

AUGMENTED REALITY AND VIRTUAL REALITY FOR RETAIL INNOVATION*



COSTAS BOLETIS, ph.d., er forsker ved SINTEF Digital. Hans forskningsinteresser inkluderer bruken av augmented og virtual reality i tjenestedesign og menneske-maskin interaksjon.



AMELA KARAHASANOVIĆ, ph.d., er seniorforsker ved SINTEF Digital og førsteamanuensis ved Institutt for informatikk, UiO. Hennes forskningsinteresser inkluderer brukeropplevelse og tjenestedesign.

SAMMENDRAG

Nye og bedre Augmented Reality (AR) og Virtual Reality (VR) applikasjoner utvikles helle tiden og brukes mer og mer i handel. Utvikling i AR and VR i løpet av de siste årene satt i gang mange innovasjoner i måten handelen foregår, innovasjoner i markedsføring, og innovasjon i design og utvikling av produkter og tjenester. Likevel, vet vi lite om muligheter som AR og VR skaper for innovasjon og om erfaringene fra de som allerede bruker dem. Denne artikkelen beskriver hvordan AR og VR kunne med fordel brukes for flere typer

av innovasjon og hjelpe forretningsvirksomhet til å vokse. Artikkelen gir en oversikt over eksisterende innovasjonspraksis i handel og kan hjelpe norske virksomheter i deres strategiske planlegging. Vår analyse viser at AR/VR innovasjon kan bidra til bygning av merkevære, restrukturering av prosesser i organisasjon, involvering av kunder i verdiskapning, kan gi ekstra after-sale tjenester ved å gi produkt relatert informasjon i kontekst, kan støtte omnimarket strategier og påvirke kjøp ved virtuell try-on opplevelser.

1 INTRODUCTION

In the retail environment, digital technology is one of the main drivers of innovation and transformation. From the use of databases for inventory management

and customer relationship management to the use of social media for marketing and virtual shops, technology enables the innovation of both onstage and backstage processes. Retailers utilize digital technologies to better connect with their customers, affecting customer purchase decisions when shopping online or in physical stores (Grewal et al., 2017).

* Ingen av forfatterne er norskspråkelige, og artikkelen publiseres derfor på engelsk.

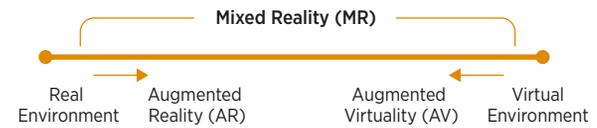
The early 2000s saw retailers increasingly adopting advanced technologies in both their physical and online stores to enhance both the store's environment and the shopping experience (Bonetti et al., 2018; Pantano, 2015). This is especially true for what can be termed “consumer-facing” technologies, namely the technologies and devices (e.g. interactive touchscreens, digital signage, RFID tags, beacon technology, magic mirrors, and mobile apps) that the consumer experiences directly while in the physical or online store and at all stages of the retail process: prepurchase, purchase, consumption, and after-sale (Bonetti & Perry, 2017; Bonetti et al., 2018). Among these technologies, augmented reality (AR) and virtual reality (VR) applications are rapidly evolving and are increasingly used in retail environments (Bonetti et al., 2018; Javornik, 2016; McCormick et al., 2014). To fully exploit the potential of new and up-and-coming technologies, one needs to understand the critical retailing areas in which innovations can change the game (Grewal et al., 2017).

1.1 AUGMENTED AND VIRTUAL REALITY

AR and VR have found their place in innovation activities. They have held great promise for a long time; this promise is just beginning to be realized. These new forms of technology-based reality and applications can enhance sensory perceptions and lead to increased user engagement (Grewal et al., 2017; Poncin & Mimoun, 2014).

VR technology represents the far end of the reality–virtuality continuum (Figure 1), enabling the creation of fully immersive virtual environments that visualize “what could be” and that “replace” reality (Steuer, 1992). Recently, major changes in VR systems have taken place, reviving interest in the field; with these changes, VR became accessible, up-to-date, and relevant again (Olszewski et al., 2016; Boletsis et al., 2017). The low acquisition cost of VR hardware transformed VR into a widely accessible and popular technology. At the same time, the quality of virtual environments improved rapidly, offering realistic graphics and full immersion while overcoming the lack of intuitive multiuser capabilities of the past and pushing the boundaries of next-generation social platforms (Boletsis, 2017). VR commerce and retailing utilize VR, head-mounted displays (HMDs), and smartphones to both enhance and drive the shopping experience; this allows retailers to

FIGURE 1 The reality–virtuality continuum (Milgram & Kishino, 1994).



immerse consumers in custom-created virtual worlds, combining traditional online shopping elements with 3D experiences to increase consumer engagement, grow sales, and increase brand loyalty (Dad et al., 2016; Pantano, 2015).

On the other hand, AR technology is closer to reality (Figure 1) on the reality–virtuality continuum because its technical characteristics enable the augmentation of the real environment (Milgram & Kishino, 1994; Azuma, 1997). Over the last decade, advances in the smartphone industry have allowed AR to become widely accessible, enabling users to enjoy memorable AR simply through their smartphones' screens (Billinghurst et al., 2015). AR has emerged as a relevant interactive technology in the retail environment, often developed in the format of smart device applications (Javornik, 2016). The ability of AR to overlay the physical environment with virtual elements such as graphics, video, and audio, which can interact with the physical environment in real time, provides new possibilities for delivering content to consumers (Javornik, 2016). Consequently, AR holds the potential to alter many consumer activities, including information searches and product trials (Javornik, 2016). AR can also help increase trust in online shopping by allowing customers to closely inspect the products they are buying (Karahasanovic et al., 2017).

The AR and VR developments that have taken place over the last few years gave birth to a number of innovations, presented herein, for how businesses operate, communicate their products, build their products, and present themselves (Scholz, 2016; Javornik, 2016; Pantano, 2015; Dad et al., 2016). These two technologies can facilitate the creation, demonstration, and application of several innovative functions, which may attract customers because of these technologies' impressively hedonic qualities and the actual usefulness and added value they can offer to existing services, products, and processes (Grewal et al., 2017; Pantano, 2015).

1.2 THE MOTIVATION FOR A REVIEW OF AR AND VR IN RETAIL INNOVATION

AR and VR have matured enough to have found their place in the retail industry – among other sectors – offering several types of innovation (Bonetti & Perry, 2017). However, there is a lack of research on how AR and VR applications are used for retail innovation and what lessons can be learned from their current use. The current work addresses this need, ultimately examining how AR and VR can be used beneficially for several types of innovation and can help retail businesses to grow.

More specifically, the current work contributes by documenting which AR and VR applications are used in practice for retailing purposes; examining how these applications are used, along with what kinds of innovation they address; and, finally, utilizing the results to synthesize conceptual knowledge and implications. The present work is a review and analysis of AR and VR applications in retail and provides an overview of the current state-of-the-art AR and VR practices in retail innovation. The results of the current review can help stakeholders in the Norwegian retail industry make sense of these practices and, ultimately, ground their future business planning and decision making in the herein synthesized theoretical knowledge.

2 METHODOLOGY

A literature review was conducted to investigate the use of AR and VR applications for retail innovation. The focus of the current review is on commercial, published applications that i) are presented, described, or analysed – to any extent – in peer-reviewed publications and that ii) are used by retail businesses in real life. The peer-review process adds to the credibility and reliability of the publications and the respective presented, described, or analysed applications. The actual use of the VR and AR applications by retail businesses was considered a significant criterion for presenting existing and usable systems beyond the conceptual level. Therefore, research prototypes and conceptual descriptions of applications were not included in the review. This review has two stages: i) documentation of the related AR and VR applications and ii) analysis of the retrieved applications based on the types of innovation they address.

During the first stage, a literature search was conducted to retrieve the related publications and extract the reviewed applications. The publications were collected during March and August 2018 via a Google Scholar and Scopus database search that scanned academic databases including IEEE Xplore, ACM Digital Library, ScienceDirect, and Springer Link. The keywords used were “augmented reality application” or “virtual reality application” and “retail”. Furthermore, applicable articles were also identified through backward reference searching, that is, by screening the reference lists of the retrieved publications and specific applications (Vom Brocke et al., 2009). Backward reference searches with Scopus, Google Scholar, and Google Search were utilized by running general searches of specific references and identifying any relevant articles. Each VR or AR application extracted from this process had to fulfil another criterion (mentioned above) to be included: it had to be used in real life and be – or had been – publicly available (e.g. as an app in an app store, app or service in a physical store, etc.).

For the second stage, the extracted AR and VR applications of the first stage were analysed regarding the types of innovation they cover within an organization. Within the context of this work, it was imperative that we cover the full spectrum of innovation; therefore – among the several related theories that exist (Popa, 2014) – we utilized the ten types of innovation typology (Keeley et al., 2013). This typology has been characterized by the EU Open Innovation Strategy and Policy Group as “a powerful framework” for describing the full spectrum of innovation (Curley & Salmelin, 2013). Retail companies and corporations often have several businesses and complicated structures. As recommended by Keeley et al. (2013), we did not analyse entire organizations, instead limiting our investigation to a particular platform within the business.

The ten types of innovation framework, as shown in Table 1, are divided into three color-coded categories. The types on the left side are the most internally focused and distant from customers. Moving toward the right side, the types become increasingly apparent and obvious to the end users. To use a theatrical metaphor, the left of the framework is backstage; the right is onstage (Keeley et al., 2013). Simple innovations use one or two types of innovation, and every company needs to

TABLE 1 The ten types of innovation framework (Keeley et al., 2013).

CONFIGURATION				OFFERING		EXPERIENCE			
PROFIT MODEL	NETWORK	STRUCTURE	PROCESS	PRODUCT PERFORMANCE	PRODUCT SYSTEM	SERVICE	CHANNEL	BRAND	CUSTOMER ENGAGEMENT
how an organization makes money	how an organization connects with others to create value	how an organization organizes and aligns its talent and assets	how an organization uses signature or superior methods to do its work	how an organization develops distinguishing features and functionality	how an organization creates complementary products and services	how an organization supports and amplifies the value of its offerings	how an organization delivers its offerings to the customer and user	how an organization represents its offerings and business	how an organization fosters compelling interactions

pursue these innovations (Keeley et al., 2013). When a market grows and becomes complicated, it demands more sophisticated innovation, which uses many types of innovation that are elegantly combined and orchestrated with care (Keeley et al., 2013). The ten types of innovation are based on their position within the value chain of the development and marketing of the product or process. The typology's goal is to draw attention to the fact that innovation involves more activities along the value chain than the common definition of "developing new products and processes" suggests. The typology uses terminology relevant to private enterprises, but the concepts are equally relevant for governments, individuals, and nonprofit organizations (Bahadur & Doczi, 2016).

After the innovation analysis of the retrieved applications, a discussion on the results follows (Section 4), synthesizing the implications that the findings might have for retail businesses that want to utilize the innovation features of AR and VR.

3 REVIEW

The review of AR and VR applications for retail is presented in this chapter. Table 2 presents the applications (in random order), their characteristics, and their supporting references. Table 3 presents their analysis based on the ten types of innovation they address.

The analysis shows a high concentration of virtual try-on (VTO) apps. The IKEA Catalogue, Uniqlo's Magic Mirror, Sephora Virtual Artist, L'Oreal Makeup

Genius, and Dulux Visualiser allow customers to try on their products (furniture, clothes, makeup products, and interior paint colours, respectively) as AR 3D graphics augmenting the physical space. These applications are developed to complement the existing products and provide a pre-purchase service for customers, thus attempting to affect a customer's purchase decision. The applications enable customers to connect with the respective products in a new and engaging way, utilizing cutting-edge technology such as AR and social-media-sharing features.

The Tesco Discover application presents the same innovation qualities as the ones mentioned above, though the application focuses more on the "service innovation" aspect. The app utilizes a location-based AR service for directing customers to the nearest Tesco store. This complimentary service connects customers with Tesco while supporting them at a pre-purchase level and facilitating their purchase decision. By utilizing AR, the application aspires to create a memorable customer experience and present the Tesco brand as highly innovative.

McDonald's Track My Maccas application also addresses the same innovation types as Tesco Discover described above; however, this application comes with a twist. McDonald's attempts to change the negative perception of its meals' quality by utilizing location-based AR to display 3D interactive stories about the origin of the meal's ingredients. The application constitutes a complimentary service to the existing products, develo-

ped to support the customer's decision at the after-sale stage, strengthening trust in the McDonald's brand. In this case, AR is the "vehicle" for carrying this trust-related message, utilizing its "wow effect" to engage customers in an emotional way. Another application that operates at the after-sales stage for adding a complimentary service to existing products is the Hyundai Virtual Guide. The application is an interactive 3D manual, offering basic car maintenance information as virtual content displayed in context, that is, in the real-world view of a Hyundai car. Here, AR is utilized to enhance customer value and provide a useful after-sale service.

The Volkswagen Virtual Golf Cabriolet, Audi Quattro Coaster AR, Volvo XC90 Test Drive, and IKEA VR Experience apps present common innovative functionalities, that is, they present 3D models of their products. The Volkswagen app presents a 3D interactive model of a car using AR and is aligned with other marketing channels such as magazines, postcards, and the web. The Audi Quattro Coaster AR app creates a transmedia experience using the car's TV ad to connect with the AR space, enabling the user to build a 3D track and visualize a 3D model of the car as well. The Volvo XC90 Test Drive application communicates a driving experience. The IKEA app presents a fully immersive VR kitchen, and its distribution takes place through a popular gaming platform (Steam). These apps are designed for the pre-purchase stage to affect purchasing decisions and increase branding. The apps focus on the fun factor through the combination of AR/VR with the products while enhancing a service that is already provided by physical shops. The innovative functionality of the apps is used to engage customers by allowing them to experience what it would feel like to possess the demonstrated products and share this feeling with their friends and family through photos and social media, thus creating new connections with the company.

Alibaba Buy+ is a VR shop application for navigating and buying products in a virtual mall. The app utilizes low-cost VR through a simple cardboard VR headset and smartphone. By creating a VR shop, Alibaba introduces distinguishing features and functionality to its already established retail brand. The app offers a holistic pre-purchase and purchase service that directly connects the products with the customer. The highly innovative character of the app, combined with

the limited availability of fully operational VR retail stores, establishes the brand as a pioneer in this space. The "wow factor" – coming from the immersive character of the app and its practical value in facilitating shopping – aspires to potentially create an engaging and useful customer experience.

The North Face VR experience and the Toms Virtual Giving Trip applications are quite similar in principle because they both use VR 360-degree videos to immerse the customer in a specific experience. The North Face app communicates a traveling experience, while the Toms app is about a charity case. Both apps attempt to evoke specific emotions (adventurousness and altruism, respectively) through virtual storytelling. Ultimately, the stories are about building the brands' images and associating them with the demonstrated experiences, here trying to foster compelling interactions with customers.

Lego AR Studio and NikeID In-store AR are two AR applications that present similar innovation qualities. Lego AR Studio enables customers to create 3D AR game content, play with it, and even have it interact with real Lego content. NikeID AR enables customers to project their customized shoe design onto a real pair of shoes, thus witnessing immediately what their customized shoes will look like. Even though both apps focus on the pre-purchase stage and affect the purchase decision, Lego AR Studio also targets the after-sale stage, amplifying the value of Lego's content and promoting an innovative brand image. However, these apps are similar in that they utilize the role of the customer as designer; thus, through these apps, their organizations attempt to connect with their customers to create value.

DHL Vision Picking and Walmart VR in Academies utilize AR and VR to support their "backstage" internal organizational processes. DHL uses the AR app to facilitate day-to-day work activities (e.g. pick ordering) and train its employees, while Walmart utilizes VR environments for training its employees in simulation settings. These innovations constitute signature and potentially superior methods for conducting work activities and arranging companies' assets to provide the best results for their employees. These internal innovative qualities can also be reflected in the onstage processes, thus improving the company's image toward customers and business partners.

TABLE 2 The reviewed AR and VR applications in retail (apps presented in random order).

APP TITLE	TECHNOLOGY	DESCRIPTION	DEMONSTRATION	REFERENCES
Tesco Discover	AR	Mobile application that displays Tesco stores near the user in AR space (GPS enabled).	https://youtu.be/gR7FsWaP3Mw	Bodhani, 2013; Baier et al., 2015; Rese et al., 2014
IKEA Catalogue	AR	Mobile application that allows users to scan select pages and images from the printed catalogue to access extended AR content and display it on top of real space.	https://youtu.be/uaxtLru4-Vw	Baier et al., 2015; Rese et al., 2014
IKEA VR Experience	VR	VR application for users to experience a VR IKEA kitchen.	https://youtu.be/c-NUbGtAeYU	Man & Qun, 2017; Edvardsson & Enquist, 2011; Kemke et al., 2006
Uniqlo's Magic Mirror	AR	AR application for users to try on different clothes in front of an AR mirror.	https://youtu.be/oUD57MpHAE8	Balaji et al., 2017; Zhao & Balagué, 2017
Sephora Virtual Artist	AR	Mobile application that allows users to instantly try on thousands of lip colours.	https://youtu.be/NFApcSocFDM	Mocanu, 2012; Yim et al., 2017
Dulux Visualiser	AR	Mobile application that allows users to test paint colours on their walls using AR and a mobile device's camera.	https://youtu.be/4IMFxJ4PDXY	Scholz & Smith, 2016
Alibaba Buy+	VR	VR application that allows customers to browse and shop items in a virtual mall.	https://youtu.be/-HcKRBKlilg	Jean, 2017
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	Grybs, 2014; Bresciani & Ewing, 2015
Volkswagen Virtual Golf Cabriolet	AR	Mobile application for displaying a 3D interactive model of a car.	https://youtu.be/pFS6EHZBGvc	Bodhani, 2013
Lego AR studio	AR	Mobile application that creates a virtual Lego gameplay experience to be combined with physical Legos.	https://youtu.be/cHvcD2FrKew	Sudarshan, 2018; Moorhouse et al., 2018; Iyadurai & Subramanian, 2016
NikeiD In-store AR	AR	AR projection of customized shoe designs on top of real shoes.	https://youtu.be/5LNIXKXaCBE	Bonetti & Perry, 2017
North Face VR Experience	VR	360-degree film about traveling experiences.	https://youtu.be/Cr-9ujLco50	Dulabh et al., 2018
Toms Virtual Giving Trip	VR	360-degree film about a charity mission.	https://youtu.be/jz5vQs9iXCcs	Grewal et al., 2017
DHL Vision Picking	AR	Application for AR eyeglasses to facilitate pick ordering, warehouse planning, and training of warehouse staff.	https://youtu.be/I8vYrAUb0BQ	Satoglu et al., 2018; Guo et al., 2015
Walmart VR in Academies	VR	VR application for training employees.	https://youtu.be/oRbmLBWdEol	Carruth, 2017; Babu et al., 2017
L'Oreal Makeup Genius	AR	Mobile application that allows users to instantly try on different styles of make-up.	https://youtu.be/zbBJfrkZRDl	Hilken et al., 2018
Hyundai Virtual Guide	AR	Mobile application that serves as a car owner's manual.	https://youtu.be/qOMvI6-cP7o	Poushneh, 2018; Hilken et al., 2018; Avila & Bailey, 2016
Audi Quattro Coaster AR	AR	Mobile application for building a 3D track and displaying a 3D interactive model of a car.	https://youtu.be/ZzQBAZ-2i24	Ruetz, 2018
Volvo XC90 Test Drive	VR	360-degree experience of driving a car.	https://youtu.be/HEkGRUkjTA	De Gauquier et al., 2018

TABLE 3 The reviewed AR and VR application in retail, analysed as to the types of innovation they address.

APP TITLE	CONFIGURATION				OFFERING			EXPERIENCE		
	PROFIT MODEL	NETWORK	STRUCTURE	PROCESS	PRODUCT PERFORMANCE	PRODUCT SYSTEM	SERVICE	CHANNEL	BRAND	CUSTOMER ENGAGEMENT
Tesco Discover						X	X	X	X	X
IKEA Catalogue						X	X	X	X	X
IKEA VR Experience						X	X	X	X	X
Uniqlo's Magic Mirror						X	X	X	X	X
Sephora Virtual Artist						X	X	X	X	X
Dulux Visualiser						X	X	X	X	X
Alibaba Buy+					X	X	X	X	X	X
McDonald's Track My Maccas						X	X	X	X	X
Volkswagen Virtual Golf Cabriolet						X	X	X	X	X
Lego AR studio		X				X	X	X	X	X
NikeID In-store AR		X				X	X	X	X	X
North Face VR Experience									X	X
Toms Virtual Giving Trip									X	X
DHL Vision Picking			X	X					X	
Walmart VR in Academies			X	X					X	
L'Oreal Makeup Genius						X	X	X	X	X
Hyundai Virtual Guide						X	X	X	X	X
Audi Quattro Coaster AR						X	X	X	X	X
Volvo XC90 Test Drive						X	X	X	X	X

4 DISCUSSION

The main observation from our review is that *current AR/VR applications are mostly used for onstage innovation, branding, and marketing, but there is a limited number of applications for backstage, internal innovation processes*. From the studied applications, only DHL Visual Picking and Walmart VR in Academies used AR/VR to innovate the internal processes in their retail organizations. Lego AR Studio and NikeID In-store AR were also good examples of how retail businesses can connect with their customers and collaborate to create value for both parties. The retail industry could benefit from *applying AR/VR innovation in internal, organizational processes, addressing structure and process innovation more intensively while also involving the*

customer or other stakeholders in the value-creation process, for instance, by applying “customer as designer” and open innovation models.

Another observation is that the *current AR/VR innovations are widely used for branding purposes*. Companies utilize AR and VR to establish their brands as innovative and engage customers, offering supporting AR/VR services or experiences. Companies such as Toms and North Face use VR directly for branding; that is, VR is a channel for directly sending out the message about the company’s values. In addition to this, AR/VR services are used to strengthen branding in an indirect way. Lego, for example, aims to “inspire and develop the builders of tomorrow through creative play and learning” (Lego, 2015). Similarly, Nike’s mis-

sion is to “bring inspiration and innovation to every athlete in the world” (Nike, 2018). Using AR/VR at the different stages of the retail process sends the message that the company stands for innovation, exploration, and creativity.

The fact that *AR/VR innovations can both support and facilitate the integration of other marketing channels* is a significant element. AR/VR applications (e.g. Sephora Virtual Artist, Volkswagen Virtual Golf Cabriolet, IKEA VR Experience, McDonald’s Track My Maccas, etc.) can be beneficial for omnichannel marketing (Verhoef et al., 2015), 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. These marketing characteristics of AR/VR can further lead to new innovations around personalized services and products (e.g. NikeID In-store AR), as well as aggregate high-quality behaviour data for customer analyses. When it comes to the type of customer engagement, *VR can create fully immersive, imaginary brand experiences with high emotional engagement* and focus on the fun and “wow factors” (e.g. IKEA VR Experience, Alibaba Buy+). On the other hand, *AR is blended into the real environment, so it feels natural to the shopping and product environment* because it enables virtual try-on sessions, product trials, and interactions to affect purchase decisions (e.g. IKEA Catalogue, Sephora Virtual Artist).

Furthermore, our findings show that *AR innovations can easily facilitate the integration of sales channels operating at the pre-purchase stage* (e.g. Sephora Virtual Artist), and these innovations can be easily integrated into the customer purchase journey through scan-to-shop applications and instant actions to buy. AR applications bridge the gap between the physical and online shops, providing the best of both worlds. This contributes to the fact that AR is easier to scale because it can be experienced from many devices, such as smartphones, tablets, and AR glasses. *VR is harder to integrate across sales channels and it is more difficult to show its direct impact on sales because VR shopping is still in its infancy*; however, important steps are being taken in this direction (e.g. Alibaba Buy+). Recent advances in low-cost VR hardware (e.g. Google Cardboard) enable the transformation of a smartphone into an efficient VR headset, thus shaping a promising future for VR

when it comes to the wider adoption of VR shopping and scalability.

Finally, *AR innovations can offer product-related information in context and provide after-sale services*. The fact that AR is blended with real life to scale provides the opportunity for applications to add virtual content into the real-life context and offer additional customer value. This enables customers to have their purchased products extended with new, virtual content (e.g. Lego AR Studio) or to get useful after-sale support (e.g. Hyundai Virtual Guide). In general, 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 supporting after-sale stages. This situation may be supported by the fact that VR is challenging to scale and hard to integrate across channels, while – on the other hand – it can create impressive, fully immersive branding experiences. The wider adoption of VR shopping in the future, though, may address this issue in favour of enhanced customer value and after-sale support.

5 CONCLUSIONS AND MANAGERIAL IMPLICATIONS

When a new technology appears or becomes widely accessible, managers and researchers should ask how one can use these technologies in the innovation process in the best possible way. It is not enough to add some AR/VR technology on top of existing retail processes and hope that this will lead to better customer experiences and an increase in revenues. Business decisions should be based on existing theoretical and practical knowledge. The current paper addresses the lack of knowledge about ways to use AR/VR applications in retail innovation by conducting a survey of AR/VR in retail within an innovation framework. Based on the results, international retail companies actively use AR/VR at different stages of the retail process to achieve their business goals; AR/VR applications are widely used for branding and marketing; and AR applications are often used at the pre-purchase stage.

The survey has generated several managerial implications. First, by using the ten types of innovation framework for the analysis, we could consider the role of AR/VR in the whole innovation spectrum. And here, broadening the innovation spectrum might help businesses better plan their innovation processes. Second,

by reviewing the existing literature on the use of AR/VR applications in the retail context, we identified how retail companies can benefit from using AR/VR applications and provided examples of some of these applications. More specifically, we recommend the use of AR/VR for the following:

- Creating imaginary brand experiences with high emotional engagement, thus developing an innovative brand image (e.g. IKEA Catalogue, Tesco Discover, North Face VR Experience, Audi Quattro Coaster AR)
- Facilitating internal organizational processes, such as training employees or performing daily tasks (e.g. DHL Vision Picking, Walmart VR in Academies)
- Involving the customer or other stakeholders in the value creation process (e.g. Lego AR studio, NikeID In-store AR)
- Enabling virtual try-on experiences and affecting purchase decisions (e.g. IKEA Catalogue, Dulux Visualiser, Uniqlo's Magic Mirror)
- Offering product-related information in context and providing after-sale services (e.g. Hyundai Visual Guide, Lego AR studio)
- Supporting and facilitating the integration of other marketing channels in omnimarketing models (e.g. Dulux Visualiser, Sephora Virtual Artist, Volkswagen Virtual Golf Cabriolet). Creating additional sales channels and directly integrating them into their respective applications (e.g. Sephora Virtual Artist, Alibaba Buy+)

AR/VR innovations have been used both to directly enhance customer value and as a tool for marketing positioning. For example, using AR to offer basic car maintenance, as done by Hyundai, directly enhances customer value. Volkswagen Virtual Golf Cabriolet and North Face VR Experience are examples of using AR/VR for marketing. As more and more companies begin using AR/VR in marketing, the companies successfully using these technologies to increase customer value will have an advantage. We believe that both of these approaches have desirable branding effects since they can contribute to perceived innovativeness. IKEA, for example, is considered by customers to be the most innovative company in Norway with the highest Perceived Innovativeness score (76 out of 100), according to the 2017 Norwegian Innovation Index (Norwegian School of Economics, 2017). IKEA also received third place for perceived innovativeness in the 2018 American Innovation Index (Fordham University's Gabelli School of Business & Norwegian School of Economics, 2018) among US companies and based on IKEA's customer perceptions. Naturally, it remains to be investigated to what degree the introduction of AR/VR innovations impacts the revenues of retail companies; however, their utilization seems quite promising for the future of retail innovation.

ACKNOWLEDGEMENTS

This research was funded by the Norwegian Research Council through the Centre for Service Innovation. **M**

REFERENCES

- Andreassen, T.W. & Olsen, L.L. (2015). *Service og innovasjon*. Fagbokforlaget, Bergen.
- Avila, L. & 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. & Makedon, F. (July, 2017). VoTrE: A vocational training and evaluation system to compare training approaches for the workplace. In *International Conference on Virtual, Augmented and Mixed Reality* (pp. 203–214). Springer, Cham.
- Bahadur, A. & Doczi, J. (2016). *Unlocking resilience through autonomous innovation*. Overseas Development Institute, London.
- Baier, D., Rese, A. & Schreiber, S. (2015). Analyzing online reviews to measure augmented reality acceptance at the point of sale: the case of IKEA. *Successful Technological Integration for Competitive Advantage in Retail Settings*. IGI Global, 168–189.
- Balaji, M.S., Roy, S.K., Sengupta, A. & Chong, A. (2017). User acceptance of IoT applications in retail industry. In Lee, I. (eds.): *The Internet of Things in the Modern Business Environment* (pp. 28–49). Business Science Reference, Hershey, PA.
- Billinghurst, M., Clark, A. & Lee, G. (2015). A survey of augmented reality. *Foundations and Trends in Human-Computer Interaction*, 8(2–3), 73–272.
- 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.
- Boletsis, C., Cedergren, J.E. & Kongsvik, S. (2017). HCI research in Virtual Reality: A discussion of problem-solving. In *International Conference on Interfaces and Human Computer Interaction, IHCI 2017, Portugal, 21–23 July 2017* (pp. 263–267). IADIS.
- Bonetti, F. & Perry, P. (2017). A Review of Consumer-Facing Digital Technologies Across Different Types of Fashion Store Formats. *Advanced Fashion Technology and Operations Management*, 137–163.
- Bonetti, F., Warnaby, G. & Quinn, L. (2018). Augmented Reality and Virtual Reality in Physical and Online Retailing: A Review, Synthesis and Research Agenda. In Jung, T. & tom Dieck, M. (eds.): *Augmented Reality and Virtual Reality* (pp. 119–132). Springer, Cham.
- Bresciani, L. & Ewing, M. (2015). Brand building in the digital age: The ongoing battle for customer influence. *Journal of Brand Strategy*, 3(4), 322–331.
- Carruth, D.W. (October, 2017). Virtual reality for education and workforce training. In *Emerging eLearning Technologies and Applications (ICETA), 2017 15th International Conference on* (pp. 1–6). IEEE.
- Curley, M. & Salmelin, B. (2013). Open Innovation 2.0: A new paradigm. In *Open Innovation 2.0 Conference* (pp. 1–12).
- Dad, A.M., Davies, B.J. & Rehman, A.A. (2016). 3D servicescape model: Atmospheric qualities of virtual reality retailing. *International Journal of Advanced Computer Science and Applications*, 7(2), 25–38.
- De Gauquier, L., Brengman, M., Willems, K. & Van Kerrebroeck, H. (2018). Leveraging advertising to a higher dimension: experimental research on the impact of virtual reality on brand personality impressions. *Virtual Reality*, 1–19.
- Dulabh, M., Vazquez, D., Ryding, D. & Casson, A. (2018). Measuring Consumer Engagement in the Brain to Online Interactive Shopping Environments. In Jung, T. & tom Dieck, M. (eds.): *Augmented Reality and Virtual Reality* (pp. 145–165). Springer, Cham.
- Edvardsson, B. & 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.
- Fordham University's Gabelli School of Business & Norwegian School of Economics (2018). *The American Innovation Index*. <https://americaninnovationindex.com/> (accessed 04/09/2018).
- Grewal, D., Roggeveen, A.L. & Nordfält, J. (2017). The future of retailing. *Journal of Retailing*, 93(1), 1–6.
- Grybs, M. (2014). Creating new trends in international marketing communication. *Journal of Economics & Management*, 15, 155.
- Guo, A., Wu, X., Shen, Z., Starner, T., Baumann, H. & Gilliland, S. (2015). Order picking with head-up displays. *Computer*, 48(6), 16–24.
- Hilken, T., Heller, J., Chylinski, M., Keeling, D.I., Mahr, D. & de Ruyter, K. (2018). Making omnichannel an augmented reality: the current and future state of the art. *Journal of Research in Interactive Marketing*. DOI: 10.1108/JRIM-01–2018–0023.
- Iyadurai, F.S. & 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.B. (2017). The Growth of Virtual Reality Technology in China. In *2017 Video Games & Digital Media Conference*. ABA.
- Karahasanovic, A., Holm, K. & Nejad, A. (2017). Design for Trust – Online Grocery Shopping. In *International Conference on Interfaces and Human Computer Interaction, IHCI 2017, Portugal, 21–23 July 2017* (pp. 239–243). IADIS.
- Keeley, L., Walters, H., Pikkell, R. & Quinn, B. (2013). *Ten types of innovation: The discipline of building breakthroughs*. John Wiley & Sons, New York.
- Kemke, C., Galka, R. & Hasan, M. (2006). Towards an Intelligent Interior Design System. In *Proc. Workshop on Intelligent Virtual Design Environments (IVDEs)*.
- Lego (2015). *LEGO Group, LEGO Foundation and UNICEF inspire children to do good through building a tower of their imagination*. <https://www.lego.com/nb-no/aboutus/news-room/2015/june/tower-of-imagination> (accessed 29/03/2018).
- Man, W. & Qun, Z. (January, 2017). The deconstruction and reshaping of space: the application of virtual reality in living space. In *Measuring Technology and Mechatronics Automation (ICMTMA), 2017 9th International Conference on* (pp. 410–413). IEEE.
- McCormick, H., Cartwright, J., Perry, P., Barnes, L., Lynch, S. & Ball, G. (2014). Fashion retailing—past, present and future. *Textile Progress*, 46(3), 227–321.
- Milgram, P. & Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, 77(12), 1321–1329.
- Mocanu, R. (2012). Chasing Experience. How Augmented Reality Reshaped the Consumer Behaviour and Brand Interaction. In *Strategica: Opportunities and Risks in the Contemporary Business Environment*, 317–323.
- Moorhouse, N., tom Dieck, M.C. & Jung, T. (2018). Technological Innovations Transforming the Consumer Retail Experience: A Review of Literature. In Jung, T. & tom Dieck, M. (eds.): *Augmented Reality and Virtual Reality* (pp. 133–143). Springer, Cham.
- Nike (2018). About Nike. <https://about.nike.com> (accessed 29/03/2018).
- Norwegian School of Economics (2017). *The Norwegian Innovation Index*. <https://www.nhh.no/en/the-norwegian-innovation-index/> (accessed 04/06/2018).
- Olszewski, K., Lim, J.J., Saito, S. & Li, H. (2016). *High-fidelity facial and speech animation for VR HMDs*. *ACM Transactions on Graphics (TOG)*, 35(6), 221.
- Pantano, E. (ed.) (2015). *Successful technological integration for competitive advantage in retail settings*. IGI Global.
- Poncin, I. & Mimoun, M.S.B. (2014). The impact of “e-atmospherics” on physical stores. *Journal of Retailing and Consumer Services*, 21(5), 851–859.
- Popa, H.L. (2014). Integrative innovation as core determinant for sustainable progress. *Procedia - Social and Behavioral Sciences*, 124, 460–467.

- 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., Schreiber, S. & Baier, D. (2014). Technology acceptance modeling of augmented reality at the point of sale: Can surveys be replaced by an analysis of online reviews? *Journal of Retailing and Consumer Services*, 21(5), 869–876.
- Ruetz, D. (2018). Digitale Tools bei Markeninszenierungen auf Messen und Events. In Zanger, C. (ed.): *Events und Marke* (pp. 131–157). Springer Gabler, Wiesbaden.
- Satoglu, S., Ustundag, A., Cevikcan, E. & Durmusoglu, M.B. (2018). Lean Transformation Integrated with Industry 4.0 Implementation Methodology. In Fethi, C. & Camgoz Akdag, H. (eds.): *Industrial Engineering in the Industry 4.0 Era* (pp. 97–107). Springer, Cham.
- Scholz, J. & 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.
- Sudarshan, S.K. (2018). *Augmented Reality in Mobile Devices* (doctoral dissertation). San José State University.
- Verhoef, P.C., Kannan, P.K. & 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. & Cleven, A. (June, 2009). Reconstructing the giant: On the importance of rigour in documenting the literature search process. In *ECIS* (Vol. 9, pp. 2206–2217).
- Yim, M.Y.C., Chu, S.C. & 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. & 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* (pp. 26–50). IGI Global.