologies can bring to retailing through the retail practices they facilitate. To that end, a literature review is conducted resulting in the documentation of 28 augmented reality (AR) and virtual reality (VR) applications from 38 publications. After analyzing the applications' functionality and use in retail, the following AR/VR-enabled retail practices emerged: branding and marketing; sales channel; after-sale customer service; virtual try-on; customer-as-designer; virtual training; and workflow management. A principal observation from the analysis is that current AR/VR applications are used mainly for customer-related innovation, with "branding and marketing" being a dominant practice. Simultaneously, some practices are available to serve organization-related and support-related innovation. Finally, it was observed that AR is a popular technology in the retail environment and of high practical value, being an ideal fit for the purchase journey and workflow management. However, VR is more difficult to implement in retail, as it can be more expensive and complicated to integrate with the sales channel. However, it can create strong emotional engagement due to high immersion and act as a useful tool for branding and training. Therefore, these two technologies in retail and their strengths can supplement each other, thereby creating promising innovation strategies when combined.

1 INTRODUCTION

Immersive technologies, such as augmented reality (AR) and virtual reality (VR), are increasingly used in retail environments (Bonetti et al., 2018; Javornik, 2016; McCormick et al., 2014; Caboni and Hagberg, 2019). VR enables the creation of fully immersive virtual environments that "replace" reality (Steuer, 1992; Boletsis and Karahasanovic, 2018). Recently, major changes in VR systems have taken place, reviving the interest in the technology. VR has become accessible, up-to-date, and relevant again due to the low acquisition cost of VR hardware and the rapid increase in virtual environments' quality (Olaszewski et al., 2016; Boletsis, 2017; Boletsis and Karahasanovic, 2018). On the other hand, AR is closer to reality because its technical characteristics enable the augmentation of the real environment (Milgram and Kishino, 1994; Azuma, 1997). Advances in the smartphone industry have allowed for the technology to become widely accessible, enabling users

to enjoy memorable AR simply through their smartphones' screens (Billingshurst et al., 2015; Boletsis and Karahasanovic, 2018). To fully exploit immersive technologies' potential in retail, one needs to understand the critical retailing areas in which their innovations can change the game (Grewal et al., 2018; Boletsis and Karahasanovic, 2018).

The application of AR and VR in retailing has been the subject of previous research. Caboni and Hagberg (2019) formulated the various types of AR applications in retail: online web-based applications; in-store applications; and mobile applications. Moreover, the authors described the utilized methodology for conducting a literature review of business-oriented research around the use of AR in retail. Bonetti et al. (2018) synthesized current debates to provide an up-to-date perspective, incorporating issues relating to motives, applications, and implementation of AR and VR by retailers, as well as consumer acceptance. Furthermore, in our previous work (Boletsis and Karahasanovic, 2018), we documented several AR/VR applications used in retail through a scoping review, and we adopted an innovation-centric approach, examining the generic types of innovation that they tar-

^a  <https://orcid.org/0000-0003-2741-8127>

^b  <https://orcid.org/0000-0003-3442-0866>

get, based on the “Ten Types of Innovation” business framework by Keeley et al. (2013).

In this work, we take inspiration from the aforementioned studies, in order to move to a subfield that has not been covered yet, i.e., examining the value that immersive technologies can bring to retailing through the retail practices they facilitate. To that end, this work contributes to the field of knowledge by: i) documenting AR and VR applications for retail, based on related research, ii) synthesizing the retail practices that AR/VR applications address, iii) investigating the differences between AR and VR when applied in the retailing domain, and iv) briefly discussing the innovation types that the AR/VR-enabled retail practices serve.

The present study’s methodology follows a linear approach and it is based on a literature review to investigate the use of AR and VR in retail. The literature review’s search elements, initially proposed by Caboni and Hagberg (2019), have been used successfully to document business-oriented research earlier (Boletsis and Karahasanovic, 2018). Therefore, we used and further extended these methodological elements here. Whereas our previous study (Boletsis and Karahasanovic, 2018) investigated AR/VR in retail from an innovation-centric perspective, this research takes a technology-centric perspective, focusing on the retail practices that AR and VR technologies facilitate and the value and functionalities they can support. Naturally, our previous (Boletsis and Karahasanovic, 2018) and current works supplement each other, providing a more complete understanding and overview of the topic from two different perspectives. We aspire for this work to act as a guide for researchers, developers, and practitioners in retail to base their future decisions and designs around AR and VR on existing theoretical and practical knowledge.

The paper is organized as follows. Section 2 presents the study’s methodology. Section 3 describes the literature review process that was followed to document the AR and VR applications. Section 4 theoretically analyzes the literature review’s results, focusing on the addressed retail practices. Section 5 discusses the results, focusing on the AR and VR technologies, with the paper concluding in Section 6.

2 METHODOLOGY

This study’s methodology is enabling the transition from specific practice to general theory by following a bottom-up approach. The ultimate goal is to investigate the use of AR and VR in retail through the analysis of commercial AR and VR retail applications that

appear in the literature. At first, we document current AR/VR-enabled retail practices through a literature review and axial coding. Then, we analyze these practices and the characteristics of and differences between AR and VR in retail are discussed.

The reasoning behind the implemented methodology is to examine current practices, as documented and accredited by peer-reviewed literature; then formulate related theory out of these practices, so that future research and practice of AR/VR in retail can have a better overview of the field and the necessary theory to ground/analyze future contributions.

3 LITERATURE REVIEW

Certain methodological elements from the our previous preliminary literature review (Boletsis and Karahasanovic, 2018) were also implemented and are highlighted below. Despite being a scoping literature review, the guidelines for systematic literature reviews (Kitchenham, 2004; Beecham et al., 2008) were considered while constructing the review process and its stages, to ensure a seamless expansion of this scoping literature review into a systematic one in the future, as described in Section 6.

3.1 Search Strategy

A literature search was performed in the Scopus academic search engine during December 2019 and May 2020. The Scopus search engine searches through the databases of other publishers, such as ACM, Elsevier, IEEE, Springer, Sage, Oxford University Press, Cambridge University Press and many more. The keywords used for the retrieval of eligible articles were “augmented reality application” or “virtual reality application” and “retail”. No publication-year-related filtering was used. Eligible articles were also identified through backward reference searching, i.e., by screening the retrieved publications’ reference lists (Vom Brocke et al., 2009). Scopus, Google Scholar, Google Search, and Web of Science were utilized for the backward reference searching to run general searches of specific references and to identify relevant articles.

3.2 Inclusion and Exclusion Criteria

At this point, the inclusion/exclusion criteria of the preliminary literature review (Boletsis and Karahasanovic, 2018) were used. Therefore, peer-reviewed articles with the following characteristics were included:

1. written in English and accepted and presented in peer-reviewed publications,
2. presenting, describing, or analyzing – at any extent – a commercial AR or VR retail application, which is used by retail businesses in real life (e.g., being an application in an app-store, application or service in a physical store, et al.).

Based on inclusion criterion #2, research prototypes and conceptual descriptions of applications were excluded.

The criteria's formulation is based on the facts that: i) the peer-review process adds to the credibility and reliability of the publications and the respective presented applications, and ii) the actual use of the VR and AR applications by retail businesses ensures that the presented applications are existing, usable, and beyond the conceptual level (Boletsis and Karahasanovic, 2018).

3.3 Screening Process and Results

The initial search elicited 243 articles. In total, 96 articles were identified as appropriate for inclusion while 25 articles satisfied the inclusion criteria. Then, backward reference searching of the extracted articles' references took place, resulting in 13 additional articles that fulfilled the inclusion criteria. The authors reviewed all 38 articles independently. The categories and themes of the review were shaped by the authors/reviewers, based on the data extraction process. A high level of agreement (>80%) between the authors/reviewers was achieved, regarding the inclusion/exclusion decisions and the formulated categories and themes. Any disagreements were discussed and settled.

3.4 Data Extraction & Synthesis

The data extracted from each article included: the article's full reference and additional descriptive information regarding the AR/VR application, such as the title, description, and/or use details.

The two reviewers jointly performed the data extraction process. The descriptions of the AR/VR applications in retail were based on the descriptions provided in the articles and/or other related publications. For demonstration purposes, YouTube video links with the applications' functionality were also collected by querying the title of each application on YouTube.

The themes of the review were conjointly synthesized by the two authors, based on the data extraction process. The AR/VR applications' retail practices

were formulated based on the applications' descriptions and functionality, as presented in the reviewed articles and the video demonstrations. Axial coding of the documented AR/VR practices took place so that each theme contains comparable and consistent categories. The main themes identified in the review and tabulated (Table 1) were:

- the AR/VR retail applications,
- their features, i.e., description, utilized technology, and video demonstration, and
- the AR/VR applications' retail practices.

4 RESULTS

4.1 AR/VR-enabled Retail Practices

The literature review resulted in the analysis of 28 AR and VR applications (AR/VR: 19/9). After documenting and analyzing their functionality and use in retail, the following retail practices emerged:

- **Branding and Marketing:** Even though these terms are quite different from their scope, in this case, they are operating together. AR/VR applications can be used i) in a short-term, tactical way to engage/activate customers by fostering compelling, emotional interactions and, at the same time, ii) in a long-term, strategic way to establish a brand as technologically innovative and creative. Most of the times, the "marketing" use of AR/VR has omnichannel functionality (e.g., L'Oreal Makeup Genius, Tesco Discover, IKEA VR Experience, McDonald's Track My Maccas, etc.), containing connections to other marketing channels, such as magazines, social media, ad videos, websites, and physical stores to create strong brand experiences and innovative multiplatform offerings (Verhoef et al., 2015; Boletsis and Karahasanovic, 2018).
- **Sales Channel:** AR/VR applications can provide an easy way to bring products or services to market so that they can be purchased by consumers, targeting to make immediate use of the customer engagement that AR and VR can achieve at a pre-sale level, e.g., during virtual try-ons, customer-as-a-designer schemes, or various marketing practices (Loureiro et al., 2019; Boletsis and Karahasanovic, 2018). Therefore, they can serve as sales channels, integrated into customers' purchase journey through instant actions to buy (e.g., Sephora Virtual Artist, IKEA Virtual Reality Store).

Table 1: The reviewed AR and VR applications in retail.

Application Title	Tech	Description	Demonstration	Retail Practice	References
Alibaba Buy+	VR	VR application that allows customers to browse and shop items in a virtual mall.	https://youtu.be/-HcKRKBkIilg	Sales channel Branding & marketing	(Jean, 2017; Mustafa et al., 2018; Farah et al., 2019; Boletsis and Karahasanic, 2018)
Audi Quattro Coaster	AR	Mobile application for building a 3D track and displaying a 3D interactive model of a car.	https://youtu.be/ZzQBZ-2i24	Branding & marketing	(Boletsis and Karahasanic, 2018)
Auto Bild AR	AR	AR application for the Auto Bild magazine that displays 3D objects and scenes when certain parts of the magazine are scanned.	https://youtu.be/XQY_leU6_5Y	After-sale customer service Branding & marketing	(Rese et al., 2017)
Carrefour VR	VR	VR application which takes users for a roller-coaster ride while showcasing several products.	https://youtu.be/513whiHw_I0	Branding & marketing	(Loureiro et al., 2019)
DHL Vision Picking	AR	Application for AR glasses to facilitate order processing, warehouse planning, and training of warehouse staff.	https://youtu.be/I8vYrAUb0BQ	Workflow management Virtual training Branding & marketing	(Satoglu et al., 2018; Guo et al., 2015; Miralades et al., 2015; Boletsis and Karahasanic, 2018)
Dulux Visualiser	AR	Mobile application that allows users to test paint colors on their walls using AR and a mobile device's camera.	https://youtu.be/4IMFxl4PDXy	Virtual try-on Branding & marketing	(Scholz and Smith, 2016; Boletsis and Karahasanic, 2018)
Hyundai Virtual Guide	AR	Mobile application that serves as a car owner's manual.	https://youtu.be/qOMv16-cP7o	After-sale customer service Branding & marketing	(Poushneh, 2018; Hilken et al., 2018; Avila and Bailey, 2016; Boletsis and Karahasanic, 2018)
IKEA Catalog	AR	Mobile application that allows users to scan select pages and images from the printed catalog to access extended AR content and display it on top of real space.	https://youtu.be/tauxLru4-Vw	Virtual try-on Branding & marketing	(Baier et al., 2015; Rese et al., 2014; Rese et al., 2017; Dacko, 2017; Boletsis and Karahasanic, 2018)
IKEA Virtual Reality Store	VR	VR application for users to furnish a virtual room in real scale and then get a list of all items selected with the unique reference code and price list.	https://youtu.be/6Ubpjje-l-TQ	Sales channel Branding & marketing	(Loureiro et al., 2019; De Silva et al., 2019)
IKEA VR Experience	VR	VR application for users to experience and customize a VR IKEA kitchen.	https://youtu.be/c-NUbGrAeYU	Virtual try-on Branding & marketing	(Man and Qun, 2017; Edvardsson and Enquist, 2011; Kemke et al., 2006; Boletsis and Karahasanic, 2018)
L'Oreal Makeup Genius	AR	Mobile application that allows users to instantly try on different styles of make-up.	https://youtu.be/zBbJfrkZRDI	Virtual try-on Branding & marketing	(Hilken et al., 2017; Hilken et al., 2018; Boletsis and Karahasanic, 2018)
Lego AR Studio	AR	Mobile application that creates a virtual Lego gameplay experience to be combined with physical Legos.	https://youtu.be/cHvcD2FrKew	Customer-as-a-designer After-sale customer service Branding & marketing	(Moorhouse et al., 2018; Iyadurai and Subramanian, 2016; Boletsis and Karahasanic, 2018)

Table 1: The reviewed AR and VR applications in retail (cont.).

Lego Connect	AR	AR application for the Lego catalogue that displays 3D objects and scenes when certain parts of the magazine are scanned.	https://youtu.be/O-62MTcpcIE	Sales channel Branding & marketing	(Miraldes et al., 2015)
Lego Digital Box	AR	AR application that scans the surface of a Lego box and presents a 3D object of its content.	https://youtu.be/BUDIduApeLI	After-sale customer service Branding & marketing	(Miraldes et al., 2015)
McDonald's Track my Maccas	AR	Mobile application for displaying 3D interactive stories about a meal's ingredients and where the ingredients came from.	https://youtu.be/7IFQQGADJf4	After-sale customer service Branding & marketing	(Grybs, 2014; Bresciani and Ewing, 2015; Boletsis and Karahasanic, 2018)
Mister Spex Virtual Mirror	AR	AR application for users to try on various pair of glasses.	https://youtu.be/IPc07J5IH0I	Virtual try-on Sales channel Branding & marketing	(Rese et al., 2017; Hilken et al., 2017)
Mitsubishi Electric MeView	AR	AR application that serves as a virtual assistant displaying instructions through 3D models.	https://youtu.be/Edi02M1nS8g	After-sale customer service Branding & marketing	(Miraldes et al., 2015)
NikeID In-store AR	VR	AR projection of customized shoe designs on top of real shoes.	https://youtu.be/5LNIXKXaCBE	Customer-as-a-designer Branding & marketing	(Bonetti and Perry, 2017; Boletsis and Karahasanic, 2018)
North Face VR Experience	VR	360-degree film about traveling experiences.	https://youtu.be/Cr-9ujLco50	Branding & marketing	(Dulabh et al., 2018; Boletsis and Karahasanic, 2018)
RayBan Virtual Mirror	AR	AR application for users to try on various pair of glasses.	https://youtu.be/2onjpEQOm64	Virtual try-on Sales channel Branding & marketing	(Rese et al., 2017)
Sephora Virtual Artist	AR	Mobile application that allows users to instantly try on thousands of lip colors.	https://youtu.be/NFApcSocFDM	Virtual try-on Sales channel Branding & marketing	(Mocanu, 2012; Yim et al., 2017; Boletsis and Karahasanic, 2018)
Tesco Discover	AR	Application for scanning Tesco publications to reveal additional content and purchasing products using buy links.	https://youtu.be/gR7FsWaP3Mw	Sales channel Branding & marketing	(Bodhani, 2013; Baier et al., 2015; Rese et al., 2014; Boletsis and Karahasanic, 2018)
Tesco Pele	VR	VR application for users to experience the environment of a Tesco store and a football field.	https://youtu.be/VXWhR_k1vvc	Branding & marketing	(Loureiro et al., 2019)
Toms Virtual Giving Trip	VR	360-degree film about a charity mission.	https://youtu.be/jz5vQs9jXCs	Branding & marketing	(Grewal et al., 2018; Boletsis and Karahasanic, 2018)
Uniqlo's Magic Mirror	AR	AR application for users to try on various clothes in front of an AR mirror.	https://youtu.be/oUD57MpHAE8	Virtual try-on Sales channel Branding & marketing	(Balaji et al., 2018; Zhao and Balagué, 2017; Boletsis and Karahasanic, 2018)
Volkswagen Golf Cabriolet	AR	Mobile application for displaying a 3D interactive model of a car.	https://youtu.be/pFS6EHZBGVc	Branding & marketing	(Bodhani, 2013; Boletsis and Karahasanic, 2018)
Volvo XC90 Test Drive	VR	360-degree experience about driving a car.	https://youtu.be/HEkGRUkqjTA	Virtual try-on Branding & marketing	(De Gauquier et al., 2019; Boletsis and Karahasanic, 2018)
Walmart VR in Academics	VR	VR application for training employees.	https://youtu.be/oRbmLBWdEoI	Virtual training Branding & marketing	(Carruth, 2017; Babu et al., 2017; De Keyser et al., 2019; Boletsis and Karahasanic, 2018)

- **After-sale Customer Service:** The fact that immersive technologies can blend with reality provides the opportunity for immersive applications to add virtual content to real-life use contexts and offer additional customer value. AR/VR applications can provide various after-sale services by offering complimentary product-related information in use-context (Grybś, 2014; Boletsis and Karahasanovic, 2018). This enables customers to have their purchased products extended with new, virtual content for several purposes (e.g., entertainment content for Lego AR Studio, good publicity content for McDonald's Track my Maccas) or to get useful after-sale customer support and guidance (e.g., Hyundai Virtual Guide).
- **Virtual Try-on:** AR and VR can visualize “what could be”. Virtual try-ons (VTOs) visualize the use of certain products as 3D graphics in AR or VR space. These try-ons enable the customers to get an idea about how the product would work or fit them, at a pre-sale stage, thus attempting to affect purchase decision (Boletsis and Karahasanovic, 2018; Scholz and Smith, 2016; Hilken et al., 2017; Hilken et al., 2018). The analysis indicates a high concentration of VTOs applications. Customers can virtually try furniture, clothes, and makeup products and more, as AR 3D models augmenting themselves and the physical space (e.g., IKEA Catalog, Uniqlo's Magic Mirror, Sephora Virtual Artist). VR VTOs immerse customers into VR spaces and try to communicate a sense of actually using the product (e.g., IKEA VR Experience, Volvo XC90 Test Drive).
- **Customer-as-Designer:** AR/VR applications can be used to extend products' value by involving customers in the value-creation process. A company provides the AR/VR tools, and customers can design the final product or formulate a different user experience with the product (Boletsis and Karahasanovic, 2018; Moorhouse et al., 2018). The “customer-as-designer” use can be present at the pre-sale (e.g., NikeID In-store AR) and/or after-sale (e.g., Lego AR Studio) stages.
- **Virtual Training:** AR/VR technologies can facilitate the development of virtual environments and simulated scenarios, offering users high immersion and engagement levels (Boletsis and Karahasanovic, 2018; Carruth, 2017; Babu et al., 2017). Companies use these features for employee training in virtual settings (e.g., Walmart VR in Academies).

- **Workflow Management:** AR/VR applications can practically affect the backstage way that retail works and utilize the technologies to provide better workflow management, e.g., regarding warehouse planning and order picking (DHL Vision Picking). The extra layers of information that can be visualized through these technologies – in real or virtual environments – provide several opportunities to annotate and organize retail workflow further (Boletsis and Karahasanovic, 2018; Satoglu et al., 2018; Guo et al., 2015).

4.2 Frequency of AR/VR-enabled Retail Practices

The AR/VR applications' analysis produced 56 instances of the seven AR/VR-enabled retail practices mentioned above (i.e., an average of two retail practices per application, one always being “branding and marketing”). The AR applications covered 42 instances of retail practices, while VR applications addressed 14 instances. The overall instances of AR/VR-enabled retail practices per technology are presented in Figure 1.

5 DISCUSSION

In this section, we examine and discuss the following issues: i) what types of innovation in retail do the documented AR/VR-enabled practices address (Section 5.1); ii) how do the features of AR and VR in retail compare (Section 5.2); and iii) what are the limitations of this study (Section 5.3).

5.1 AR/VR-enabled Retail Practices & Innovation

A main observation from Figure 1 is that current AR/VR applications are used mainly for customer-related innovation¹. Branding and marketing is a dominant practice, with all reviewed applications addressing it, along with potentially some additional functionality (e.g., after-sale support service, virtual try-on, et al.). Companies advertise their AR/VR practices as an innovative feature and utilize the technologies to establish their brands and send the message that they stand for innovation, exploration, and creativity, thereby attempting to create loyal customers (Boletsis and Karahasanovic, 2018). The

¹They are front-line innovations, including new product lines, product categories, retail services, store formats or channels to market (Hristov and Reynolds, 2015).

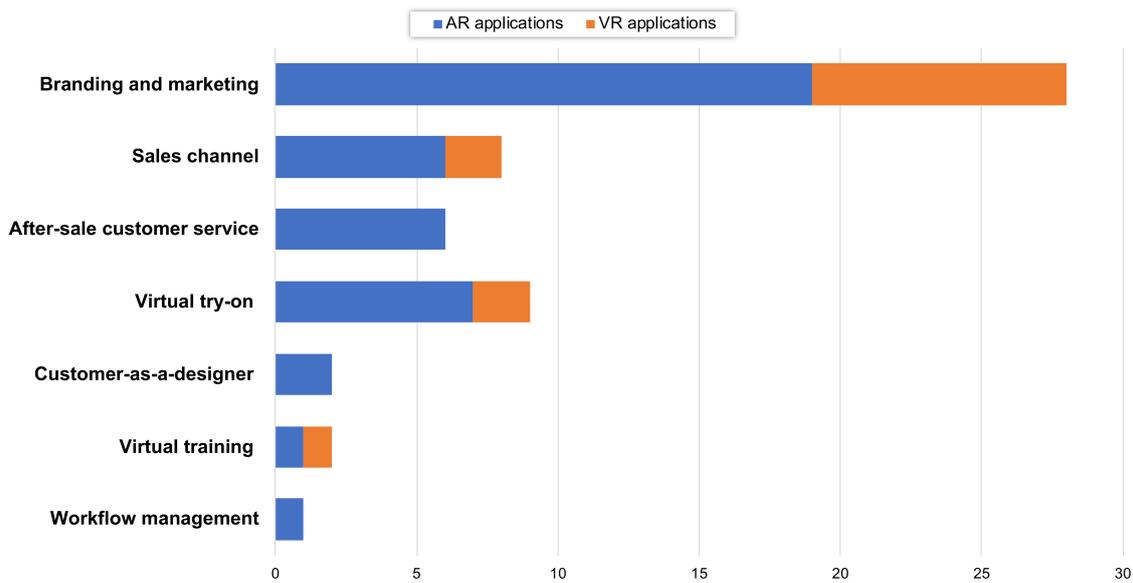


Figure 1: The number of instances of the AR/VR-enabled retail practices from the 28 reviewed AR/VR applications.

other retail practices that occupy that space concern the use of AR/VR applications to provide added customer value at different periods of the purchase journey (Bonetti and Perry, 2017; Bonetti et al., 2018): pre-sale (e.g., virtual try-ons, customer-as-a-designer); sale (e.g., sales channel); and after-sale (e.g., after-sale customer service).

At the same time, there is a limited number of practices for organization-related² and support-related innovation³ processes, i.e., the virtual training and workflow management retail practices. To tackle this issue, the retail industry could apply AR/VR innovation more intensively in support-related and organizational-related processes. These innovations could focus on organizing company assets – hard, human, or intangible – in unique ways that create value and/or develop activities and operations that produce a company’s primary offerings beyond the “business as usual” stage. (Boletsis and Karahasanovic, 2018; Keeley et al., 2013).

5.2 AR vs. VR in Retail

Apart from AR and VR retail practices, and the innovation types they serve, we consider it useful to exam-

²It mostly concerns business model innovation, which might include new organizational structures, operating routines, or administrative processes (Hristov and Reynolds, 2015).

³It encompasses information and communications technologies, supply chains and broader operational systems. Such innovations are less visible from a customer perspective (Hristov and Reynolds, 2015).

ine the different elements that each technology brings to the table to inform this work’s practical implications further. Three main differences were identified based on the review presented herein:

5.2.1 Use

The fact that AR is blended with real life to scale provides the opportunity for applications to add virtual content to the real-life context. This feels natural to the shopping and product environment because it enables virtual try-on sessions, product trials, and interactions to affect purchase decisions (Boletsis and Karahasanovic, 2018; Catchoom, 2017). Moreover, AR applications can offer product-related information in context, provide after-sale services, and offer additional customer value. These enable customers to have their purchased products extended with new, virtual content or get useful after-sale support. At the organizational level, AR applications can facilitate management processes that utilize and can benefit from the aforementioned functionality, i.e., adding virtual content to real-life context (Boletsis and Karahasanovic, 2018; Catchoom, 2017). However, VR can create fully immersive experiences in virtually simulated spaces with high emotional engagement. At the sales level, VR is presented as being used more as a tool for branding and evoking the “wow factor” than as a tool for creating customer value and/or supporting after-sale stages. At the organizational level, VR can create high-quality training environments, simulating various scenarios that would be challenging to recreate in real life (Boletsis and Karahasanovic,

2018; Catchoom, 2017; Biocca and Delaney, 1995; Farah et al., 2019).

5.2.2 Technology Penetration

Figure 1 shows a much wider penetration of AR in retail compared with VR. The main reason might be that AR is easier to scale across users because it can be experienced from many devices, such as smartphones, tablets, desktop PCs, and AR glasses (Catchoom, 2017). That scalability also affects the cost of implementing AR projects in retail by keeping costs low. However, VR is challenging to scale because of the need for a specific user device (i.e., VR headset). Moreover, VR remains a largely under-used tool due to its considerable high cost, the physical space needed for interaction, and user familiarity, i.e., several users may not be completely familiar with VR technology and the new devices, thus limiting its target group (Boletsis and Karahasanovic, 2018; Catchoom, 2017; Farah et al., 2019).

5.2.3 Sales Channels

The findings show that AR innovations can easily facilitate the integration of sales channels operating at the pre-sale stage. These innovations can be integrated easily into customer purchase journey through scan-to-shop applications and instant actions to buy. AR applications bridge the gap between physical and online shops, providing the best of both worlds (Boletsis and Karahasanovic, 2018; Catchoom, 2017). However, VR is more difficult to integrate across sales channels and, its direct impact on sales is more difficult to demonstrate because VR shopping remains in its infancy. Nevertheless, important steps are being taken in this direction (e.g., Alibaba Buy+, IKEA Virtual Reality Store) (Wu et al., 2018; Boletsis and Karahasanovic, 2018; Catchoom, 2017). It should be noted that both technologies – based on the aforementioned current and scheduled advances – can positively affect the way people perceive shopping and perform shopping activities, especially during times or situations in which physical shopping may be a challenging task (e.g., for people with physical disabilities or during pandemics).

5.2.4 Summary

Overall, AR is widely used in the retail environment. Its main advantage is that it can display digital information on the real place, thus making it ideal for purchase journeys and workflow management. Its implementation can be inexpensive and easily scalable at the same time. Consequently, it can be said that AR is

of high practical value for retailing. VR is more difficult to implement in retail since it can be more expensive and is cumbersome – so far – to integrate with the sales channel; however, it can create strong emotional engagement due to high immersion and can be a useful tool for branding and training. Therefore, the practices of these two technologies in retail and their strengths can supplement each other, thereby creating promising innovation strategies when combined, such as in the case of IKEA (Edvardsson and Enquist, 2011).

5.3 Research Limitations

This study contains certain limitations. The AR/VR applications that were included and documented herein were commercial applications, but they had to have been presented in peer-reviewed research publications. As explained in Section 3.2, this methodological choice aimed to ensure that we included reliable AR/VR applications and not theoretical concepts or prototypes. However, by introducing this research-related criterion some applications that exist in the market but are not included in peer-reviewed research publications may have been left out. Still, the total number of reviewed applications ($N=28$) can be viewed as adequate for providing a representative overview of current AR/VR-enabled retail practices.

Moreover, the innovation elements that the two technologies introduce are discussed briefly in Section 5.1 because the technologies' contribution to retail innovation is analyzed and discussed at length in our previous publication (cf. (Boletsis and Karahasanovic, 2018)), utilizing the “Ten Types of Innovation” business framework by Keeley et al. (2013). As stated in Section 1, this study extends our previous innovation-centric paper, focusing more on the technological contributions of AR and VR to retail.

6 CONCLUSION

Current work demonstrated that retail companies actively use AR/VR at different stages of the retail process to achieve their business goals. The two technologies, despite operating on the same continuum, can offer different values to retail practices, and these characteristics were captured in this study. Therefore, we consider that the theoretical knowledge produced in this work can guide retail practice and shed more light on how companies are using AR/VR in retail, thus informing their future strategies.

Nevertheless, the work presented here is descriptive and a prescriptive approach is needed in future re-

search. Future work will entail a systematic literature review around the use of AR and VR in retail, mapping the reviewed AR/VR applications further by introducing more aspects (wherever available), such as cost and profitability. The goal of future work will be the synthesis of novel theoretical knowledge, such as design guidelines, process models, or decision frameworks to inform retailers about the benefits from utilizing AR and VR and guide them regarding the implementation of AR/VR applications.

REFERENCES

- Avila, L. and Bailey, M. (2016). Augment your reality. *IEEE computer graphics and applications*, 36(1):6–7.
- Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators & Virtual Environments*, 6(4):355–385.
- Babu, A. R., Rajavenkatanarayanan, A., Abujelala, M., and Makedon, F. (2017). Votre: A vocational training and evaluation system to compare training approaches for the workplace. In *International Conference on Virtual, Augmented and Mixed Reality*, pages 203–214. Springer.
- Baier, D., Rese, A., and Schreiber, S. (2015). Analyzing online reviews to measure augmented reality acceptance at the point of sale: the case of ikea. In *Successful Technological Integration for Competitive Advantage in Retail Settings*, pages 168–189. IGI Global.
- Balaji, M., Roy, S. K., Sengupta, A., and Chong, A. (2018). User acceptance of iot applications in retail industry. In *Technology Adoption and Social Issues: Concepts, Methodologies, Tools, and Applications*, pages 1331–1352. IGI Global.
- Beecham, S., Baddoo, N., Hall, T., Robinson, H., and Sharp, H. (2008). Motivation in software engineering: A systematic literature review. *Information and software technology*, 50(9):860–878.
- Billinghamurst, M., Clark, A., Lee, G., et al. (2015). A survey of augmented reality. *Foundations and Trends® in Human-Computer Interaction*, 8(2-3):73–272.
- Biocca, F. and Delaney, B. (1995). Immersive virtual reality technology. *Communication in the age of virtual reality*, 15:32.
- Bodhani, A. (2013). Getting a purchase on AR. *Engineering & Technology*, 8(4):46–49.
- Boletsis, C. (2017). The new era of virtual reality locomotion: a systematic literature review of techniques and a proposed typology. *Multimodal Technologies and Interaction*, 1(4):24:1–24:17.
- Boletsis, C. and Karahasanovic, A. (2018). Augmented reality and virtual reality for retail innovation. *Magma-Tidsskrift for økonomi og ledelse*, 7:49–59.
- Bonetti, F. and Perry, P. (2017). A review of consumer-facing digital technologies across different types of fashion store formats. In *Advanced fashion technology and operations management*, pages 137–163. IGI Global.
- Bonetti, F., Warnaby, G., and Quinn, L. (2018). Augmented reality and virtual reality in physical and online retailing: A review, synthesis and research agenda. In *Augmented reality and virtual reality*, pages 119–132. Springer.
- Bresciani, L. and Ewing, M. (2015). Brand building in the digital age: The ongoing battle for customer influence. *Journal of Brand Strategy*, 3(4):322–331.
- Caboni, F. and Hagberg, J. (2019). Augmented reality in retailing: a review of features, applications and value. *International Journal of Retail & Distribution Management*, 47(11):1125–1140.
- Carruth, D. W. (2017). Virtual reality for education and workforce training. In *2017 15th International Conference on Emerging eLearning Technologies and Applications (ICETA)*, pages 1–6. IEEE.
- Catchoom (2017). Virtual vs. Augmented Reality Experiences in Retail. Available online: <https://catchoom.com/blog/virtual-vs-augmented-reality-experiences-in-retail/>. (accessed on 17 Jun 2020).
- Dacko, S. G. (2017). Enabling smart retail settings via mobile augmented reality shopping apps. *Technological Forecasting and Social Change*, 124:243–256.
- De Gauquier, L., Brengman, M., Willems, K., and Van Kerrebroeck, H. (2019). Leveraging advertising to a higher dimension: experimental research on the impact of virtual reality on brand personality impressions. *Virtual Reality*, 23(3):235–253.
- De Keyser, A., Köcher, S., Alkire, L., Verbeeck, C., and Kandampully, J. (2019). Frontline service technology infusion: conceptual archetypes and future research directions. *Journal of Service Management*.
- De Silva, R., Rupasinghe, T. D., and Apeagyei, P. (2019). A collaborative apparel new product development process model using virtual reality and augmented reality technologies as enablers. *International Journal of Fashion Design, Technology and Education*, 12(1):1–11.
- Dulabh, M., Vazquez, D., Ryding, D., and Casson, A. (2018). Measuring consumer engagement in the brain to online interactive shopping environments. In *Augmented Reality and Virtual Reality*, pages 145–165. Springer.
- Edvardsson, B. and Enquist, B. (2011). The service excellence and innovation model: lessons from ikea and other service frontiers. *Total Quality Management & Business Excellence*, 22(5):535–551.
- Farah, M. F., Ramadan, Z. B., and Harb, D. H. (2019). The examination of virtual reality at the intersection of consumer experience, shopping journey and physical retailing. *Journal of Retailing and Consumer Services*, 48:136–143.
- Grewal, D., Motyka, S., and Levy, M. (2018). The evolution and future of retailing and retailing education. *Journal of Marketing Education*, 40(1):85–93.
- Grybś, M. (2014). Creating new trends in international marketing communication. *Journal of Economics & Management*, 15:155–173.
- Guo, A., Wu, X., Shen, Z., Starner, T., Baumann, H., and

- Gilliland, S. (2015). Order picking with head-up displays. *Computer*, 48(6):16–24.
- Hilken, T., de Ruyter, K., Chylinski, M., Mahr, D., and Keeling, D. I. (2017). Augmenting the eye of the beholder: exploring the strategic potential of augmented reality to enhance online service experiences. *Journal of the Academy of Marketing Science*, 45(6):884–905.
- Hilken, T., Heller, J., Chylinski, M., Keeling, D. I., Mahr, D., and de Ruyter, K. (2018). Making omnichannel an augmented reality: the current and future state of the art. *Journal of Research in Interactive Marketing*.
- Hristov, L. and Reynolds, J. (2015). Perceptions and practices of innovation in retailing. *International Journal of Retail & Distribution Management*.
- Iyadurai, F. S. and Subramanian, P. (2016). Smartphones and the disruptive innovation of the retail shopping experience. In *2016 International Conference on Disruptive Innovation*.
- Javornik, A. (2016). Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behaviour. *Journal of Retailing and Consumer Services*, 30:252–261.
- Jean, M. (2017). The growth of virtual reality technology in china. In *2017 Video Games & Digital Media Conference*.
- Keeley, L., Walters, H., Pikkell, R., and Quinn, B. (2013). *Ten types of innovation: The discipline of building breakthroughs*. John Wiley & Sons.
- Kemke, C., Galka, R., and Hasan, M. (2006). Towards an intelligent interior design system. In *Proc. Workshop on Intelligent Virtual Design Environments (IVDEs)*.
- Kitchenham, B. (2004). Procedures for performing systematic reviews. Technical Report TR/SE-0401, Keele University and National ICT Australia Ltd.
- Loureiro, S. M. C., Guerreiro, J., Eloy, S., Langaro, D., and Panchapakesan, P. (2019). Understanding the use of virtual reality in marketing: A text mining-based review. *Journal of Business Research*, 100:514–530.
- Man, W. and Qun, Z. (2017). The deconstruction and re-shaping of space: the application of virtual reality in living space. In *2017 9th International Conference on Measuring Technology and Mechatronics Automation (ICMTMA)*, pages 410–413. IEEE.
- McCormick, H., Cartwright, J., Perry, P., Barnes, L., Lynch, S., and Ball, G. (2014). Fashion retailing—past, present and future. *Textile Progress*, 46(3):227–321.
- Milgram, P. and Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, 77(12):1321–1329.
- Miraldes, T., Azevedo, S. G., Charrua-Santos, F. B., Mendes, L. A. F., and Matias, J. C. O. (2015). It applications in logistics and their influence on the competitiveness of companies/supply chains. *Annals of the Alexandru Ioan Cuza University-Economics*, 62(1):121–146.
- Mocanu, R. (2012). Chasing experience. how augmented reality reshaped the consumer behaviour and brand interaction. *Opportunities and Risks in the Contemporary Business Environment*, page 317.
- Moorhouse, N., tom Dieck, M. C., and Jung, T. (2018). Technological innovations transforming the consumer retail experience: A review of literature. In *Augmented reality and virtual reality*, pages 133–143. Springer.
- Mustafa, T., Matovu, R., Serwadda, A., and Muirhead, N. (2018). Unsure how to authenticate on your vr headset? come on, use your head! In *Proceedings of the Fourth ACM International Workshop on Security and Privacy Analytics*, pages 23–30.
- Olszewski, K., Lim, J. J., Saito, S., and Li, H. (2016). High-fidelity facial and speech animation for VR HMDs. *ACM Transactions on Graphics*, 35(6):221.
- Poushneh, A. (2018). Augmented reality in retail: A trade-off between user’s control of access to personal information and augmentation quality. *Journal of Retailing and Consumer Services*, 41:169–176.
- Rese, A., Baier, D., Geyer-Schulz, A., and Schreiber, S. (2017). How augmented reality apps are accepted by consumers: A comparative analysis using scales and opinions. *Technological Forecasting and Social Change*, 124:306–319.
- Rese, A., Schreiber, S., and Baier, D. (2014). Technology acceptance modeling of augmented reality at the point of sale: Can surveys be replaced by an analysis of on-line reviews? *Journal of Retailing and Consumer Services*, 21(5):869–876.
- Satoglu, S., Ustundag, A., Cevikkan, E., and Durmusoglu, M. B. (2018). Lean transformation integrated with industry 4.0 implementation methodology. In *Industrial Engineering in the Industry 4.0 Era*, pages 97–107. Springer.
- Scholz, J. and Smith, A. N. (2016). Augmented reality: Designing immersive experiences that maximize consumer engagement. *Business Horizons*, 59(2):149–161.
- Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of communication*, 42(4):73–93.
- Verhoef, P. C., Kannan, P. K., and Inman, J. J. (2015). From multi-channel retailing to omni-channel retailing: introduction to the special issue on multi-channel retailing. *Journal of retailing*, 91(2):174–181.
- Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R., and Cleven, A. (2009). Reconstructing the giant: On the importance of rigour in documenting the literature search process. In *Proceedings of the European Conference on Information Systems*, pages 2206–2217.
- Wu, J., Joo, B. R., and Sina, A. S. (2018). Personalizing 3d virtual fashion stores: Module development based on consumer input. *Back to the Future: Revisiting the Foundations of Marketing*, page 296.
- Yim, M. Y.-C., Chu, S.-C., and Sauer, P. L. (2017). Is augmented reality technology an effective tool for e-commerce? an interactivity and vividness perspective. *Journal of Interactive Marketing*, 39:89–103.
- Zhao, Z. and Balagué, C. (2017). From social networks to mobile social networks: applications in the marketing evolution. In *Apps management and e-commerce transactions in real-time*, pages 26–50. IGI Global.