What impact will immersive technologies such as augmented and virtual reality have on the retail sector?

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Abstract

A new wave of technology is set to transform the retail sector. This includes immersive technologies such as augmented reality (AR) and virtual reality (VR) that could revolutionize how people shop. This paper aims to study the impact that these immersive technologies will have on the retail sector from the perspective of the consumer. To do this, it goes in depth into the background and evolution of the AR/VR field before looking at the response of the user when using the technology, the current and potential uses within a retail setting as well as what is required for the proper implementation of the technologies. The literature review then discusses the potential negatives of the technology and whether these they will be a long-term success or if they are simply a novelty. The methodology section then seeks to continue this discussion by examining how other researchers in the field conducted their research to help justify this paper's methodological approach of a survey. The survey will be conducted to help explore the attitudes and perceptions of consumers towards these technologies in a retail setting. After the survey data is collected, it is analysed using SPSS to see its relationships and significance. The implications of these results will then be discussed before concluding with the limitations of the study and the possibility of future studies. The results found that consumers believe these technologies will indeed have an impact on retail and enhance the shopping experience.

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Introduction

Rapid technological development over the last few decades has led to a new wave of emerging technologies which are set to transform both personal and professional worlds. These emerging technologies were once the stuff of science fiction but thanks to advances in computing processing power they are now real technologies with many real-world applications. Examples of these technologies include Internet of Things, AI, Robotics & nanotechnology. Each of these respective technologies will have a significant impact on our everyday lives. Immersive technologies such as AR/VR are no exception to this with many considering them to be some of the most exciting of the new technologies.

Using their 'Emerging Tech Focus Tool' PwC tracked over 150 technologies and found AR and VR both to be part of the 'essential eight' technologies which together will lead to more autonomous, intelligent and connected devices (Likens, 2019). While these new emerging technologies can initially struggle to compete with existing technologies in their primary domain of application, they can still become viable if they out-perform these existing technologies on at least some performance criteria (Adner & Levinthal, 2002). This is particularly the case for these AR/VR technologies as they are quite flexible and can compete with existing technologies across multiple criteria.

The aim of this research paper is to explore the potential impact of these immersive technologies on the retail sector. As of now, most research within the AR/VR field looks at the technology itself, its relationship with users and its current and potential applications in various fields including retail. There is currently a lack of research with regards to customer perceptions of the technology which is what this paper sets out to do. To properly explore this impact, 5 hypotheses are proposed.

Main Hypothesis:

H1: AR/VR will have a significant impact on retail.

Secondary Hypotheses:

H2: AR/VR will have a bigger Impact on online shopping than in brick and mortar stores.

H3: Enhanced product information will be the most attractive feature of these technologies.

H4: Augmented reality will be bigger than virtual reality.

H5: Any risks/obstacles associated with these technologies will prove insignificant.

It is predicted that these AR/VR technologies will transform both personal and professional worlds. Their popularity has grown quickly over the last decade and show no signs of stopping. As computer technology continues to advance these technologies will become cheaper and more refined which will lead to an increased likelihood of them being further implemented into society. Most of the current uses for these technologies have been based around the entertainment industry. As of now, gaming, movies and other technological novelties are how most people are familiar with them as they are yet to make a significant impact in other industries.

This looks to be changing though with the global AR/VR market set to be worth $209 billion by 2020 (Statista, 2018). Corporate investment in these technologies also totalled $2.3 billion in 2016 along with 52 of the Forbes top 500 having either implemented or testing these technologies (Kaiser, R. and Schatsky, 2017). In the corporate world, these technologies have the capabilities to influence many different business processes. They can help improve employee productivity, lower costs and reduce risk. This is particularly true for the retail industry. Traditionally, brick & mortar stores and shopping centres were the go-to place for people to meet their every shopping needs. This has quickly changed in recent times with the rise of the internet and online shopping growing exponentially each year. Retail no longer revolves only around the products they sell but now they also compete on the overall experience they provide. The focus is on the customer now more than ever.

Many retailers are currently unprepared for this shift as technological advances happen so quickly. Lots of smaller retailers are already struggling to integrate the internet and current technologies into their business model never mind dealing with new emerging technologies. Most companies currently don't have an emerging technology strategy or don't monitor them at all (Likens, 2019).The reason retailers fail to integrate or maintain new technologies is often due to 'emotional posturing' at a managerial level where those in charge refuse to adopt a new strategy, but rather stick to the one that is already in place or has worked in the past (Redd & Vickerie, 2017). Examples of this in recent times include the lack of use of social

media and online platforms by certain businesses which has seen them struggle to survive in an increasingly competitive environment.

With retail moving towards a more online based approach, retailers need to do everything they can to attract customers to their physical stores. These technologies not only can create real value to the shopping experience but can also create ‘hype’ and attract customers that way. Virtual shopping would also have serious implications for the retail industry. Customers would potentially no longer have to even leave their own homes but could instead browse a virtual store from the comfort of their own living room. More forward-thinking companies are already starting to invest in implementing these technologies into their business models. With retailers like Ikea and Dulux paint already displaying the uses of this technology, their potential is clear to see.

Literature Review

Immersive Technologies

'Immersive technologies' is an umbrella term commonly used within the tech industry to describe technologies such as augmented and virtual reality. These technologies blur the lines between what is real and what is not. Immersive technologies are also often used interchangeably with 'Mixed Reality'. Mixed Reality was defined by Milman (2018) as the anchoring of virtual objects into the real world. In most fields the term 'immersion' is often used to describe experiences where someone is immersed in something such as art, cinema and gaming (Kitson, Prpa & Rieke, 2018), yet in technology related fields, immersion is a "description of a technology and describes the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant" (Slater & Wilbur, 1997, p. 3). The importance of immersion in these technologies was evidenced by Bowman & McMahan (2007) where they found that successful implementation of these technologies had at least one thing in common – they all provided a high level of sensory fidelity whether it be visual, audio or other senses. Each sense that was triggered by the technology would then trigger the expected stimuli response in the brain. They also proposed that Immersion is usually focused on the actual experience the technology (hardware and software) provides which can be measured while presence is more to do with the individuals response. This immersion is affected by things such as field of view, quality of graphics, head movement-based rendering and lighting.

Augmented Reality (AR)

Augmented Reality allows users to visualize and interact with superimposed computer graphics over a real-world environment (Azuma, 1997). These systems should display and use relevant information to guide the user in real-time manner as AR is not just about showing information on a screen but rather contextualising and segmenting it. Despite recent growth in the use of AR, most current applications and equipment are suited for short-term usage rather than continuous use. New advances would help overcome this issue that would allow AR systems to offer 'Pervasive Augmented Reality' which would provide continuous augmented information to the real world which could adapt to the changing needs of the user's context (Grubert et al, 2016).

There are also several different types of augmented reality. Perhaps the most basic type is Marker based AR. This involves the use of a camera or other equipment to scan a QR code which then produces a virtual object over the space where the code is situated. This type of AR has been commonly used in children's books and education to create a more immersive experience. Markerless AR does not require a QR code instead relies on the locational data and orientation of the smartphone to primarily deliver information such as mapping routes. Superimposition based AR relies on the technology being able to reliably and consistently identify real world objects and landscapes, so that new objects can overlay them. This type of AR technology is commonly used to display furniture/clothes etc. over real world environments.

While these types of AR each have their own place in society, Baumeister et al (2017) conducted a comparison of several types of AR and found that Spatial Augmented Reality (or Projection based AR) saw the biggest increase in user performance and reduction in cognitive load. Projection based AR is perhaps the most exciting yet unproven form of augmented reality technology. It involves projecting artificial light and holograms onto real surfaces that can detect and respond to user input. Its uses are almost endless and could help reduce the number of tablets and equipment currently required for AR technology. This projection-based AR is currently used by Disney theme parks in their haunted house attraction so that they can transform the current environment without making structural changes (Mine et al, 2012).

AR is predicted by many to become the biggest type of immersive technology. Apple CEO Tim Cook who stated that "There's virtual reality and there's augmented reality - both of these are incredibly interesting, but my own view is that augmented reality is the larger of the two, probably by far" (ABC News, 2016).

Virtual Reality (VR)

Virtual Reality is the creation of computer-generated environments or realities that are designed to simulate a person's physical presence in a virtual environment (Mantovani & Castelnuovo, 2003). According to Cipresso et al (2018), there are three main types of VR. Non-immersive VR is the technology in its most basic form where a desktop computer is used to produce real-world images. Semi-Immersive VR involves projecting a 3D image onto a monitor in combination with a head-mounted display to provide a view of the environment that the

user can interact with by moving their head. The third type and the one that most people would be familiar with is fully immersive VR. This involves using the use of equipment such as a head-mounted display (headset), special haptic-gloves and multi-directional treadmills to create a completely immersive experience.

In the same way people have been exposed to AR through various smartphone apps, most people have already been exposed to the potential uses of VR through the entertainment industry. Numerous studios have so far used VR in their movies and games with many future projects planned. One of these being Netflix who have released an app that can show movies such as Jaws and the Jungle Book in VR. Forecasts also show that VR alone will be worth £801 million in the UK entertainment industry by 2021 (Ampofo, 2017). As of now, HTC Vive, Oculus and PlayStation VR are the current market leaders with regards to consumer VR technology. Facebook's acquisition of Oculus VR for $2 billion in 2016 also help demonstrate its potential to affect various social media platforms. Despite these uses, it is argued that VR faces a higher barrier compared to AR due to the need for specialised equipment to use it.

Current Uses of AR/VR

Popular smartphone apps have helped showcase the potential of smartphones as an AR enabler. An example of one of these apps is Pokémon Go which has generated over 800 million downloads (BBC, 2018). Through this app, users can track down, battle and then catch Pokémon creatures that are super-imposed over a real-world environment. Another app that has showcased the potential of AR through smartphones is Snapchat. Snapchat allows its users to place filters over pictures and selfies in real-time. Although these apps are incredibly popular, the average user might not realise that AR is the technology used behind them and therefore still view AR as more of an abstract idea rather than something with everyday uses. Another app that uses AR is Google Translates relatively new feature 'Word Lens' that allows users to translate photos of signs, menus etc. in real-time.

Apart from the media industry these technologies are also currently used to at least some degree in advertising, tourism, education, medical and military industries. London's Gatwick Airport have developed an AR app that acts as a guide to help travellers reach their check-in gate. Both the medical and military industry have used these technologies for training

purposes. These technologies are likely to further become a staple of several other industries in the not so distant future.

For both AR and VR, mixed-reality headsets were once predicted to be the go-to piece of equipment to facilitate these experiences, but many have argued that they have only stunted the growth of these technologies due to how bulky and impractical they are. This is illustrated by the 33.7% decline in global sales of these headsets in 2018 (IDC, 2018). It is important for the tech to advance to allow lighter, sleeker models such as glasses and contact lenses. Because of this, these headsets have been generally replaced by the practical and more mobile smartphone. These handheld devices are more robust, and consumers are more comfortable using them. Even before the introduction of smartphones, small display devices were often chosen to enable AR experiences rather than big clunky equipment (Schmalstieg & Wagner, 2007).

History of AR/VR

In 1968, Ivan Sutherland developed a 'virtual head-mounted display system' which is now viewed as the first iteration of mixed reality technology that paved the way for the technology we have today (Sutherland, 1968). The next significant step in the creation of immersive technology was Krueger's 'Videoplace' project which used video cameras and a projection system to produce shadows on the screen to give the user a sense that they were in an interactive environment (Krueger, 1974).

At this point in time, these technologies were thought of as futuristic concepts by the average person rather than something that could become reality. This changed in 1990 when Boeing researcher Tom Caudell came up with the term 'augmented reality'. Caudell designed an interface with a see-through display head set, which combined with head-position sensors and workplace registration systems to augment the visual field of the user with all necessary information (Caudell & Mizell, 1992).

Milgram & Kishino (1994) designed the reality-virtuality continuum that differentiates between the different types of mixed reality technology. The continuum is still commonly used by researchers and consists of the different types of mixed realities that exists between the two extremes of real and virtual environments.

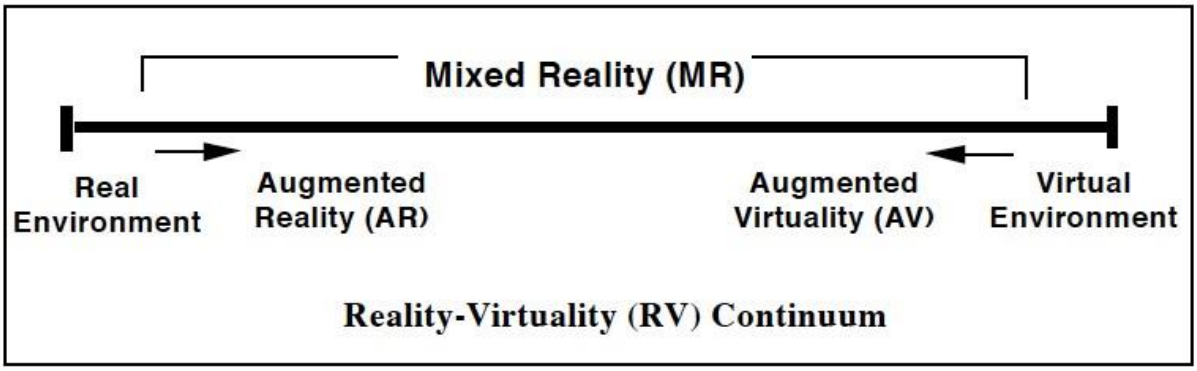


Figure 1: Reality-Virtuality Continuum (Source: Milgram & Kishino, 1994)

As these immersive technologies became more refined, the late 1990's helped showcase the potential of them to the mainstream public. Sega and Nintendo in the gaming industry and several film studios were just some of those who were working on mixed reality projects at the time. One of these includes the iconic 1999 film, The Matrix, where humanity is depicted as living in a virtual world. This film and similar media helped bring the topic of simulated reality into the mainstream. Later that year, NASA used a special AR dashboard on their X-38 spacecraft to overlay relevant data and visualisation for enhanced navigation which was one of the first examples of AR being used outside a laboratory or media environment. In 2003, one of the first commercial uses saw the NFL use AR to digitally overlay lines on the pitch in real-time using an aerial camera. Wagner & Schmalstieg (2005) were the first to show the viability of AR through a handheld device. They created a personal digital assistant attached with a camera that provided the user with an augmented view of the environment. This helped lead the way for AR on devices such as smartphones. Further advancements in the 2000's in computer technology have further showcased the uses of these technologies while also decreasing the costs of the required components to help make the introduction of these technologies into everyday life a real possibility.

Engagement & Presence

The importance of engagement was illustrated by Dede, Dunleavy & Mitchell (2008) where they found that user engagement with an activity was higher when using mixed reality technology. To increase these engagement levels, it is essential that a high-quality AR application is used. This is an issue with the current generation of AR/VR technology as a

considerable number of apps/equipment are lacking in several areas e.g. limited resolution or field of view (Van Krevelen, 2010).

The importance of a high-quality application was also noted by Baumeister et al (2017) who found that the more limited the field of view in an AR app, the more of a cognitive toll the technology takes on a user, which in turn leads to reduced engagement.

When displaying information, AR technology must ensure that the spatial perceptions of the users are taken into consideration. This includes issues like depth perception, data localisation and consistency between virtual objects and the real world (Luboschik, Berger & Staadt, 2016). It is also essential that these applications ensure that any virtual objects (whether in a virtual or real-world setting) maintain the correct size and orientation from the point of view of the user. This should remain consistent even when the user changes their point of view to help create a seamless experience (Fogliaroni, 2012).

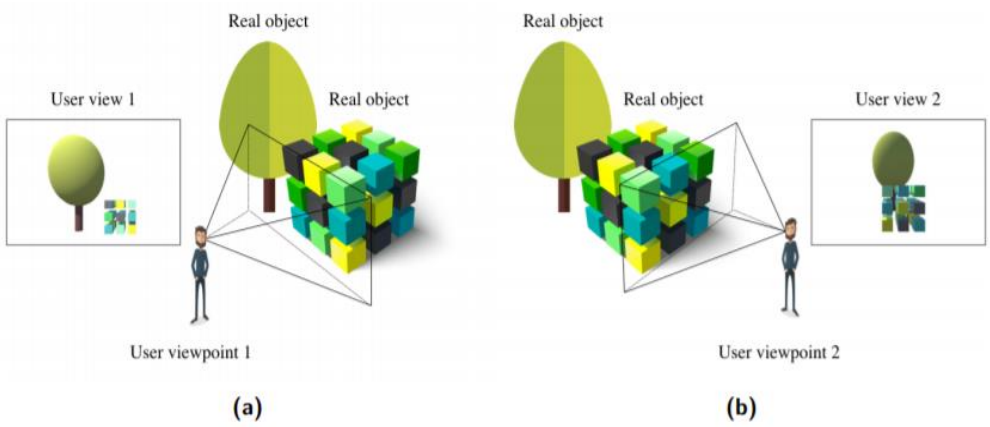


Figure 2: Mixed Reality for Archaeology and Cultural Heritage (Source: Fogliaroni, 2012)

While the effects of Immersive technologies tend to be mostly visual, the role of other senses also play an important part in the overall feeling of presence in a virtual world. An example of this is audio effects which allow users to differentiate which direction noises are coming from. Another important effect is haptic feedback which allows for the feelings of touch sensation. An example of a common use of haptic feedback is the vibration felt on touchscreen smartphones to simulate the press of a button. In VR, special haptic gloves are used to simulate the feeling or presence of real-world objects in the hands of the users. When all these senses are taken into consideration, it can be difficult to tell the difference between the virtual world and the real one.

Riva et al (2007) found that this sense of presence in a virtual environment is vital to feel the emotional responses that the technology is trying to elicit from the user. Repeated use of these mixed reality technologies is also unlikely if there is no emotional connection. Javornik (2016) noted how connectivity is lacking with regards to current AR apps which can lead to less engagement. This was further emphasised by Schroeder (2006) who argued that to increase the feeling of presence in a virtual world, it is important to work towards making that virtual world a "multi-user or collaborative" experience. This would involve people 'being there together' in the same virtual world and enabling varying degrees of interaction between users.

AR/VR in Retail

One of the industries that these technologies are predicted to have the biggest impact on is the retail industry. These technologies can provide benefits for both consumers as well as businesses themselves. As well as displaying information, Pantano & Naccarato (2010) argued that AR can also influence customer engagement as well as purchasing patterns. They stated that these technologies increased the speed of obtaining information as well as generating an overall positive influence on customer experience and service. This was also reaffirmed by Martinez-Navarro et al (2019) who found that the levels of 'presence' in VR technology does indeed increase customer purchase intention. These technologies also need to provide "experiences of efficiency and empowerment, increased awareness and knowledge, intuitiveness, and required them to be usable and offer relevant, personalised and reliable content in a privacy-sensitive and safe way" (Olsson, Lagerstam & Karkkainen, 2011, p. 13).

In-Store

The potential of these technologies as having an actual tangible benefit to customers was displayed by Vlahakis et al (2002) who created the ARCHEOGUIDE (an AR based cultural heritage guide). This AR guide allowed users at the archaeological site of Olympia in Greece to see the augmented reconstruction of ancient ruins, based on their position and orientation, as well as providing on-site help and relevant information, all in real time. This is a good example of the potential benefits that AR could have as a guide for retail customers, displaying relevant product locations and information.

Most brick and mortar retailers suffer from lack of space which means that promotion and advertising space can be limited. AR can help overcome this with its "basically unlimited visualization possibilities and the intuitivism of the interface" (Spreer & Kallweit, 2014, p. 2).

Real world examples of Augmented reality being currently used in retail include Harley Davidson who use AR in their showroom to allow customers to customize motorcycles instantly to see which colours and features they might like before buying. Sephora (cosmetics retailer) used AR to allow their customers to see what different cosmetic items would look like on their face in real time. Another example is Topshop (fashion retailer) who have introduced AR in their Moscow store to allow customers to see what clothes look like on themselves without having to try them on. These applications are examples of a 'try before you buy' service. This is something that is beneficial to both customer and retailer as it means less products being damaged and less returns. Kaewrat & Boonbrahm (2017) noted how virtual fitting rooms were able to track the users body size and their movements through image processing cameras to display these virtual clothes on the user. Hilken et al (2017) furthered this by emphasising the importance of providing this service in a personally relevant context such as being able to make natural movements to adjust virtual sunglasses when trying them on.

Online

Retail Ireland Director Thomas Burke stated that despite overall sales growing "there is consensus in the sector that footfall levels in traditional shopping hot spots are continuing to decline" (IBEC, 2019). As this shift towards online shopping happens, it is essential that retailers also have an online strategy in place to accommodate these new technologies.

Like brick and mortar stores, one of the major issues that affects online shopping is the huge number of items that are returned after purchase. These returned items cost online UK retailers £20 billion a year (Ram, 2016). These technologies can help alleviate this issue as they can also offer the 'try before you buy' service online. This is often done through smartphone apps using AR to free potential customers from time and place constraints. One such example is Ikea (furniture retailer) whose app allows users to superimpose furniture over the users personal living space to see what it looks like before buying the physical item.

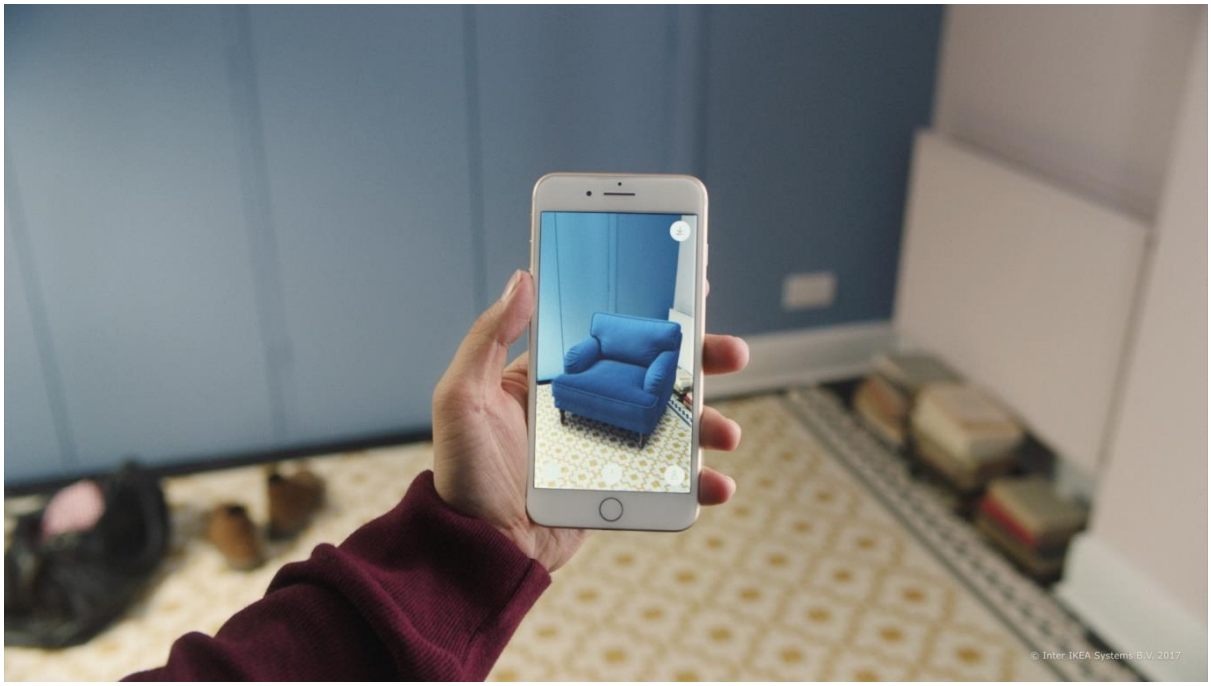


Figure 3: Example of 'Try Before you Buy' (Source: Ikea, 2017)

Another example is Dulux (paint retailer) whose app allows customers to see what different colours look like on their own walls before buying the paint. While AR is predicted by many to be the bigger technology in the retail and professional world, Virtual stores have the potential to be bigger than anything AR can offer. VR generated stores allow customers to browse stores whenever they like from the comfort of their own homes. They can walk down aisles, browse shelves and pick products up just like a physical store. This gives retailers the possibility of using VR to replace current services with more convenient alternatives. A real-world example of this is Karen Millen (fashion retailer) who launched a virtual version of their London store. Van Kerrebroek, Brengman & Willems (2017) noted these virtual stores to be beneficial as they found that shopping in a virtual world rather than a crowded shopping mall had positive effects on user attitudes and experiences. Virtual stores were also found to have an increased cognitive effect on the user compared to physical stores which led to increased engagement (Martinez-Navarro et al, 2019). Brand recall was also found to be higher in virtual stores compared to standard physical stores/online shopping.

Figure 4: Virtual Store (Source: Cricket, 2018)

AR/VR technologies can also intertwine online shopping features with brick and mortar stores. This is done as AR can help provide a 'link' between the real world and the virtual one to allow for a seamless shopping experience where customers can switch between the two (Billinghurst & Kato, 2003). This in turn leads to an increase in customer engagement and shopping satisfaction (Rashid, Peig & Pous, 2015). This move towards a seamless shopping experience is further backed up with mobile smartphone quickly becoming the main platform for online shopping (Dillon & McFeely, 2018) as well the 'vehicle of choice' for Augmented Reality.

Implementation

Pantano & Di Pietro (2012) also argue that as technology use increases so do the expectations of customers which means that any technologies implemented must fit in with their overall business strategy. Retailers who are thinking of implementing an AR/VR system must take multiple factors into consideration. They must decide which type of Immersive technology to implement – AR, VR or both. If implementing VR, they must be aware that VR faces a higher barrier compared to Augmented Reality due to extra required equipment such as headsets and haptic gloves. They must also decide what they want from their technology as different forms of these technologies specialize in different areas, so it is important to ensure that it is

the best fit for the area of business they are in e.g. different requirements for retail vs manufacturing.

Retailers must also choose which technology best suits their needs, whether it be in-store or online. As there are several emerging technologies with lots of potential, managers can be forgiven for being overwhelmed by them all. Lots of these technologies are similar sounding to someone who isn't tech savvy. Even in specific technologies such as AR there are several different types of the technology, which makes the choice of which is best for your store even more daunting (Farshid et al, 2018). Marker based AR involves scanning a QR code (like a barcode) which then produces a virtual object over the code which could help provide enhanced product information. Markerless AR uses locational data and orientation of the smartphone to help deliver store guides and mapping routes. Superimposition based AR enables the 'try before you buy' service while projection-based AR allows for the most user interaction and flexible approach. Projection based AR could perhaps be the most beneficial in store rather than online. Once the technology has been decided, retailers must ensure that the technology is integrated with their current IT infrastructure. Stores providing large tablets and digital screens is essential to facilitate this technology with any AR hardware/software that retailers implement meeting the needs and expectations of its customers (Van Krevelen, 2010).

When looking at a previous technology that was implemented into the retail experience, Meuter et al (2003) found that many people who used self-service technology in-store suffered from technology related anxiety which negatively impacted the shopping experience, so it is essential that stores create the right environment to overcome and avoid these issues.

Training

These technologies can also provide value to the retailers beyond their customers. They allow for more immersive employee training carried out in a more efficient way and at a reduced cost. AR training was found to help participants to focus more when doing their work as AR can help emphasise the key stages/objectives of each task (Webel et al, 2012). It can also lead to users making less errors when using VR applications during training (Seymour et al, 2002). In the business world these AR/VR technologies act as a "collaborative, skill-learning,

explainable, and guidable tool for workers, managers, and customers" (Lee, 2012, p. 3). VR could enable potential work scenarios to be simulated so that employees can be better prepared for them. AR could be used across several different business functions such as HR, accounting, marketing and advertising as well as allowing both managers and employees to better track performance through more informative graphics and visualisation methods.

Figure 5: AR in Training (Source: PoinDext AR, 2017)

Obstacles & Negatives

While these technologies having many current and potential benefits within retail as well as overall society, most researchers within the immersive technology field have only really examined the positive impacts. As of now, there has been a lack of consideration around the potentially negative impacts.

One of these negative impacts is the safety concerns that arise. A Russian man who was using VR in his apartment died after losing his bearings and falling onto a glass table (Moscow Times, 2017). VR manufacture HTC themselves stated while wearing the product's headset you are blind to the world around you. This issue is not just exclusive to VR but also can affect AR to a certain extent. It is further exasperated when using these technologies in unfamiliar surroundings such as retail outlets. When using poorly designed AR equipment, it can impair

your vision to the same extent as medical issues such as presbyopia, glaucoma and retinitis pigmentosa which all lead to trouble focusing and tunnel vision (Sabelman & Lam, 2015).

Some of the common issues that people have complained about include dizziness and motion sickness while using the equipment. The addition of extra positional tracking equipment can help to overcome this (Desai et al, 2014). While Bouchard, Wiederhold & Renaud (2009) found that the severity of the side effects when using these technologies is quite low, (Bouchard et al (2011) found that with continued advancement and growth in the technologies the greater the chance for unwanted side effects. They also found that nausea and eye fatigue were some of the most persistent issues among users.

Giving out personal data and a general lack of privacy is also another potential negative affect that is commonly mentioned. Users were found to be irritated by AR apps requiring access to the user's name and location (Olsson, 2012). Users were also less likely to use these apps if they feel their privacy is being violated, particularly if the application being used was of low quality. These technologies are in a sense 'rewiring' our brains with it taking years until we can get an accurate view of the long-term effects (Davidow, 2012).

Some have argued that new disruptive technologies like AR/VR could also lead to potential job losses as certain jobs may be replaced or made redundant by these technologies, but these potential job losses should be offset by the overall economic growth that these technologies should help bring. It is yet to be determined whether these technologies will positively affect the performance of retailers with numerous benefits or if they will potentially have a negative impact on the existing nature of relationships with the customers (Pantano & Di Pietro, 2012).

Perceptions & Novelty

The impact that AR will have in retail will also depend on how customers perception of the technology evolves. In recent times, many perceived these technologies as more of a novelty rather than anything else. This is shown by Snapchat Spectacles and Google Glass which both failed to take off due to consumer attitudes and perceptions of them being intrusive and without real use. This has led to Google Glass redirecting their efforts towards a more business orientated approach rather than a consumer one.

One of the biggest questions is whether these technologies will have a significant impact, or will they simply be little more than a fad. CCP Games CEO, Hilmar Veigar Pétursson, stated in an interview with (PCgamer, 2018) that he expected the VR industry to be two or three times bigger than it is right now. Bonetti, Warnaby & Quinn (2017) argued that while these technologies can help improve the overall customer experience, perhaps they will be predominantly used to help create a 'buzz' around the store and attract new customers rather than being an actual long-term solution. Wessel (2014) also argued that while technologies like AR/VR might be pervasive, the impact will be nowhere near as significant as the disruption caused by the introduction of the android operating system in the mobile phone industry or Ford's automation in the motor vehicle industry.

Methodology

Aims & Objectives

This research paper aims to explore the potential impact of immersive technologies such as AR/VR on the retail sector from the perspective of the consumers. It will seek to do this by using a mixed quantitative and qualitative approach to the research. The main hypothesis for this research paper is that AR/VR will have a substantial impact on the retail sector. It is also assumed that this impact will be a mainly positive one with numerous benefits that will outweigh any of the potential negatives (as identified in the literature review). For these benefits to be achieved, such criteria such as feeling of presence and user engagement must be met. It is also assumed that online shopping will be more interesting to consumers as it is quickly becoming the dominant shopping platform. AR is also predicted to be the bigger technology compared to VR.

Previous Research Methods

In terms of the current field of knowledge of immersive technology related literature, there are two main areas. the first area focuses on how different variables affect user experience. The second area looks at how user performance and experiences are improved by these technologies. Previous researchers in the AR/VR field have used a plethora of different research methods. These include experiments, interviews, surveys, questionnaires or a combination of different methods. Out of these, experiments were the most common method of research followed by surveys and questionnaires.

Many of the experiments conducted within the field were used to examine how immersive technologies affect user's cognitive responses (Suh & Prophet, 2017). One experiment conducted by Smets & Overbeeke (1995) measured how important the quality of the AR/VR image resolution is. This was done by comparing two groups who were tasked with a 'search and find' activity. The first group used equipment with poor-quality resolution while the second used VR of a more standard-quality resolution. They found that the interactivity of these technologies could compensate for this loss in resolution compared to more traditional media. Slater et al (1998) used an experiment to measure how body movements of the user can influence their overall feeling of 'presence' in a virtual world. In this experiment, participants walked through a virtual world where they were required to count several trees

that varied in size. This required participants to stand up, crouch down and move their heads. The results of this experiment showed a strong correlation between presence and how much movement a participant did.

Bian et al (2016) carried out an experiment where “electromyography (EMG) was used to measure users' facial muscle activity and electroencephalogram (EEG) to detect electrical activity of the brain”. This indicated the flow and presence experienced while using immersive technologies using facial muscle movement as an indicator. Another experiment was conducted by Poushneh & Vasquez-Parraga (2016) to understand the impact of AR on users shopping experience. Users were assigned to one of three random groups where they were then given either two versions of AR shopping technology or standard desktop shopping to purchase a pair of sunglasses. They found that participants using the AR technology saw significantly higher levels of satisfaction and willingness to buy compared to traditional methods.

Along with experiments, surveys and questionnaires have also often been conducted to find out people’s perceptions and feelings towards the technologies. Usoh et al (2000) proposed a reality test experiment where two test groups were tasked to search for a box – one group in a real room while the other in a virtual room. Immediately after each group were given a questionnaire about their experiences with the hypothesis being that the questionnaires should pass a ‘reality’ test where participants in the real room scoring higher than those in a virtual room. The results of this questionnaire saw only a marginal difference between the two which led to the conclusion that questionnaires were unreliable when contrasting two different states of reality. Olsson & Salo (2014) made use of an online survey to find out consumer attitudes and experiences of AR applications. From the 90 respondents who answered the survey, their results were rather mixed with any positive experiences also meeting complaints of unreliability and limited content.

Kourouthanassis et al (2014) used a questionnaire to determine participant attitudes towards their augmented reality travel guide. Their findings suggested that users evoked feelings of pleasure which in turn increased chances of reusing the technology. A survey was conducted by Speicher, Cucerca & Kruger (2017) to find out customer perceptions of their current shopping experience. From the results of this survey, they were able to design a virtual store

experience that met the needs of the customers. They found that a VR interface should have clarity, efficiency, orientation, personality and quality.

Research Methods

These research methods along with the ones mentioned in the literature review show how varied the field is in terms of methodology. Due to the nature of this study, this research paper will follow other researchers in the field and conduct the research using the second most commonly used type of research method, a survey. This quantitative approach will then allow for inferences about the survey data to be made.

This survey will be conducted to find out whether consumers believe whether these immersive technologies could potentially enhance the shopping experience. As of now, there is currently a lack of research with regards to customer perceptions of the technology with most researchers in the field instead focusing on the retailer's perspective or the importance of engagement/presence.

The survey will be sent out using SurveyMonkey. This site will be used as it is a free service which allows 10 questions and up to 100 respondents while also providing helpful statistical analysis. Once respondents decide to answer the survey, they will be directed to SurveyMonkey where they will be given a very brief explanation of these technologies before being instructed to answer 10 relatively straightforward questions. This survey should take no more than 2 minutes and respondents are free to close the survey at any time. All answers will be made anonymously and if respondents have any queries the researcher's email will be made available. This information will be made in the form of a declaration of consent at the start of the survey.

Survey Design

The survey design will consist of mainly closed ended questions with two questions allowing respondents to give extra information by selecting the 'other' option. This is to suit the purpose of a survey and to get as many responses as possible to reduce the margin for error. The sample of this survey will be taken using SurveyMonkey's random sampling where every member of the population has an equal chance of being chosen. This sampling is chosen as in most cases it creates the greatest chance of accurately representing the whole population.

There are no exclusion criteria for this survey as almost everyone shops either online or in store.

The first two survey questions will ask the respondents their gender and age group. These questions will be used as identifiers to see which members of the population are answering the survey. Age will be an interesting identifier as the difference in ability and attitudes between people of different ages has been one of the biggest debates across many technology related fields. Laguna & Babcock (1997) found that there is a significant age difference in computer related technology in older adults compared to younger age groups. They also found that older adults tended to take longer and make more mistakes. These findings were consistent with those of Salthill (1987) who studied the spatial ability of different age groups. In this experiment they found that the greater the number of operations required, the poorer the performance was in older adults. More modern studies indicate that this relationship between age and technology is a lot more complex than some stereotypes and older studies suggest. Mitzner et al (2010) found that adults were not opposed to many 'modern' technologies in general (such as microwaves and personal health equipment) but rather it was the perceived complexity and inducement of anxiety which saw older adults being less likely to use them. This further emphasises the importance of retailers offering a simple, easy to use AR experience.

The next two questions will also be used as identifiers to find out the respondents shopping habits and familiarity with the technologies. Once that information is collected, the next set of questions will be focused around testing the hypotheses.

Hypotheses

Hypothesis 1 is the main hypothesis. It is quite broad and consists of two questions. The first question seeks to find out whether consumers believe if these technologies will enhance the retail experience to see if they are worthwhile implementing or if they will simply not have much use in a retail setting. The second question continues this and asks consumers whether they believe if these technologies will have staying power or if they are just a novelty. As previously mentioned, these technologies are only really a mainstay in the media industry and have not entered other industries to the same degree, so their long-term viability remains to be seen.

The next question centres around Hypothesis 2 and involves discovering whether consumers feel these technologies will have more of an impact in-store or online. Whether people feel comfortable using them in store or perhaps they feel it will have more of an impact in an online setting e.g. virtual store. Hypothesis 3 is tested by asking what service that these technologies provide would be the most useful e.g. 'try before you buy' or an in-store guide. Testing Hypothesis 4 involves determining which of AR/VR will be bigger in the eyes of the consumer. The final question looks to test Hypothesis 5 and to determine whether consumers believe there are any obstacles or risks involved in implementing these technologies that could prevent them from having a significant impact. Ideally, these questions will help demonstrate the overall consumer perception of these technologies within a retail setting.

Data Analysis

Once enough data is collected, brief data analysis will be done using SurveyMonkey's built in analysis tools. The survey data will then be exported into an excel file where numerical values/labels will be assigned to each question and their respective responses. From there, this excel file will then be imported to SPSS to give a more in-depth view of the data and to study the relationship between different variables. Frequency distribution will be used to give a helpful overview of the data to see the differences in responses. Each question will then be cross-tabulated with the previously mentioned identifiers (and other relevant questions) to see how they relate to each other. In certain cases, a chi-square test will then be used to determine the statistical significance of this relationship for a more comprehensive analysis. Finally, the implications of these findings will then be discussed.

Analysis & Discussion

After conducting the survey, this analysis sets out to examine the results of the questions using the 5 hypotheses previously mentioned as a framework. There was a total of 113 respondents to the survey. The data was then exported from SurveyMonkey into the form of an excel file. It was then opened in SPSS before being analysed. The SPSS raw data was then exported back to excel which is attached in appendix (4).

Identifiers

The first question of the survey asks the age of the respondents while the second question asks the gender. This information is shown on the table below.

	Under 18	18 - 24	25 - 34	35 - 44	45 - 54	55 - 64	65+	Total
Male	0.88%	15%	14.16%	9.73%	6.19%	3.54%	7.08%	56.64%
Female	0%	7.96%	8.85%	5.31%	9.73%	4.42%	7.08%	43.36%
Total	0.88%	23.01%	23.01%	15.04%	15.93%	7.96%	14.16%	100%

(Figure 6: Age & Gender of Respondents)

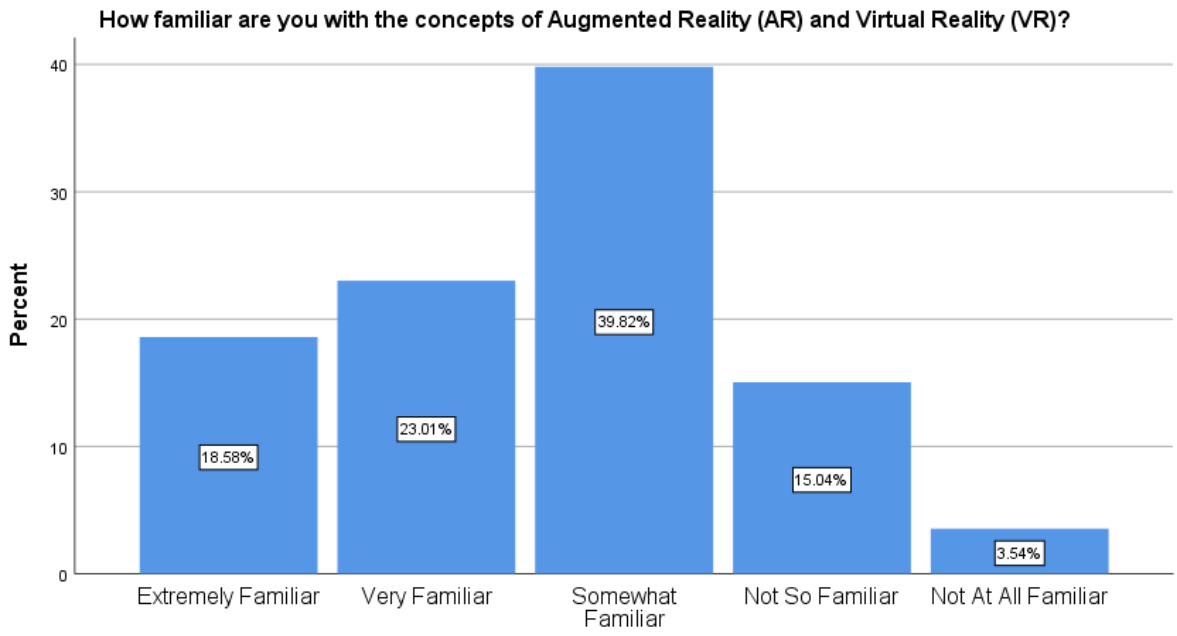
From this we can see there is a somewhat similar number of male (56.4%) and female (43.36%) respondents. Age is also relatively well represented without their being one age group dominant over the rest. Having well distributed responses was very important to get an accurate reflection of the differences across gender and particularly age where relationship between age and attitudes/user ability towards technology have been well documented, particularly in older studies.

It is also important to determine whether the respondents to the survey were knowledgeable enough to give a genuine insight on what they were answering. To assess the validity of the views of those responding to the survey, the next two questions centred around the shopping habits of the users as well as their familiarity with AR/VR technologies.

Figure 7: Shopping Habits (112 Responses, 99% response rate)

This question helped give a brief overview of the shopping habits of the respondents. 66.7% of respondents answered that they go shopping at least 'once a week' or more while a majority of 86.6% claimed that they shopped at least a 'few times a month' or more. This question helps give more validity to the study, as their regular shopping habits suggest that they could provide genuine insight based off their previous experiences in retail.

Figure 8 - Familiarity with AR/VR (113 Responses, 100% response rate)



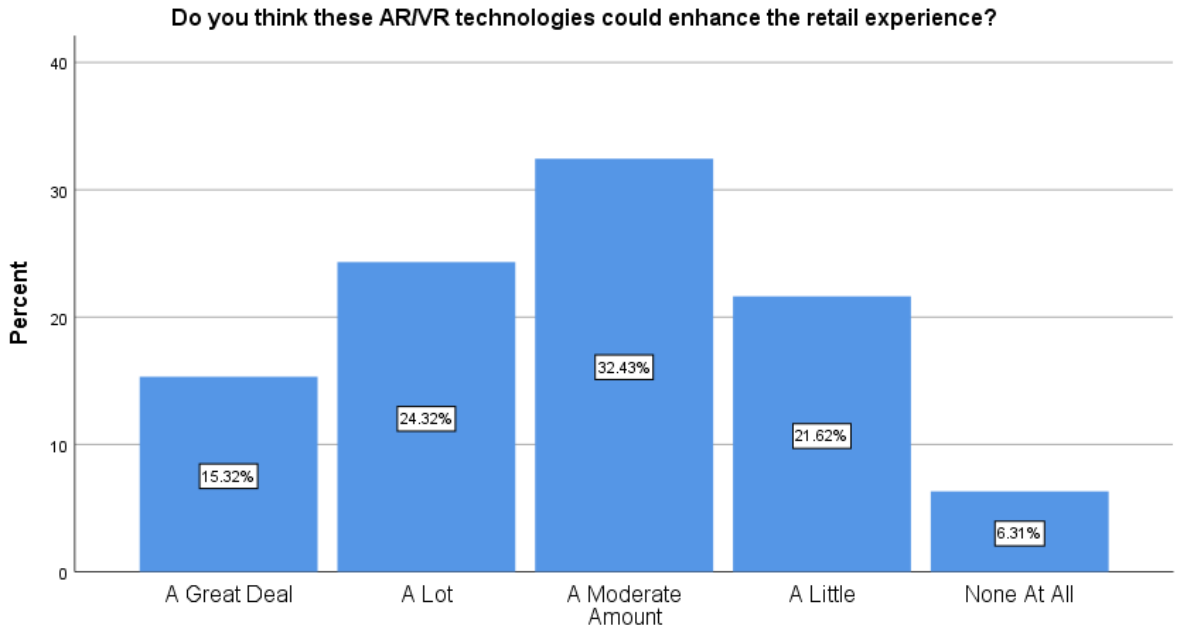
Fortunately, most of the respondents had some previous knowledge of these technologies with 81.4% of participants answering that they were 'at least somewhat familiar' with the technologies. How accurate this is remains to be seen, as many people will have heard of the technologies to some extent but may not know much about how the technologies work or their uses. Respondents who claimed to be familiar may also have only been familiar about one type of technology e.g. know about VR but not AR. 80.9% of those who answered either very or extremely familiar were aged 44 or under which indicates a difference in knowledge between the different age groups. This relationship between age and familiarity of technologies was also shown to be statistically significant with a p-value of .005. In terms of gender, males tended to be more familiar with 50% of male respondents claiming to be either extremely or very familiar with these technologies compared to just 30% for females. The reason for this difference in gender could be due to exposure, as one of the industries where these technologies are most prevalent is the gaming industry which sees significantly more males identifying as 'gamers' compared to females (Romrell, 2013).

Hypothesis 1

The first hypothesis is made up of two questions to try and determine the overall impact of these technologies. It looks to discover whether consumers believe these technologies will be

worthwhile implementing and if these technologies will add real value to their shopping experience.

Figure 9: - Whether AR/VR will enhance the shopping experience (111 Responses, 98% response rate)

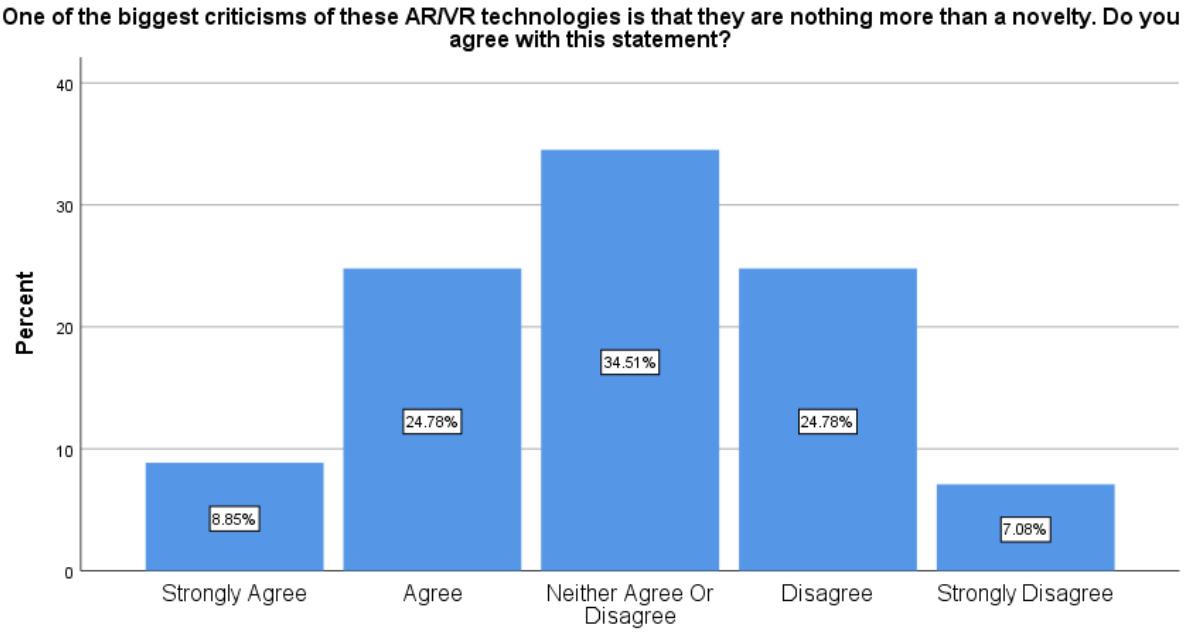


The responses for this question were relatively evenly distributed with the majority thinking it will have at least some benefit. Only 6.31% of respondents think it will not at all enhance the shopping experience. This data shows a potential for the success of these technologies. There were no apparent differences between age but in terms of gender, 79.2% of females felt that it would at least 'moderately affect' the shopping experience compared to 66.7% for males. Every female respondent also felt that it could enhance the shopping experience at least 'a little' with 0% selecting 'none at all'. Over half (54.5%) of the respondents to the survey went shopping once a week or more and felt that these technologies would at least moderately enhance the shopping experience. There was a statistically significant relationship between how often people shop & if AR/VR will enhance the shopping experience with a p value of .008 which indicates that those who shopped regularly could give a better insight. 71.43% of those who claimed to be 'extremely familiar' with the technologies believe that these technologies will enhance the shopping experience either 'a lot' or 'a great deal'. The relationship between familiarity of technologies and whether AR/VR will enhance the shopping experience was also statistically significant with a p value of .000 which shows

a strong relationship between knowledge of these technologies and the significance of the impact that they will have on retail.

To further expand on Hypothesis 1, a follow up question was asked to find out whether consumers believe these technologies will have staying power or if they are simply a novelty.

Figure 10: - Novelty or not? (113 Responses, 100% response rate)



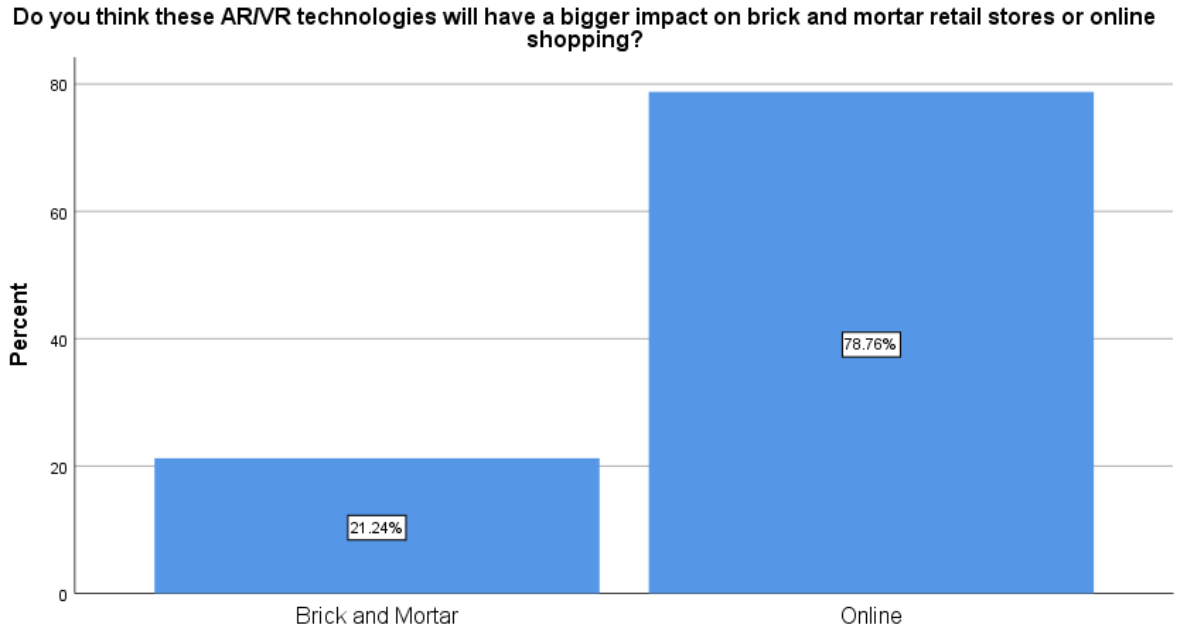
This question sought to find out whether respondents believed these technologies had staying power or if they were just a novelty. The majority of 34.51% selected 'neither agree or disagree' which showed that people were still unsure as to whether they would turn out to be more than a novelty. With 33.63% agreeing to some extent and 31.86% disagreeing to some extent, opinions were split on the matter. Even when cross-tabulated with identifiers such as age, gender, shopping habits or familiarity with the technologies the results continued to be inconclusive as the majority neither agreed or disagreed with the statement regardless of which identifier was chosen. This could change in the future once these technologies become more prevalent in society and people have a better understanding and experience with them. Despite this, there was in fact a statistically significant relationship between whether the technologies would enhance the shopping experience and whether they are a novelty with a p-value of .043.

Overall Hypothesis 1 was shown to be somewhat accurate with consumers believing there will be some sort of impact on retail. Whether these technologies will have a long-term impact is less clear with opinions on if they are a novelty showing to be rather inconclusive.

Hypothesis 2

The second hypothesis revolved around determining whether consumers feel these technologies will have more of an impact in-store or online. Will people feel comfortable using them in store or perhaps they feel it will have more of an impact in an online environment.

Figure 11: Bigger impact on brick & mortar or online (113 Responses, 100% response rate)



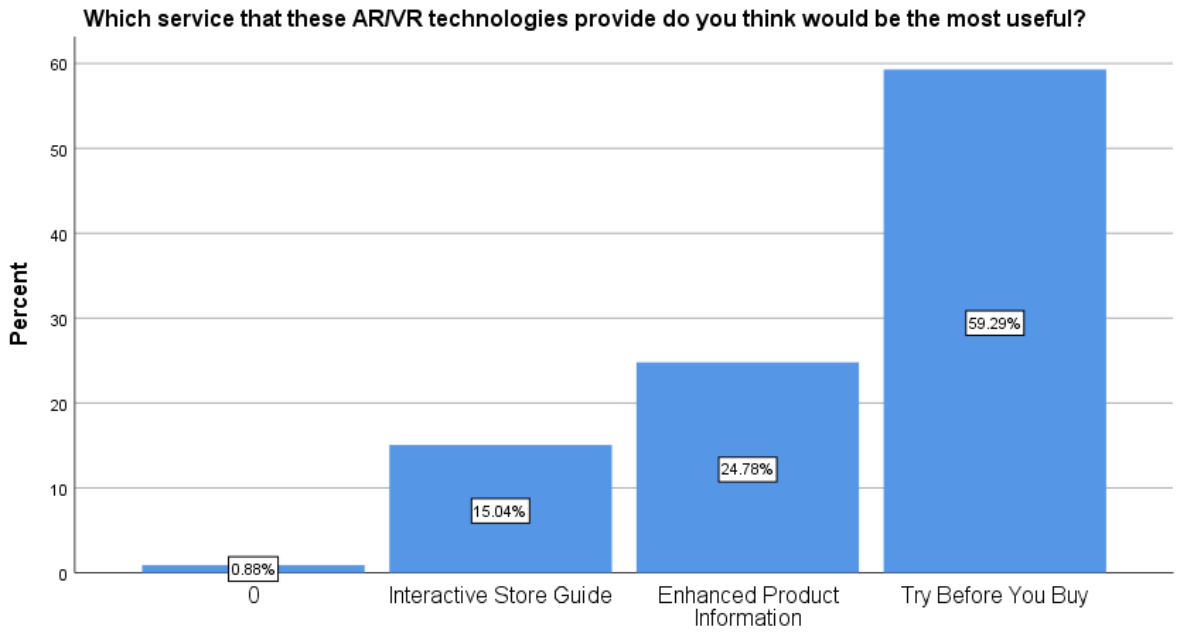
This question gave perhaps the most interesting response. 78.76% of respondents felt that these technologies would have a bigger impact online rather than in-store. This was surprising how one-sided the responses were as although it is consistent with the hypothesis, the margin of victory for online shopping was a lot bigger than expected. This included 82.6% of 18–44 year olds and 72.1 % of 45+ year olds selecting online shopping. 82.8% of males and 73.5% of females selected online shopping. Over half of the respondents to the survey was made up of those who shopped once a week or more and felt that these technologies will have a bigger impact online. Of those who claimed to be at least somewhat familiar with the technologies, 82.4% chose online shopping. All these results are relatively consistent across all identifiers which suggests that most groups believe in online shopping over in-store. While this is in line

with the overall shift towards online shopping, perhaps with more information and trials etc. this is something that could change once people become more aware of the features and benefits that these technologies could have in-store.

Hypothesis 3

Hypothesis 3 explores the types of services that these technologies could provide. This links in to the first hypothesis as it tries to explore these potential benefits from the view of the consumer by asking which service would be the most useful to enhance the retail experience.

Figure 12: Most useful service that these technologies provide (113 Responses, a 100% response rate)

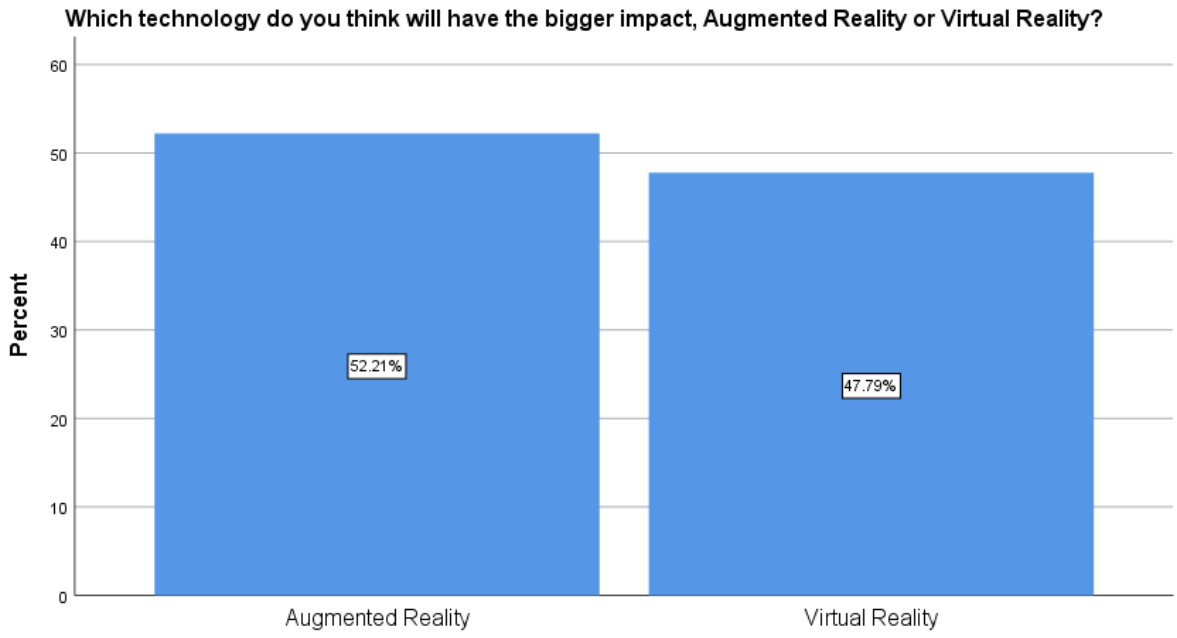


From these options the 'try before you buy' service was by far the most popular choice across all identifiers amassing a total of 59.29%. This goes against the hypothesis that 'enhanced product information' would be the most popular option. Perhaps this is due to the age of the internet where any information you could need is already available through a smartphone. The 'try before you buy' service provides something new and exciting and solves a problem that many people face. In terms of age, 55-64 year-olds were the only age group where 'try before you buy' was not the most selected option with 'interactive store guide' instead being more popular. For 18-44 year olds, try before you buy made up 66.7% of selection compared to just 46.5% for 45+ year olds. Results between genders was very similar with 59.4% of males

and 59.2% of females choosing 'try before you buy'. 56% of those who shop once a week or more also selected 'try before you buy' compared to 64.9% for those who shop a few times a month or less. This could indicate that these technologies could be more beneficial for those who don't shop as much as they make the shopping experience more convenient and interesting. 62% of those who claimed to be at least somewhat familiar also picked 'try before you buy' with 23.9% choosing enhanced product information and just 13% choosing interactive store guide. The relationship between which service was most useful and whether these technologies would enhance shopping experience was also significant with a p-value of .007. It was surprising how dominant one type of service was with other options seemingly unappealing. The only respondent who answered the 'Other' category simply stated that none of these services would be useful.

Hypothesis 4

Figure 13: Which of AR or VR to have the bigger impact (113 Responses, 100% response rate)



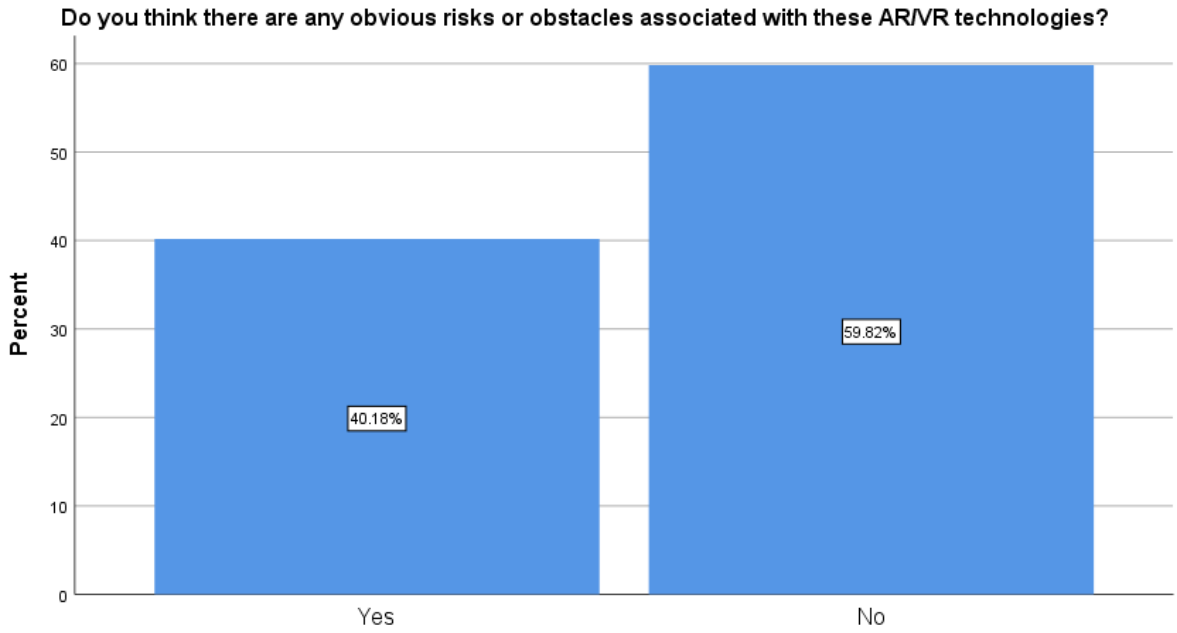
This was one of the more even responses with Augmented Reality (52.21%) slightly edging out Virtual Reality (52.21%). This was closer than expected as it is against the presumption that Augmented Reality would have a significantly greater impact. Perhaps the respondents are more aware of virtual reality because it is the technology that they have been more exposed to and is more well known throughout society even though it may not have as many

real-world applications. While the results were very similar across each age group, the relationship between gender was significant with a p-value of .033. 60.1% of males believe augmented reality to be the bigger technology compared to just 40.8% for females. This is significant and indicates a substantial difference in attitudes towards these technologies between genders which could make for an interesting study. Of those who shop once a week or more, 56% chose AR compared to 44% for VR. These results were somewhat consistent with familiarity of the technologies as 53.3% of people who claimed to be somewhat familiar also chose AR compared to 46.7% for VR. Overall, these results are in line with the hypothesis that AR will be the bigger technology. The only surprise is the margin of victory with the assumption being that AR would be comfortably more popular. This could change in the future as people become more aware of the current and potential uses of AR.

Hypothesis 5

The final hypothesis revolves around whether consumers believe if there are any obstacles or risks in implementing these technologies that could prevent them from having a significant impact.

Figure 14: Risks or Obstacles (112 Responses, 99% response rate)



Most respondents stated that they see no risks or obstacles with regards to the technologies. This was expected as it is not something that is regularly discussed when it comes to these

technologies, so even if there are issues, they will not be in the forefront of the respondent's mind. 43.8% of males feel that there are indeed risks or obstacles associated with these technologies compared to just 35.4% for females. Results between those of varying different levels of familiarity with the technology showed no difference to the overall results. There was also a significant relationship between which of AR/VR will be bigger and if there are any risks attached to the technologies with a p-value of 0.04. For those who answered 'yes' and specified their answer, they had concerns such as: cost, inaccuracy, loss of privacy, inducing psychological/mental issues and lack of technical knowledge. Results across all age groups were quite similar with no obvious outliers.

Discussion

Overall, the results were relatively consistent with the stated hypothesis with only one hypothesis not being accurate. H1 was shown to be reasonably accurate with most respondents feeling that AR/VR will enhance the shopping experience but are not yet sure whether they are more than a novelty. Those who were the most familiar with the technologies felt that they would have the greatest impact which was significant. H2 which involved these technologies having a bigger Impact on online shopping was also shown to be accurate with the vast-majority feeling that way. While this was expected, such a landslide victory for online shopping was not. H3 assumed that enhanced product information would be the most useful feature that these technologies could provide in a retail environment. This was shown to be false, with a 'try before you buy' system easily the most attractive to the consumers. H4 that augmented reality will be bigger than virtual reality was also accurate with respondent's belief in AR slightly edging out VR. While this hypothesis was proven true it was still quite surprising how close it was as it was predicted that AR would be considerably bigger. H5 consisted of the belief that most consumers would not see any risks/obstacles with regards to the implementation. This was also shown to be accurate. Many users did have concerns, but these are relatively small/straightforward issues that could be easily overcome by retailers.

When using the chi-square test to determine the asymptotic significance (or p-test) there was largely no real statistically significant relationship between many of the responses with a few exceptions. This could be due to several factors. The relatively low sample number, the impersonal nature of the survey and lack of knowledge of the consumer could all be factors

which led to people taking the neutral option. These neutral or midpoint options are often used as ‘undecided’ votes (Raaijmakers et al, 2000).

Conclusion

The findings of this survey somewhat support the research question. Four out of the five hypotheses were shown to be accurate with 'which would be the most useful service' the only hypothesis proven to be false. Most people felt that these technologies, particularly AR, will have some sort of impact on the retail sector with the majority feeling that this impact will be seen in an online setting. These results were in line with the findings of previous researchers in AR/VR related fields where the potential for these technologies to have a significant impact is clear.

As this research paper was for an undergraduate thesis, there were some clear limitations. Despite giving a strong indication of the level of impact, it was quite difficult to get a fully accurate representation of the impact of these technologies on the retail sector. This is due to lack of time and budget which meant that carrying out more complex experiments or getting a larger sample was not feasible. Another limitation with the research is the knowledge of the general population about these technologies. As of now, most people tend to think of these technologies as an abstract concept or something for the future rather than something which can have real world uses right now. The people responding to the survey may not be knowledgeable enough about these technologies to give an accurate answer before using the technologies themselves. Future studies could see trials being used in retail outlets or in online settings where users could use the technology to give more accurate feedback.

Another approach that could be taken with more time would be to contact relevant people working within the retail sector to find out their views on these technologies. Once collected these views could be then compared with the views of the consumers. This could show the difference in attitudes between the two groups towards the technologies. More time could also allow the research to explore how these technologies impact different types of retail businesses – e.g. whether it will have a bigger impact on supermarkets or furniture retailers.

Other future studies relating to these technologies could also explore the impact that emerging technologies will have on each other. For example, the internet of things (IoT) involves computer chips/processors in everyday items and appliances so everything is more connected. This has started to become common with smart homes where fridges, lights,

coffee pots etc. can all be controlled from the one place e.g. a smartphone. This provides the opportunity for a more advanced AR experience as the more suited an environment is for AR/VR technologies the better and more reliable they will perform. When these technologies each reach their full potential, a seamless technological ecosystem can be created.

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Appendices

1) Declaration of Consent

This research survey looks to discover consumer perceptions of new technologies such as Augmented Reality (AR) and Virtual Reality (VR) being used in a retail environment. Augmented reality enables users to see and interact with superimposed computer graphics over a real-world environment. Virtual Reality is the creation of computer-generated environments or realities that are designed to simulate a person's physical presence in a virtual environment. These technologies are an example of the many exciting new technologies that have the potential to reshape the retail sector. This survey is completely anonymous, so any answers given will not be traced back to any one individual. The survey consists of 10 questions and takes approximately 2 minutes to complete. Surveyor is contactable at stevencarton1@gmail.com.

2) Survey Questions

1. What is your age?
2. What is your gender?
3. How familiar are you with the concepts of Augmented Reality (AR) and Virtual Reality (VR)?
4. How often do you shop in retail stores/online?
5. Do you think AR/VR technologies could be beneficial for retail?
6. Do you think these AR/VR technologies will have a bigger impact on brick and mortar retail stores or online shopping?
7. Which of these AR/VR technologies do you think will have the bigger impact?
8. Do you think there are any obvious risks or obstacles associated with these technologies?
9. Do you think you would buy more if these technologies provided services like try before you buy, in-store guide, product information etc.?
10. Do you think these technologies are nothing more than a novelty?

3) NCI Ethics Form

4) Excel Raw Survey Data