The Power of Sight: The Impact of AR Smart Glasses on the Smartphone Industry

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Abstract (English)

The smartphone industry has experienced a phenomenal growth in the last 15 years of its existence, but it has begun to plateau. This dissertation evaluates the likelihood of an emerging Smart Wearable (SW), the AR Smart Glasses, significantly impacting the smartphone industry. This research used qualitative and quantitative methods, including 14 expert interviews, to better understand the workings of AR and future potential of AR Smart Glasses, as well as a survey with 196 respondents to determine what consumers think about AR Smart Glasses.

Experts believe that AR Smart Glasses will have a significant impact on the smartphone industry, and even take its place in the future, but there is a lack of confidence regarding the time period in which may occur. Experts believe the biggest threats to its success are its affordability, AR's complex technology, and the lack of consumer education on the issue.

The success of AR Smart Glasses was viewed with skepticism by respondents. They are more interested in its capacity to improve engagement with reality than in having another platform to consume content, and were primarily worried about how it would affect their comfort and interfere with reality. They prefer to check time, notifications, weather, use GPS, voice assistant and take pictures on AR Smart Glasses, but given that the majority of respondents consider themselves unfamiliar with AR and AR Smart Glasses, their preferences may shift to AR Smart Glasses once they gain a better understanding of the device's potential.

Title: *The Power of Sight: The Impact of AR Smart Glasses on the Smartphone Industry*

Keywords: *Smartphones; Augmented Reality; Smart Glasses; Technology; Wearables.*

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Abstracto (Portuguese)

A indústria de smartphones testemunhou um crescimento significativo nos últimos 15 anos, mas começou a estagnar. Esta dissertação avalia a probabilidade de um *Smart Wearable* (SW) emergente impactar significativamente a indústria de smartphones: os *AR Smart Glasses*. Esta investigação usou métodos qualitativos e quantitativos, incluindo 15 entrevistas com especialistas, para entender melhor o funcionamento de AR e o futuro potencial dos AR Smart Glasses, bem como um questionário com 196 respondentes para determinar o que os consumidores pensam sobre os AR Smart Glasses.

Os especialistas acreditam que os *AR Smart Glasses* terão um impacto significativo na indústria dos smartphones, e poderão até substituí-los no futuro, mas há alguma incerteza quanto ao período de tempo em que tal pode ocorrer. Os especialistas acreditam que as maiores ameaças ao seu sucesso são o preço, a tecnologia complexa de AR e a falta de educação dos consumidores sobre o assunto.

O sucesso dos AR Smart Glasses é mais incerto para os respondentes do questionário. Estes estão mais interessados na sua capacidade de melhorar a interacção com a realidade do que em ter outra plataforma para consumir conteúdos, e estão principalmente preocupados com conforto e interferência com a realidade. Preferem consultar horas, notificações, previsão do tempo, usar GPS, assistente de voz e tirar fotografias nos AR Smart Glasses, mas, como a maioria dos respondentes não se considera familiarizado com AR Smart Glasses e AR, as preferências podem mudar para AR Smart Glasses assim que obtiverem uma melhor compreensão do potencial do dispositivo.

Título: *O Poder da Visão: O Impacto de AR Smart Glasses na Indústria dos Smartphones*

Palavras-Chave: *Smartphones; Realidade Aumentada; Smart Glasses; Tecnologia; Wearables.*

Autor: *Beatriz dos Santos*

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1. Introduction

Consumers have become accustomed to the smartphone in its current iteration, but technologists predict that the way that the hardware is used might be about to change (Zuckerberg, 2021). As one of the most important tools that individuals use throughout the day, smartphones not only make phone calls, but are the means for accessing the internet and various applications. With a smartphone and internet capability, a consumer holds all of human knowledge anywhere he or she goes.

Considering its mass use and multiple functions, the smartphone has revolutionized how individuals function. Consumers have become dependent on these devices and their associated technology to establish communication, express themselves through social media, access vital information through the internet, navigate their way to work through their GPS, among many other use cases. The smartphone can be considered as one of the greatest contributors of the fast-paced development of technology and the online world.

The smartphone industry was considerably impacted by the Covid-19 pandemic. Economic uncertainty prompted consumers to resist buying nonessential products, so in 2020, smartphone sales witnessed a decline of 20.2% in the first quarter, the worst ever recorded year-to-year drop, and suffered an overall dip of 12.5% in 2020 (Gartner, 2021). While it is forecast that worldwide smartphone sales will likely rebound by growing 11% in 2021, the industry is projected to drop in its second consecutive year (Gartner, 2021).

To examine the smartphone industry, it is crucial to consider the influence of other products. In recent years, there has been considerable growth of a complementary market that may radically change the way smartphones are used: *smart wearables (SW)*. The SW market represents a broad category of devices that can be simply defined as smart technology that is worn on the body as an accessory (Hayes, 2020), such as smartwatches, earbuds, fitness trackers, glasses, rings and even clothing.

By choosing SW, consumers are beginning to segment the use of smartphones, where some actions are taken directly in the wearable instead of the smartphone. This change marks a transformation of the smartphone as the exclusive and most valuable piece of technology that

consumers carry. Through their microprocessors and incorporation of IoT, smart devices are becoming a vital source of user data.

AR Smart Glasses

With the success of these gadgets and technological innovation, new forms of SW – AR Smart Glasses - are starting to gain traction. These devices have the potential to radically impact how consumers interact with smartphones. For example, users gain the ability to visualize notifications, text and videos, to take pictures, answer and make calls and receive turn-by-turn directions. Consumers are able to access information related to their surroundings, through Augmented Reality (AR), that adds layers of digital content in the form of text, graphics, audio and other virtual components integrated with real world objects (Gartner, 2021). To reach its potential, AR needs to be supported by a device with a powerful processor, a practical display and multiple sensors. Currently, this technology is more commonly used by corporations, by delivering hands-free experiences that improve efficiency, accuracy and collaboration in work tasks (Glass, 2021).

Various tech companies have launched versions of Smart Glasses, such as Google Glass Enterprise Edition 2 (Google, 2021), Facebook x Ray-Ban Stories (Ray-Ban, 2021), Nreal Light (Nreal, 2021), and Amazon Echo Frames (Amazon, 2020), but the technology has yet to achieve mass market appeal. Furthermore, brands have experimented with different technologies. Some make use of AR technology, others use the glasses format solely to implement cameras that capture day-to-day moments, or use microphones that enable users to interact with a virtual assistant. Xiaomi's technological concept for Smart Glasses will use AR technology to allow consumers to make calls, navigate, take photos and translate texts (Xiaomi, 2021); (Appendix 4).

While not yet official, rumors suggest that Apple's version of Smart Glasses, the Apple Glass, will also feature AR technology, using data derived from LiDAR sensors present in iPhone and iPad devices since 2020. For this and other reasons, Apple is regarded as the company that will likely be the market leader in AR headsets, as it was for smartphones (Leswing, 2021). A respected industry analyst, Ming-Chi Kuo, even stated that "Apple's goal is to replace the iPhone

with AR in ten years, representing the demand for ABF of AR headsets will exceed at least one billion pieces in ten years" (Kuo, 2021).

Are Smart Glasses a disruptor that will enable a next wave of digital transformation? Or will they ultimately fail? What will be the interaction between them and smartphones? Are there other wearables with even greater potential to disrupt the smartphone market? Technology-enabled changes will potentially reshape industry dynamics and the competitive landscape, and thus decision makers should be prepared to manage for change in their respective companies.

The main Research Questions that will be addressed in this dissertation are:

RQ1: How will AR Smart Glasses impact the Smartphone industry?

RQ2: What will be the future result of such impact on the Smartphone industry as we know it?

The dissertation begins with a literature review that provides an overview of current knowledge through relevant publications, followed by discussion of methodology that will be used to interrogate the RQs. We will then analyze the data collected, as well as draw appropriate conclusions from the results found.

2. Literature Review

2.1 Introduction

The Literature Review first discusses the smartphone industry, namely its relevance, impact and evolution. Next we look at Smart Wearables (SW) and Smart Glasses; and, finally, the interaction between the smartphone industry and AR Smart Glasses is discussed.

Managerial related topics will also be approached, namely material pertaining to strategy, innovation, disruption, competitive advantage and marketing. These topics will be developed through high level academic sources.

2.2 The Smartphone Industry

2.2.1 The Impact of Smartphones and the Reason for their Success

The smartphone was popularized by Apple with the introduction of the first iPhone in 2007, transforming the industry through consumer-friendly features as a touch screen interface and a virtual keyboard (O'Dea, 2021). Since its introduction, the smartphone market has grown from 122.32 million sales to end users worldwide in 2007, to 1535.36 million forecasted sales in 2021 (O'Dea, 2021), and its major players are currently Samsung, Xiaomi, Apple and Oppo.

Smartphones allow seamless communication and access to information. They revolutionized society in less than a decade through better communication, learning opportunities, exposure to enormous levels of information, acceleration of new trends, personality development, access to applications with various purposes, new business models, access to health information, online purchases and more (KeyIdeas, 2017).

The smartphone further has had an enormous impact on culture where social media apps dictate, for the most part, what is desirable at a given time and popularity and stardom become more accessible. The ability to constantly carry a camera contributed to an era of imaging, as users capture every moment and choose to share events on an online platform (Yoshida, 2019). Notions of privacy have also been transformed, individuals are less focused, and the smartphone has accustomed users to constant sources of entertainment (Yoshida, 2019).

Smartphone usage numbers demonstrate the scope of its impact with these devices. Smartphones are one of the fastest-selling gadgets in history, outselling personal computers four to one (The Economist, 2015). Smartphone usage was also impacted by the Covid-19 pandemic, which increased collective screen time worldwide. Users are spending an average of 4.2 hours a day using apps on their smartphones, representing an increase of 30% from two years prior (Perez, 2021); (Appendix 1). In 2021, there were 6.378 billion smartphone users worldwide, which corresponds to 81% of the global population. This figure is predicted to continue to grow until 2026, with an estimated 7.516 billion individuals using smartphones (Statista, 2021).

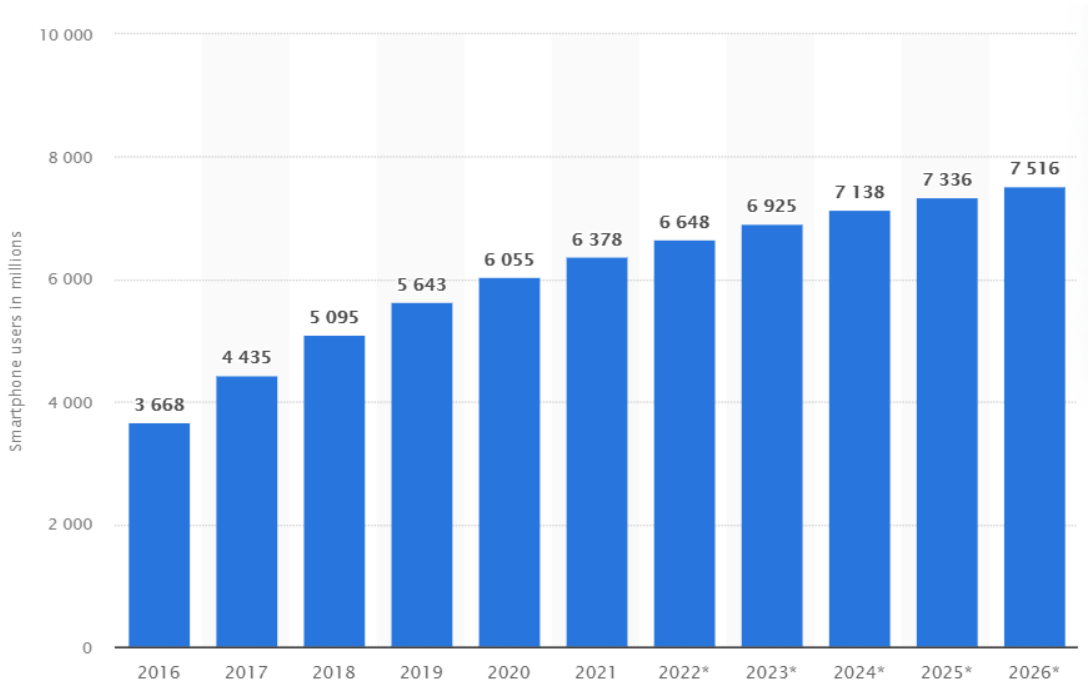

Figure 1: Number of smartphone users 2016-2021 (Statista, 2021)

The real transformative power of smartphones comes from their size and connectivity (Economist, 2015). Its compact size makes it a truly personal gadget that caries the processing power of previous supercomputers while allowing for data collection that customized the device to adapt itself to its specific user, contributing to an exceptionally personal experience.

2.2.2 Changes in the Smartphone Industry

The two mains market players, Samsung and Apple, have maintained a nearly constant market share. Samsung leads the market in 2012-21, followed by Apple, Xiaomi, Oppo and Huawei. Huawei experienced a significant drop in market share since Q2'2020, after being unable to do business with any company that operates in the USA (Brown, 2019). Huawei became unable to use Google services, which severely hindered their products.

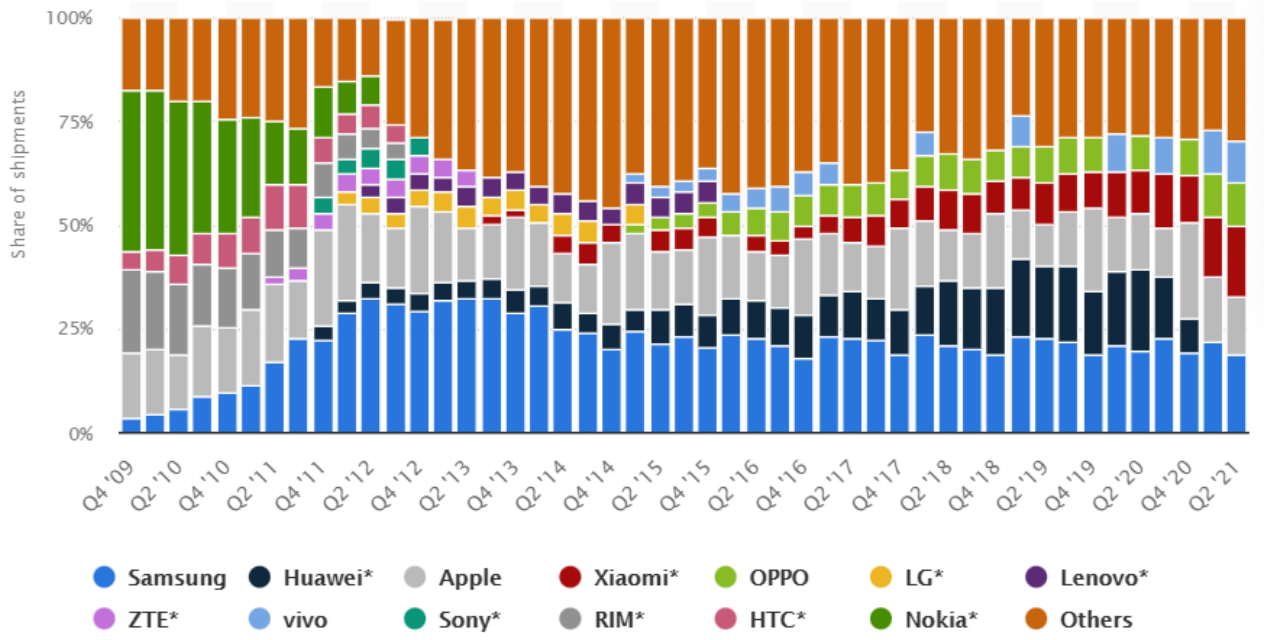

Figure 2: Global smartphone market share from 4th quarter 2009 to 2nd quarter 2021 (Statista, 2021)

The device has been a simple glass rectangle that has grown considerably in size in a short time span. Screens above 7 inches were the second less common format in 2018, and have become the second most common in 2021, and they will tend to become larger as time progresses (Statista, 2021). The increase in size is due to mobile media consumption where many consumers use their smartphones to stream various forms of entertainment. To accommodate this trend, new forms factors are emerging such as folding smartphones that allow consumers to have regular sized smartphones that unfold into a tablet sized screen.

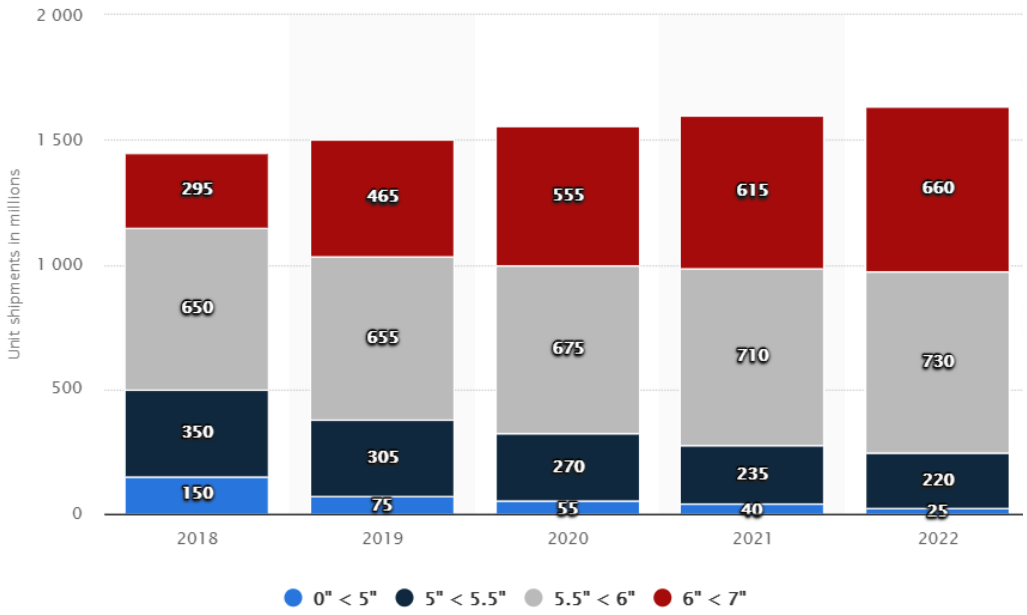

Figure 3: Smartphone unit shipments worldwide by screen size from 2018 to 2022 (in millions) (Statista, 2021)

Despite its entertainment value, smartphones are criticized for being less than desirable for user's mental health (Mastroianni, 2020). Health and fitness entities have also rejected the smartphone as the main source of data collection as it does not adapt optimally to the human body and retrieve data in a dynamic manner. By not being attached to the body, the smartphone is also less practical to carry and easier to misplace or leave behind. For these reasons, the Smart Wearable (SW) industry has been on the forefront of mobile technology (Research and Markets, 2021).

Commentators suggest that the smartphone industry is reaching maturity (The Economist, 2019). Most smartphones share similar design characteristics to the point of being indistinguishable from their peers. Furthermore, smartphones present an increasing number of issues related to privacy and addiction which also poses headwinds.

2.3 The SW Industry

2.3.1 Overview

The SW industry is an example of strategic product innovation. Introducing new and practical products that can be easily used by consumers seeking to incorporate technology into their routines. Successful and effective innovations start small, and to innovate, a company should consider a specific need that can be satisfied by a new product, exploiting such opportunity to its

own benefit (Drucker, 1985). Before considering product innovation, companies need an effective strategy that relies on consistency of operations, a complete plan of action and a guiding decision (Brandenburger, 2015). Contrarily, an ineffective strategy stems from the failure to face challenges when such cannot be defined, as well as by mistaking goals for strategy and having bad strategic objectives, as they are not focused or realistic, but rather superficial (Rumelt, 2011).

SW are surpassing smartphones as the fastest growing technological innovation, partially due to the growing fitness trend that motivated individuals to track health data. In 2020, SW shipped globally 266.3 million units. This is projected to reach 776.23 million units by 2026, representing a CAGR of 19.48% from 2021-2026 (Research and Markets, 2021).

The SW industry is powered almost entirely by smartwatches and other wrist fitness trackers. These are estimated to represent 95% of all wearables shipped in 2021 and in 2022 (Richter, 2021).

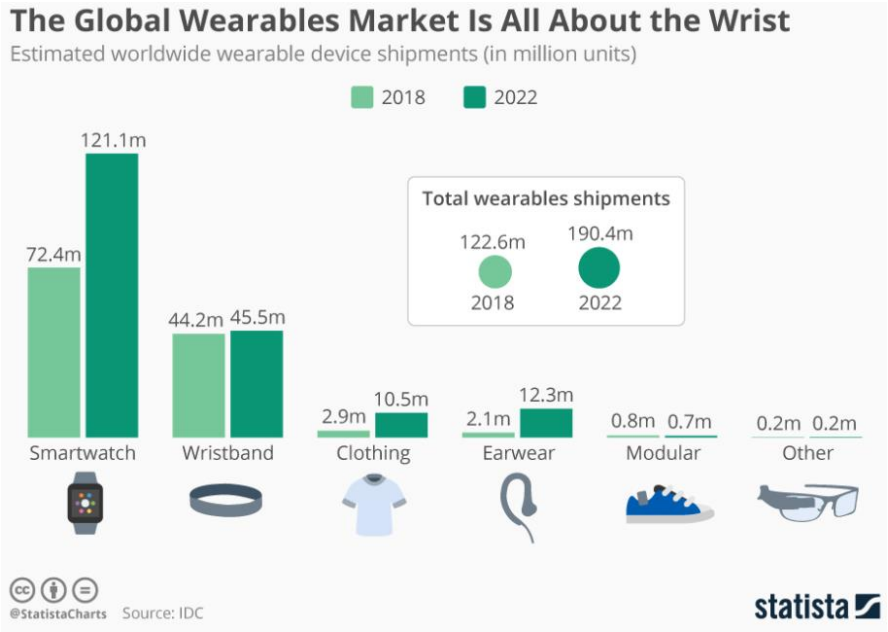

Figure 4: Estimated Worldwide Wearable Device Shipments (in million units) (Richter, 2021)

The smartwatch is therefore the most popular wearable, in which Apple holds 55% of the market with its Apple Watch, which has also become the top-selling watch worldwide in 2017 (Kolodny, 2017). The immense success of smartwatches is attributed to their ability to check time

in the dark and more efficient track the user's activity, as individuals become increasingly oriented towards healthier lifestyles and benefit from connecting personal data to their smartphones. SW offer convenient mobile notifications instead of having to reach for smartphones. They also can make phone calls, which make smartwatches almost independent of smartphones, and they represent tech-savvy fashion statements, with which users can express themselves and build a desired image (Li, 2019).

2.3.2 IoT

IoT (Internet of Things) is commonly defined as an array of physical objects connected to the Internet, but its definition has extended to objects that can "talk" to each other through different sensors, making them "smart" devices (Burgess, 2018). IoT encompasses interactions between devices, data collected and the networks created, all used to conveniently serve users in mundane tasks. For this reason, IoT is present in the form of smartphones, wearables and even home appliances such as refrigerators. It is estimated that the number of IoT connected devices will continue to grow considerably over the next ten years, to an estimated 25.44 billion worldwide IoT devices in 2030 (Statista, 2021).

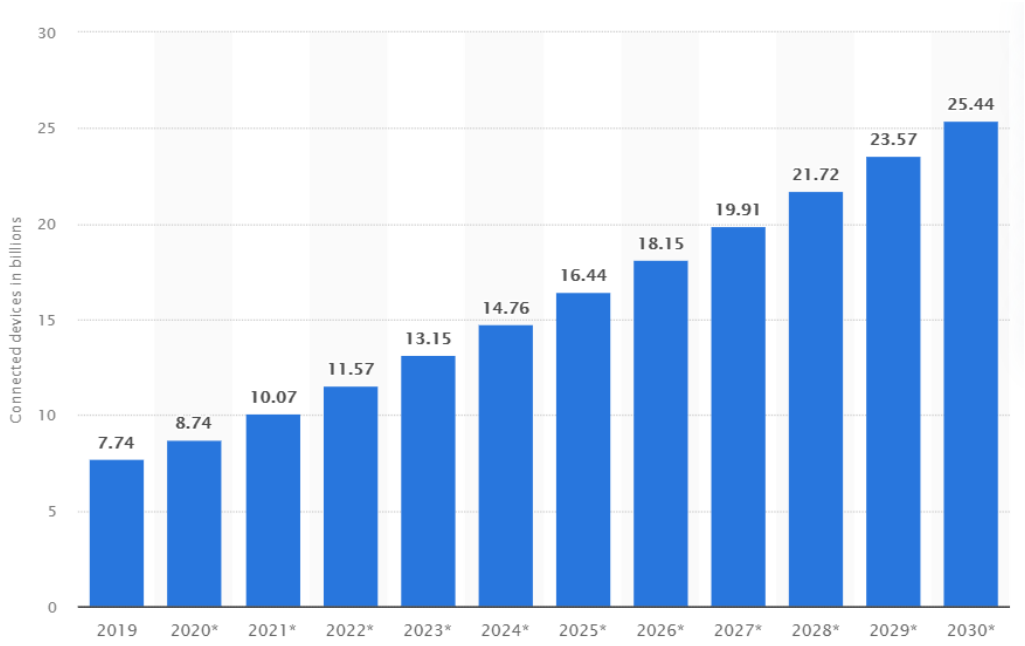

Figure 5: Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2030 (Statista, 2021)

SW make use of IoT so users benefit from having a device that provides more accurate and in-depth analysis of their health and behavior in general.

2.3.3 Captology

Captology, or persuasive technology, is the study of how interactive systems are designed with the objective of persuading and motivating people towards various individual or collective behaviors (Hamari et al, 2014). In this instance, persuasion is defined as "an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action" (Fogg, 1998). All technological gadgets and systems can have an influence over individuals on some level. To become persuasive, they have to be designed deliberately to lead the user to some form of behavioral change (Fogg, 1998).

Persuasive technologies are typically implemented in circumstances where users already had the intention of changing their behavior to the determined outcome, but were previously discouraged from starting or continuing to work towards it, such as in the case of healthy habits, learning and ecological behavior (Hamari et al, 2014). The encouraged activity by persuasive technologies must therefore pertain to something that the user is already trying to accomplish regardless of the persuasion.

When developing persuasive technology systems, variables such as culture are considered. The seven strategies that are used in persuasive technology systems are reduction, tunnelling, customization/tailoring, suggestion, self-monitoring, surveillance, and conditioning (Fogg, 2003). These strategies have the overall objective of motivating individuals to change their behavior.

2.4 Smart Glasses

2.4.1 Overview

Smart Glasses are a category of SW that consist of glasses with added digital features. While there are different types of Smart Glasses, this dissertation is focused on AR Smart Glasses which have a higher potential to achieve mass market success due to multiple AR applications that add value. Some examples of AR Smart Glasses in the market are Google Glass Enterprise Edition

2, North Focals, Vuzix Blade, Solos, Everysight Raptor, Epson Moverio BT-300, Microsoft HoloLens, Nreal Light, Magic Leap 1, and Dream Glass.

AR Smart Glasses allow consumers to enjoy improved workout experiences through real-time tips and challenges. They provide shopping experiences with additional product information and advertising in retail settings, educational training through more interactive content, gaming experiences by allowing for more immersive and challenging content, and they could provide aid to businesses with new ways of interacting with consumers, executing tasks and making the interactive experience more memorable (Rupareliya, 2021).

The AR Smart Glasses market is very limited as unit sales worldwide in 2021 only amount to 0.41 million. However, a considerable growth is expected over the next two years, more than doubling sales between 2021 and 2022 (Statista, 2021).

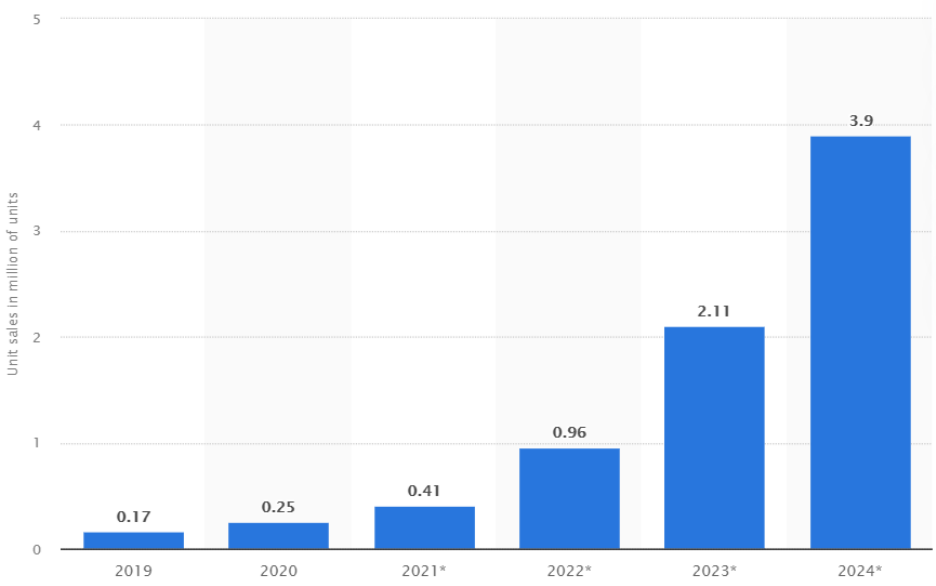

Figure 6: Augmented reality (AR) glasses unit sales worldwide from 2019 to 2024 (Statista, 2021)

Despite the current apparent lack of mass market success, companies should consider the potential AR Smart Glasses offer across particular use cases for various industries.

2.4.2 AR Technology

AR (Augmented Reality), which digitally complements reality in real time, has many different applications that can have an impact in the way consumers behave and function. AR has been under development for a long time, and ceased being considered an emerging technology in 2019, as that it has matured significantly (Herdina, 2020); (Appendix 2 & 3). Consumers rely on devices such as TVs, tablets and smartphones to experience AR. For instance, Pokémon GO and Snapchat have added layers of content that can only be experienced through a smartphone's screen and camera. AR starts to become less practical when considering that it requires additional apps in consumers' smartphones, as well as being ergonomically challenging. AR users also become aware that others around them cannot see the given content that is being interacted with, resulting in a fear of judgement by others (Baird, 2019). AR worldwide active users represent a modest figure of 81 million in 2021, that has steadily grown and is estimated to double in 2024.

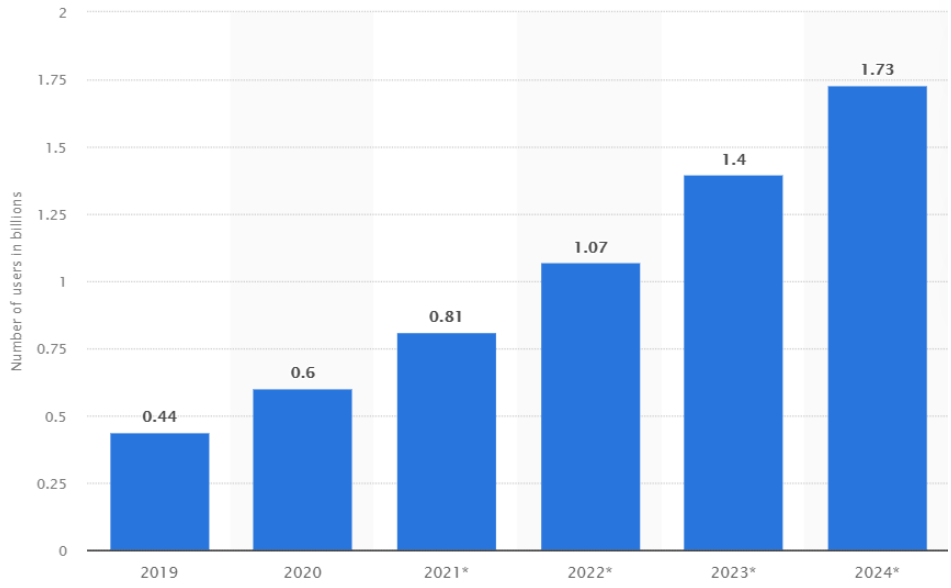

Figure 7: Number of mobile augmented reality (AR) active users worldwide from 2019 to 2024 (Statista, 2021)

With the introduction of AR Smart Glasses, consumers would be able to experience AR directly, allowing for a seamless contact in the new added reality. This contributes to a higher level of immersion with the content and feeling that the technology is worthwhile. There are

groundbreaking applications such as in retail settings, where consumers use Smart Glasses when shopping (Köhler et al, 2017).

The success of AR Smart Glasses, however, does not turn solely upon the preferences of consumers. AR is a demanding technology that requires many working mechanisms to make it efficient. Its success is heavily dependent on its interface and how it interacts with the users' vision as it cannot completely block reality. Additionally, AR Smart Glasses would have some limitations. Consumers are required to use glasses constantly and a high number of components have to be integrated in a relatively small handset. Such components result in a heavy gadget that may be uncomfortable for consumers to wear. At this stage, there is also a very high starting price for such a novelty device, and there are privacy concerns since these devices would require users to be constantly collecting data, even in private and intimate situations (Stenina, 2021).

Compared to the smartphone, AR Smart Glasses have a better ease of use, portability, constant monitoring and more seamless integration of smart features such as information related to what the user is seeing in every given moment.

2.4.3 Change Management and Disruption in Tech

A company's success depends on the efficiency of its strategy for the future. Change management is crucial for companies in the technological industry with its fast-paced change. It can be described as the practice of applying a strategic plan to transition a company from a current state into a desired future state (ACMP, 2021). Management and change are synonymous (McCalman, 2008), and companies that ignore change do so at their own peril, as some managers are risk-averse out of fear of the unknown and are comforted by the familiar. Change management adequately handles the complexities of a given industry by evaluating, planning and implementing strategic decisions (McCalman, 2008) tailored to each individual company.

Successful companies tend to be efficient at adapting to market dynamics, which can be characterized as sustaining innovation (Christensen, 1997). Sustaining technologies are innovations that improve a product's or service's performance in ways that mainstream customers value (Christensen, 1997). Examples would be further improvements of a smartphone's camera array, advances in its building materials or battery technology that satisfy consumers by providing

greater value than what was previously offered. Conversely, disruptive innovations generate an altogether new market by introducing a new type of product or service where the market lacks what mainstream buyers value in terms of performance criteria (Christensen, 1997). This is the case with folding smartphones which provide novel functionality, but may also result in a poor performance experience due to their experimental nature as a first-generation gadget. In these circumstances, AR Smart Glasses would also be a disruptive innovation as they would create a new market for most mass market consumers with a product that would initially perform worse than a smartphone or other gadget capable of performing similar tasks.

In the face of disruption, incumbent firms tend to fail to recognize the impact that it might pose to their businesses. Having managers that can recognize the relevance of a disruptive innovation it is key for companies as is the organizational capacity to pursue disruptive in a fully resourced autonomous business unit (Christensen et al., 2015). AR Smart Glasses manufacturers can reasonably anticipate consumers holding off on adopting the new technology unless they believe the quality and price warrant the move.

For the company to survive a changing environment it needs to take advantage of its existing assets to be able to expand into different spaces by developing new capabilities (O'Reilly III et al, 2011). For instance, a tech company's track record with change is a predictor of future success with technology initiatives, where obstacles to introduce change come in the form of employee resistance, insufficient resources or resistance from middle management (WIPFLI, 2014). Therefore, managers should always focus on a strategy for the future, considering new trends, preferences and technological developments in their field and complementary ones.

2.5 Interaction Between the Smartphone Industry and AR Smart Glasses

2.5.1 Brand Ecosystems and Competitive Advantage

With the addition of new products to a company's portfolio, companies might profit from developing new SW. Consumers have different needs that can be satisfied by different products instead of one multifunctional one, and companies have at their disposal new forms of profiting from consumer trends (Gackstatter, 2019).

A good predictor that a given company will be able to implement AR Smart Glasses successfully is the presence of a well-developed brand ecosystem that allows consumers to seamlessly use different products in an exceptional joint experience. Brand ecosystems are important to companies because they are efficient at “locking” consumers with needs met by a single brand, instead of having to look to others. By increasing its portfolio, a company can expand to new audiences and keep up with new technological trends (Raghavan, 2021).

With such ecosystem, the given company will be able to obtain considerable competitive advantage over other companies. Competitive advantage grows fundamentally out of the value a firm is able to create for its consumers that exceeds the firms cost of creating it (Porter, 1985). Value is what consumers are willing to pay for, and superior value stems from notions that include offering lower prices than competitors for equivalent benefits or providing unique benefits that more than compensate for a higher price. Competitive advantage also occurs from cost leadership, differentiation, and can be enhanced in one industry by interrelationships with business units competing in related industries if these interrelationships can actually be achieved. Interrelationships, or in this instance, ecosystems, among business units are the principal means by which a diversified firm creates value for consumers (Porter, 1985). For example, Apple possesses competitive advantage over its competitors in technological industries such as smartphones, tablets and computers since they benefit from a well-crafted brand ecosystem and product differentiation. Its current successful interrelationships can yield favorable results from future products to enter the brand ecosystem, such as AR Smart Glasses.

2.6 The Knowledge Gap

Studies focus on specific use cases in which AR Smart Glasses can be valuable, such as fashion, fitness and health, office productivity, and gaming. As a result, there has not been much research on how AR Smart Glasses and smartphones could interact in the future, and how the former might affect the latter. Given the importance of the smartphone market to the firms that operate in it, it is critical to comprehend how the introduction and subsequent broad consumer acceptance of AR Smart Glasses may affect the way smartphones are used, and how to use such a situation in the company's benefit.

2.6.1 The Technology Acceptance Model

The *technology acceptance model* (TAM) was developed by Davis to predict why people adopt technology and innovation in technology-oriented environments (Holden, & Karsh, 2010). TAM proposes two key constructs, *perceived usefulness* (PU*)* and *perceived ease of use* (PEOU) (Figure 8) that influence acceptance (Davis et al., 1989). *Perceived usefulness* is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). This is coupled with *perceived ease of use* (PEOU) which pertains to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989).

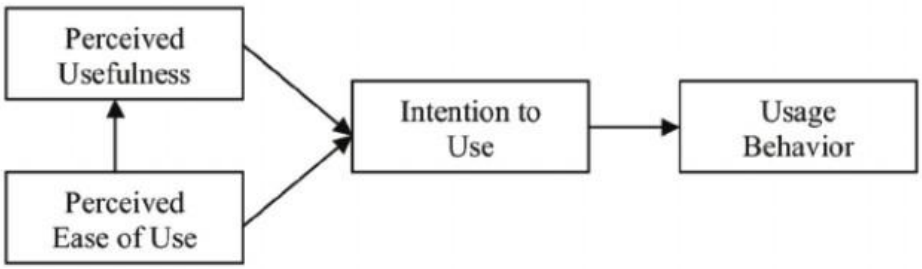

Figure 8: Original TAM Conceptual Framework proposed by Davis (Davis, 1986)

Chircu et al. (2000) expand upon Davis' conception and add *attitude and trust toward technology (ATT)* as a further variable that predicts user acceptance. Trust relates to anxiety associated with using the new technology (Chircu et al., 2000).

3. Methodology

3.1 Research Design

The research design in this dissertation consists of a combination of qualitative and quantitative approaches. To elaborate probable future outcomes, scenario planning was used where 3 hypothetical future scenarios pertaining to AR Smart Glasses were considered relying on Schoemaker's (1995) framework. The first scenario portrays a future where AR Smart Glasses reach the mass market and are quick to replace smartphones, the second scenario considers a medium impact, in which mass adoption also occurs but smartphone replacement is slower and uncertain, and the final scenario assumes that the device will not reach mass market appeal and AR will continue to struggle to take off.

To better formulate these scenarios, semi-structured interviews were conducted, where 14 experts from related fields shared their knowledge in relation to the future of AR Smart Glasses and the smartphone industry. An online survey was developed to determine consumers' perceptions of AR Smart Glasses, as well as if, how and when they would be willing to adopt such device. The survey was constructed using information gathered from expert interviews and the literature review.

3.2 Data Collection

3.2.1. Primary Data Collection

Primary data was acquired from 14 semi-structured interviews with experts within the technology industry. Semi-structured interviews "are great for finding out *Why* rather than *How many* or *How much*" (Fylan, 2005) and were structured to allow experts to feel comfortable elaborating their reasoning. First, an "ice-breaker" question was used regarding their occupation and how it relates to AR or smartphones. Then there was a transition question to get closer to the main topic, followed by questions about AR Smart Glasses specifically. Finally, there was one final question where experts had the opportunity to add anything if they wished (Gubrium & Holstein, 2001). The interviews consisted of 13 questions (Appendix 8) with an average duration of 32 minutes. Through the interviews it was possible to better understand the interviewees' knowledge regarding the subject while allowing for more in depth and complex responses.

ID	Role	Type of Company	Range of Revenues
1	Chief Marketing Officer	Information Technology and Services	< 2 million USD
2	Technology and Innovation Manager	Technology Manufacturer	> 500 million USD
3	Head of the Innovation Department	Telecommunication	> 40 billion USD
4	Chief Executive Officer and Founder	Content Creation	< 2 million USD
5	Managing Partner	Consultancy	< 2 million USD
6	Founder and Executive Director	Software Development	> 2 million USD
7	XR Business Expert	Technology and Energy	> 80 billion USD
8	eXtended Reality & Digital Twins Lead	Information Technology and Services	> 100 million USD
9	Marketing Lead	Software	< 1 million USD
10	Entertainer	Entertainment	n/a
11	Business Developer	International Trade and Development	< 6 million USD
12	Project Manager & Mixed Reality Expert	Information Technology and Services	< 1 million USD
13	Independent Creative Director	Freelance	n/a
14	Technical Director	Gaming	< 40 million USD

Table 1: Experts Overview (Own Creation)

There were 227 total respondents to the survey, but 31 were removed due to incomplete answers, resulting in a total of 196 respondents. They were from 21 different countries in which Portuguese with 62% of respondents and American with 13.8% were the most common. This variety in nationalities was due to sharing the survey in international Facebook groups, which complemented the survey responses gathered from relatives, friends and colleagues. Regarding

gender and age, the majority were female between 18 and 34 years old. There was a somewhat even split among respondents regarding income, and most had a bachelor's or master' degree.

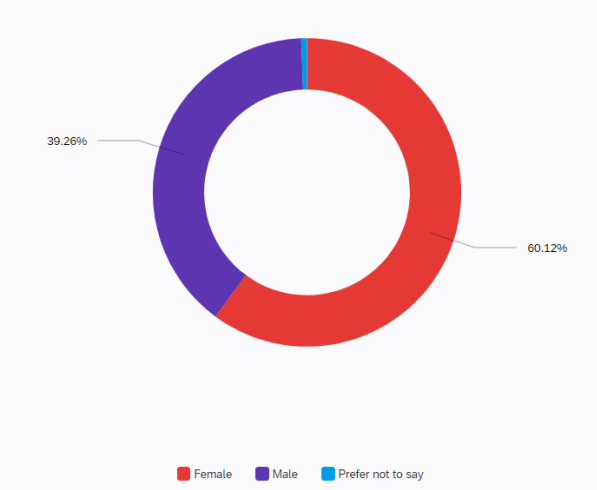

Figure 9: Gender (Own Development)

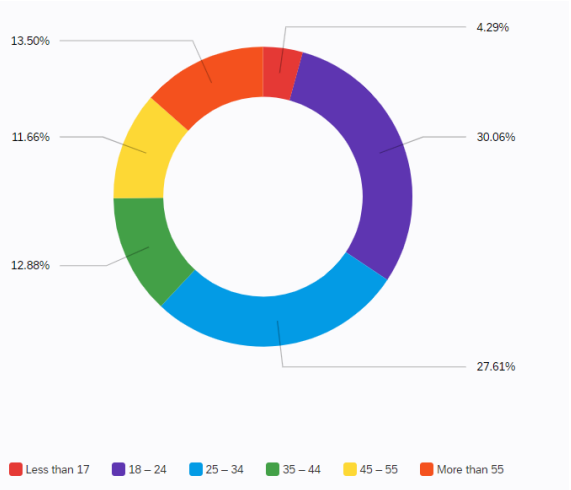

Figure 10: Age (Own Development)

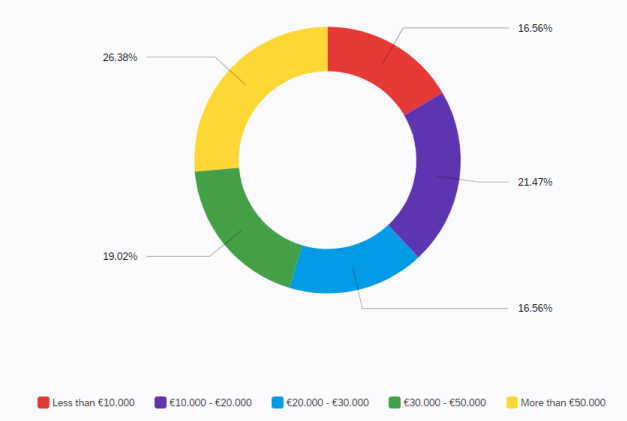

Figure 11: Household yearly net income (Own Development)

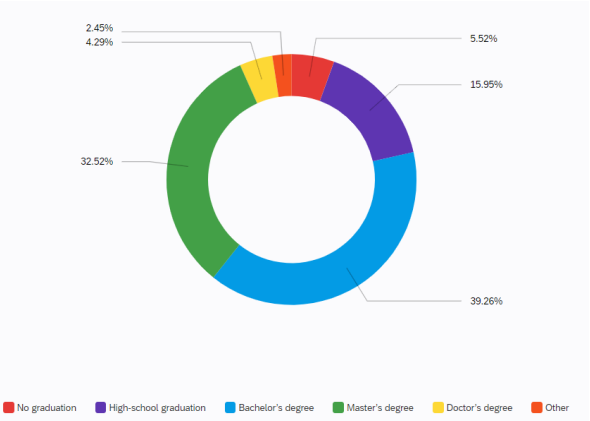

Figure 12: Educational degree (Own Development)

3.2.2. Secondary Data Collection

Secondary data was acquired to complement primary data collection by researching multiple articles and journals that pertain to the dissertation topic. For the most part, secondary data collection was concluded via the literature review, where important themes such as the smartphone market, SW market, AR, change management, captology, AR Smart Glasses,

innovation, disruption, competitive advantage and brand ecosystems were addressed through sources such as academic articles, at least nine grade-A journals, books and reports.

4. Analysis and Findings

4.1 Semi-structured Interviews

Expert interviews were assessed based on three primary themes. The first concerned the most significant obstacles and enablers for AR Smart Glasses to thrive and reach the mass market. To do so, the characteristics of AR as a technology and at the key opportunities and threats for AR Smart Glasses to reach the mass market were considered.

Second, questions were posed regarding the likelihood of future smartphone replacement, considering topics such as how long it will take for AR Smart Glasses to reach the mass market and the likelihood of smartphone replacement in the future. Other questions included if AR Smart Glasses may become the smartphone alternative, which companies would do better in the industry, and whether there was any other innovative product that could have a greater future influence on the smartphone industry.

The final topic concerned the future interaction between AR Smart Glasses and smartphones, considering potential consumer changes in smartphone usage, adjustments in smartphone design to accommodate such changes, smartphone's biggest flaws, and potential advantages of using AR Smart Glasses instead of a smartphone.

4.1.1. Obstacles and Enablers for AR Smart Glasses to Reach the Mass Market

Obstacles

The majority of experts considered the intricacy of AR technology and consumer adoption as the most significant hurdles to the success of AR Smart Glasses. Experts pointed out that scene and object detection are important for how digital content matches reality by accurately detecting the shapes of various objects and their positions in space (Bobeshko, 2017). The environments that surround users are complex, dynamic, and one-of-a-kind, and for that reason it is practically

impossible to deliver the precise experience intended by developers, as different scenarios are difficult to foresee at the time of conception. According to Expert 4, this is the primary reason for VR's quicker growth. The reality that users interact with is entirely produced by the developer, making it much easier to regulate for a more seamless user experience.

Experts also identified challenges within the device's hardware. Powerful CPUs and fast connections are essential to power AR devices. Given that such processors would have to be built within the frames of regular-sized glasses, the lack of powerful and compact processors that fit in a small area, yet do not overheat, remains a challenge. Another hardware barrier, according to experts, is connected to electronic component shortages and the headsets' field of view (FOV). Ideally users should be able to consume content utilizing their whole FOV, which is currently impractical.

Despite the fact that AR technology has been available for decades, experts claim that consumers are still unaware of its various applications and how it might benefit their daily lives. Furthermore, due to its demanding tech, the form factor of AR Smart Glasses headsets is yet to be determined, as most are cumbersome and susceptible to overheating. At this point, AR Smart Glasses are likely to stand out due to their unusual aesthetic, introducing a fear of social judgment as most users are not eager to draw that much attention to themselves.

Finally, the cost of AR Smart Glasses is a stumbling block to their success. Consumers may be hesitant to acquire AR Smart Glasses due to their high price. This cost, along with the lack of need recognition among consumers, presents significant impediments for adoption.

Enablers

AR has the ability to change users' perceptions of reality, altering how they make decisions and interact with the physical realm (Porter & Heppelmann, 2017). AR has an almost unlimited number of functional and enjoyable applications in, for example, media consumption, education, safety, and health. It will influence how businesses provide value to consumers, engage with employees, create new products, and manage their value chains (Porter & Heppelmann, 2017). Unlike VR, that represents an escape from reality, AR represents a way to unlimitedly enrich the real-world.

Experts believe that companies from various industries will play a key role in the further adoption of AR Smart Glasses, and 5G's faster connections will enable a much better quality of service for applications like streaming and gaming, allowing developers to deliver innovations based on cloud computing or new technologies that are not yet available today.

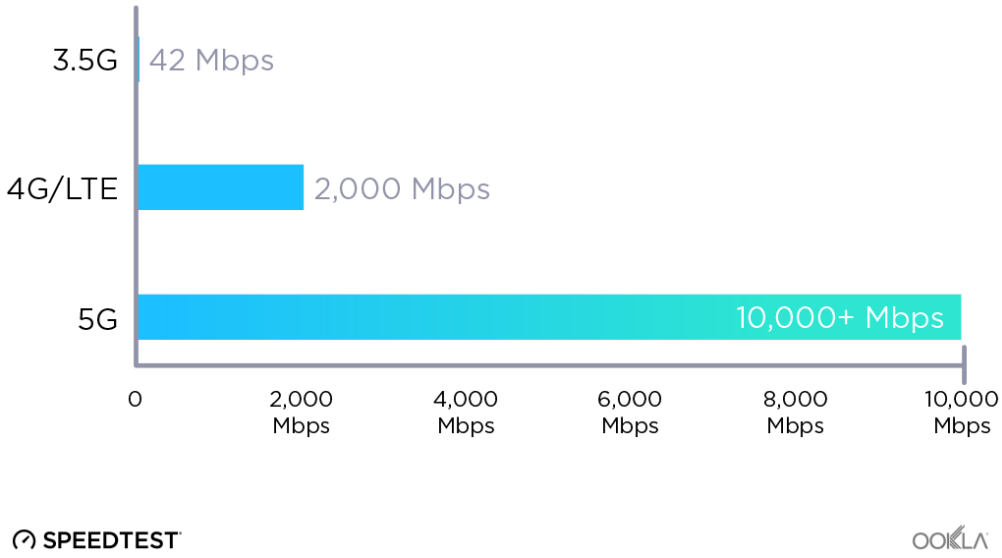

Figure 13: Max Download Speed by Technology (Milanović, 2018)

If the computational power were not in the headset itself, but rather in a cloud service or the users' smartphone, the headset might be significantly lighter. 5G is critical to the gaming industry's progress over the next years, and five experts saw this as a catalyst for AR Smart Glasses' potential wider acceptance, since immersion and new and enhanced forms of interaction are important aspects of the industry. According to one expert, telecommunication firms will leverage AR to promote attractive use cases for their new and improved connection services. This would be attained through effective marketing strategies that educate consumers about why they need devices like AR Smart Glasses in order to instill a desire for 5G services, which is already taking place in a VR headset campaign by NOS (NOS, 2021); (Appendix 5). This might accelerate their acceptance, since consumers would benefit from considerably quicker and lower-latency connections, resulting in higher-resolution visuals and a greater engagement with AR Smart Glasses headsets (O'Donnell, 2020).

One expert suggested trial period experiments where the headsets' concept may be further explored directly with target consumers. Concept testing ensures a successful product launch by lowering the risk of project failure (Barnes, 2020), which would contribute for further consumer familiarization with AR. Consumers would feel compelled to purchase their own AR Smart Glasses once they concluded how they would actually use the device. Consumers would test the headset without making a financial commitment, and these would be available at locations such as museums, supermarkets, and other establishments where consumers may try out the device briefly and in a controlled setting.

Another company that experts considered crucial for the advancement of AR Smart Glasses, was Facebook, now Meta, and its Metaverse. The Metaverse is "a set of virtual spaces where you can create and explore with other people who aren't in the same physical space as you" (Meta, 2021) and that can be thought of as the internet in which users can be inside the content instead of viewing it from a device (Zuckerberg, 2021). Users can carry out different tasks digitally such as socializing, go to work and attend office meetings, go to concerts, shop for clothes, play games, workout, learn and much more. Meta claims that "it's about making the time you do spend online more meaningful" (Bosworth, 2021), in which developments on AR and VR will "deepen human connection regardless of physical distance and without being tied to devices" (Bosworth, 2021).

Figure 14: The Metaverse and How We'll Build It Together - Connect 2021 (Meta, 2021)

The Metaverse will be reliant on AR and VR technologies to provide the desired experience to consumers. This will have a considerable impact on the consequential adoption of AR Smart Glasses, educating consumers on their different use cases and value proposition. The Metaverse initiative will also bring a significant investment into AR and VR, as Meta announced that $150 million USD were invested "to train the next generation of creators building immersive educational content" (Tech@Facebook, 2021), as well as an investment of $50 million USD investment in "global research and program partners to ensure these products are developed responsibly" (Bosworth, 2021). Such initiatives may help to accelerate the growth of the AR Smart Glasses market, as well as the enhancement of AR and its content quality.

According to experts, social media companies have played a significant role in the rise in popularity of AR and, as a consequence, may influence consumers' future outlook of AR Smart Glasses. Platforms like Facebook Messenger, Instagram, Snapchat and TikTok introduced filters that adapt to users through a layer of digital information via AR, with the possibility of entirely transforming the real faces and bodies of users beyond recognition. Filters can be applied to the face, body, background, voice and objects, and they also provide the ability of seeing digital objects, advertisements, people or creatures layered over the physical surroundings of the user. Filters have remained a part of social media users' online behavior throughout the years, as 90% of young women say that they sometimes use filters when posting a selfie, and of these, more than half say that they used a filter half of the time or more (Gill, 2020). The technical development of filters and their massive adoption from consumers may signal the potential for other future AR applications, such as AR Smart Glasses.

Finally, experts believe that the Covid-19 pandemic's lockdowns have accelerated the widespread adoption of AR and AR Smart Glasses, since consumers are seeking engaging technologies that bring deeper connections. Global spending on AR and VR headsets, as well as related software and services, rose in 2020 to $12 million, which is an increase of 50% from 2019 (Vardomatski, 2021). Additionally, 32% of consumers used AR for shopping in 2020, and the AR and VR markets associated to the retail industry is expected to reach $2 094.08 billion until 2027, which represents a market growth rate of 68.5% between 2020-27 (Vardomatski, 2021).

4.1.2. Likelihood of Smartphone Substitution

It is challenging to make long-term projections since technology evolves at such a rapid pace. Experts stressed that new and unexpected occurrences may bolster technologies that have not even been contemplated yet, as well as advanced technologies that are believed to exist in the future may never happen, at least as they are envisioned. For this research, the likelihood of smartphone substitution is considered in a period of less than 20 years.

When asked if they believed this would happen, the majority seemed to agree that AR Smart Glasses will play a significant role in the future, but differed on the degree to which this will happen. Smartphones will most likely be replaced in the long term, according to eleven experts, and most likely by AR Smart Glasses. These experts predicted that while AR Smart Glasses will initially function as a complement to smartphones, consumers will gradually shift to them as a result of its more "natural" integration with human behavior. Experts pointed out that smartphones have only been present for around 15 years, putting the development of a new technology that may replace them in a comparable timeframe as a likely outcome.

1	Certain in B2B. Likely in B2C. Complementary at first.	8	Highly likely in 15 to 20 years.
2	Highly likely in more than 5 years.	9	Highly likely in 15 years.
3	Highly unlikely in the next 50 years.	10	Highly likely in 10 to 15 years.
4	Unlikely, it will be complementary.	11	Likely in 15 years.
5	Highly likely. Complementary at first.	12	Highly likely in 5 years.
6	Highly likely. Almost certain.	13	Highly likely, hard to say when.
7	Unlikely, it will be complementary.	14	Highly likely, but not necessarily by AR Smart Glasses.

Table 2: Likelihood of smartphone substitution (Own Development)

One expert added that a distinction between B2B and B2C scenarios was required. The dominance of AR Smart Glasses in a B2B context was almost guaranteed and currently taking place, since these devices are a productivity tool with unmatched efficiency. In a B2C setting,

however, there will be more variables at play, such as the identity and privacy of consumers, where the management of personal data will be a critical element of the experience.

The remaining three experts disagreed, claiming that smartphones would be unlikely, if not impossible, to be replaced by AR Smart Glasses in the near future. According to them, the headset will remain a complement to the smartphone experience, similar to smartwatches, which provide functions that the smartphone cannot, but do not pose a significant threat to the smartphone's role in users' lives.

When asked when AR Smart Glasses could reach the mass market, experts seemed to agree that they would become common in the next decade, more specifically in 5 years or even less. Experts predict that Big Tech firms like Apple, Google, Facebook, Amazon and Microsoft, as well as other hardware companies like Xiaomi and Lenovo, will be most successful in developing and commercializing AR Smart Glasses. These would become appealing to consumers as a part of their seamless integration with the rest of the company's products. Seven experts mentioned that Apple would be the number one company with the biggest potential to successfully launch this new product category into the mass market. It is interesting to see reported that Apple is giving its top hardware and software engineers out-of-cycle bonuses to stop them from jumping ship to Meta. These bonuses are being allocated in the form of restricted stock valued in the range of $50,000 to $180,000, according to Bloomberg. (Paleja, 2021)

1	Less than 10 years.	8	Between 5-10 years.
2	Around 2 years.	9	Between 5-10 years.
3	More than 10 years.	10	Around 5 years, 10 maximum.
4	Around 3 years.	11	Around 10 years, at best.
5	Between 5-10 years.	12	Around 2 years.
6	Around 10 years.	13	Between 5-10 years.
7	Around 5 years.	14	Between 5-10 years.

Table 3: How many years until the mass market (Own Development)

Companies in the "regular" glasses market, according to one expert, will want to become engaged in the creation of AR Smart Glasses since these futuristic devices have the potential to become the "regular" glasses of the future. Meta's and Luxottica's Ray-Ban Stories, even without AR, are an example of a collaboration between tech and eyewear firms. This partnership may ultimately benefit the consumers through the provision of optimal software in the eyewear that they have become accustomed to. With AR Smart Glasses, users would not need to change lenses as their vision improved or deteriorated; instead, AR technology would adapt to their specific needs as required, as well as have the potential to improve the users' vision in other ways, such as through night vision and zooming in and out of subjects. AR Smart Glasses might then assist users with low-vision to better handle their surroundings, which can increase their ease of mobility by 50% and grasp performance by 70% (Angelopoulos et al, 2019).

Finally, experts were asked if they thought there was another innovative device on the horizon that might have a bigger impact on the smartphone industry in the future. Some experts responded that they were unaware of such future potential or that the biggest impact on the smartphone industry, rather than a new product, will come from new and improved ways of integrating different devices, which could make the smartphone an even more important control center in consumers' lives.

1	Improved integration of devices.	8	Brain implants and more integration.
2	Brain implants.	9	Other AR devices, such as contact lenses.
3	Speakers.	10	AR Smart Glasses are a transition product until we reach contact lenses and implants.
4	Improved integration of devices.	11	Other AR devices and services, or advanced voice assistants.
5	Contact lenses and brain implants.	12	Nothing comes to mind.
6	Nothing comes to mind.	13	Neural devices such as headbands and implants.
7	Improved integration of devices.	14	Neural devices such as headbands and implants, namely Neuralink's.

Table 4: Other innovative products (Own Development)

Six experts had a specific product in mind: a future brain implant. They implied that it will be conceivable in the future to implant a type of computer chip into humans' brains, opening up new realms of human potential. Human augmentation, often known as "Human 2.0" (Gartner, 2020), is a term used to describe the combination of man and machine. Human augmentation entails the application of science and technology to enhance human performance beyond what is attainable biologically (Gaebelein & Amison, 2021). This implies that humans might evolve to become part machines, and if this occurs, they will not need any external gadgets. Instead, they would become their own source of external information.

The next step in the evolution of our vision could come through AR contact lenses. Mojo Vision is developing smart contact lenses that contain a small microLED display the "size of a tiny grain of sand" (Mojo Vision, 2021) as well as small sensors and batteries. These contact lenses correct the user's vision and use AR by adding a layer of digital information into the real world, similarly to the AR Smart Glasses.

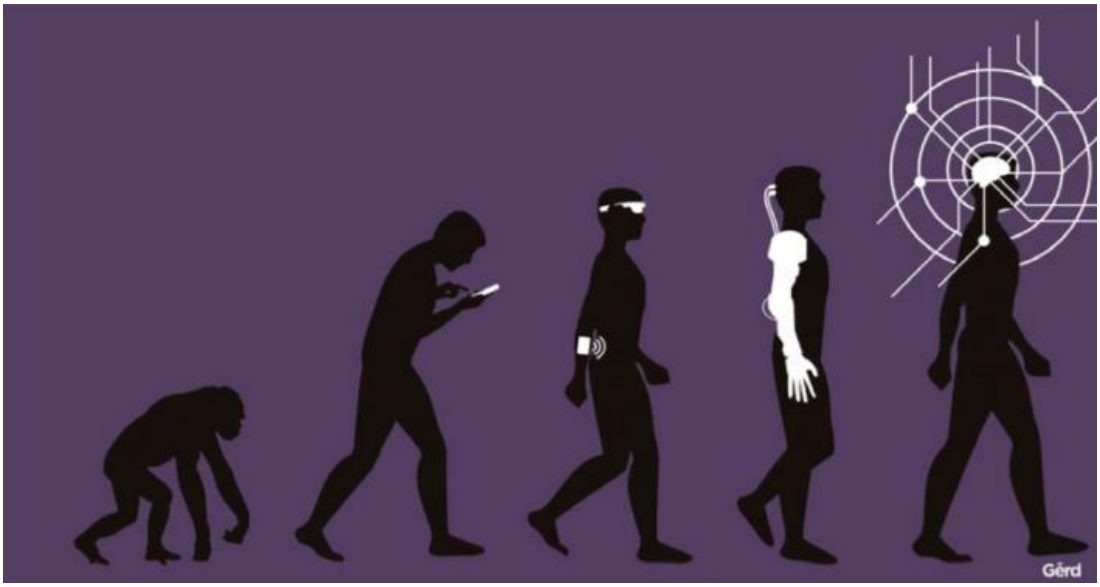

Figure 15: Human Augmentation: The Dawn of a New Paradigm (Gaebelein, & Amison, 2021)

The next step of the evolution may be for the consumers themselves to become a "machine". Companies such as Neuralink have already started moving in this direction. Neuralink is a technology company that is developing a device that is implanted in a user's brain with the aim of recording and stimulating brain activity, which Elon Musk refers to as "Fitbit in your skull"

(Hamilton, 2021). The microchip's potential appears to stretch in different directions, such as to treat neurological illnesses such as Parkinson's and Alzheimer's, as well as technological mind control that would allow seamless interaction with digital content and meld human consciousness with artificial intelligence.

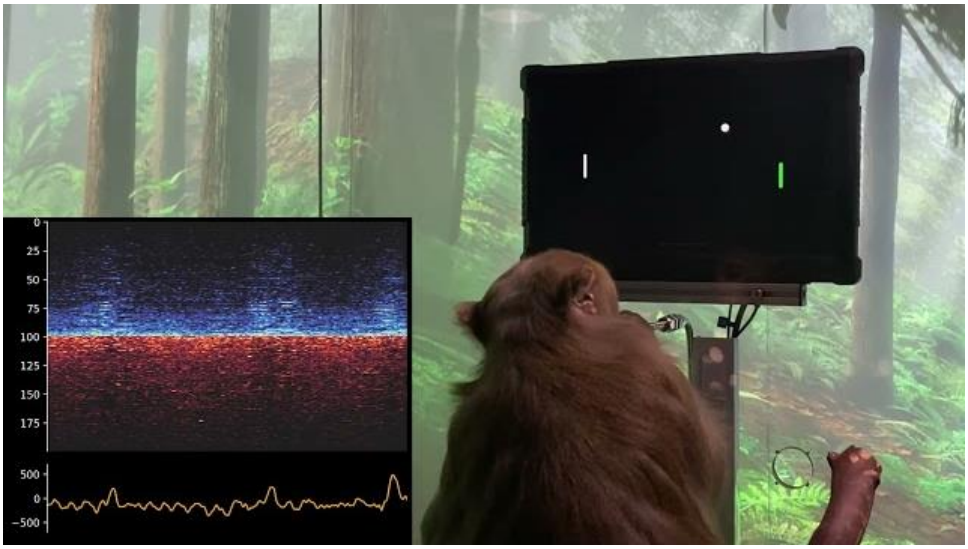

Figure 16: Neuralink shows Pager the monkey playing Pong using signals from his mind (Khare, 2021)

Experts, however, believe that these implants will take significantly longer to reach the mass market, not only because of their intricate technology, but also because of expected slower consumer adoption. Consumers are more likely to be concerned than enthused about the prospect of brain implants in the future (Funk et al, 2016); (Appendix 6), therefore resistance is to be expected as it raises a plethora of concerns regarding safety, health, ethics and control over one's free will.

4.1.3. The interaction between AR Smart Glasses and Smartphones

In the event that AR Smart Glasses become widely available, experts were asked how users' smartphone usage patterns will change when combined with AR Smart Glasses. All experts agreed that consumers would gravitate away from their smartphones. While both devices would be used in combination, the smartphone's use would be limited to certain use cases that would be difficult to execute with the AR Smart Glasses. As a result, fundamental smartphone tasks like making

phone calls, listening to music, and taking photos may shift to AR Smart Glasses, establishing the groundwork for their eventual independence. Even in this instance, most experts believe that the smartphone will remain relevant by adapting to emerging trends. In the survey section, the influence of AR Smart Glasses on smartphone usage will be addressed in further detail.

1	No relevant impact.	8	Designed to be AR Smart Glasses' processing power. Will become smaller.
2	It might disappear.	9	No relevant impact.
3	None.	10	Will become a complement of AR Smart Glasses. Will become smaller.
4	Low impact, design will change according to emerging trends.	11	Designed to become a control center.
5	Will become smaller.	12	It might become useless and disappear.
6	Designed to be AR Smart Glasses' processing power. Will become smaller.	13	Direct impact, can't say which.
7	No direct impact, might become smaller.	14	Designed to become a processing unit and will continuously shrink in size.

Table 5: Impact on smartphone's design (Own Development)

Experts were split on whether AR Smart Glasses will have an influence on the future design of smartphones. Five felt there will be no direct influence, but that they will develop in response to changing industry trends and consumer preferences. The remaining experts believed that the smartphone's primary purpose will be to provide processing power to other devices, such as AR Smart Glasses, and that their adoption will result in a reduction of the smartphone's display size, which would go against the current trend of larger displays to watch content. This shrinkage would be attributed to the fact that consumers would be able to consume content more effectively using AR Smart Glasses, and would no longer want to carry such a large device in their pockets.

Despite its numerous advantages, the smartphone is not without flaws. When questioned about the device's primary shortcomings, experts mentioned that it must be held in one hand, which implies that users must restrict themselves when using it. Three experts stated that smartphones have inhibited consumers from interacting with their immediate surroundings. Individuals no longer need to connect with people to obtain knowledge; instead, they may use their smartphone

to avoid social situations. Furthermore, despite the fact that the smartphone has enabled consumers to socialize in previously unheard-of ways, allowing them to reach out to a larger number of people more easily and quickly through social media, it has also contributed to individuals feeling more isolated and reliant on their gadgets. Teenagers who heavily use social media are 3 times more likely to feel socially isolated (Primack et al, 2017).

The majority of experts also mentioned the smartphone's influence on privacy, since the way the device is used can lead to oversharing of personal data. Other flaws identified were restricted battery capacity, a screen size restriction to retain portability and a decreased innovation year-to-year.

AR Smart Glasses may be a solution to some of these problems, but they may exacerbate others. One expert noted that the future of AR and AR Smart Glasses is reliant on the performance of smartphones, which is now the most common device used by developers to provide AR experiences to consumers. AR Smart Glasses provide a hands-free alternative in which users just need to use voice commands to do daily tasks, as well as the ability to gaze up from their smartphone and up at their surroundings.

AR Smart Glasses would have the potential to enhance reality and make it more engaging for individuals, but they also have significant downsides. According to experts, the fact that each consumer would have a unique experience may collide with our existing understanding of "reality", as reality will mean different things to different individuals. Such disparities in reality perception are already worsened by social media and other platforms, which limit consumers to seeing only what the platform believes would keep them online the longest, personalizing specific material to support their current views and leading to the creation of echo-chambers (Travierso, 2021). The constant presence of the devices' cameras would result in a loss of individual privacy, forcing users to decide which aspects of their life they are prepared to disclose to their AR Smart Glasses cameras.

4.2 Survey

The consumer perspective is critical to understanding how AR Smart Glasses may succeed or fail in the future. Three primary issues were examined to complement the information gathered

from expert interviews and to better examine consumers' preferences. To begin, respondents were asked what the main benefits and drawbacks would be of using AR Smart Glasses over a smartphone, as a way to understand how they currently perceive this new device. Then, respondents were instructed to choose which situations they would prefer to use AR Smart Glasses or their smartphones to reveal use cases where consumers would be more likely to switch away from their smartphones. Thirdly, respondents were asked if they considered the possibility of the smartphone being replaced in the future likely.

4.2.1. Perceived Benefits and Drawbacks of Using AR Smart Glasses Over a Smartphone

When asked which would be the main benefits of using AR Smart Glasses over a smartphone, the provision of useful information in real time was the most selected option. This was closely followed by the provision of a hands-free experience and of a greater interaction with reality. These findings suggest that consumers would be interested in AR Smart Glasses due to their potential of further interaction with reality and to acquire more information about their surroundings, rather than having another platform to watch content on.

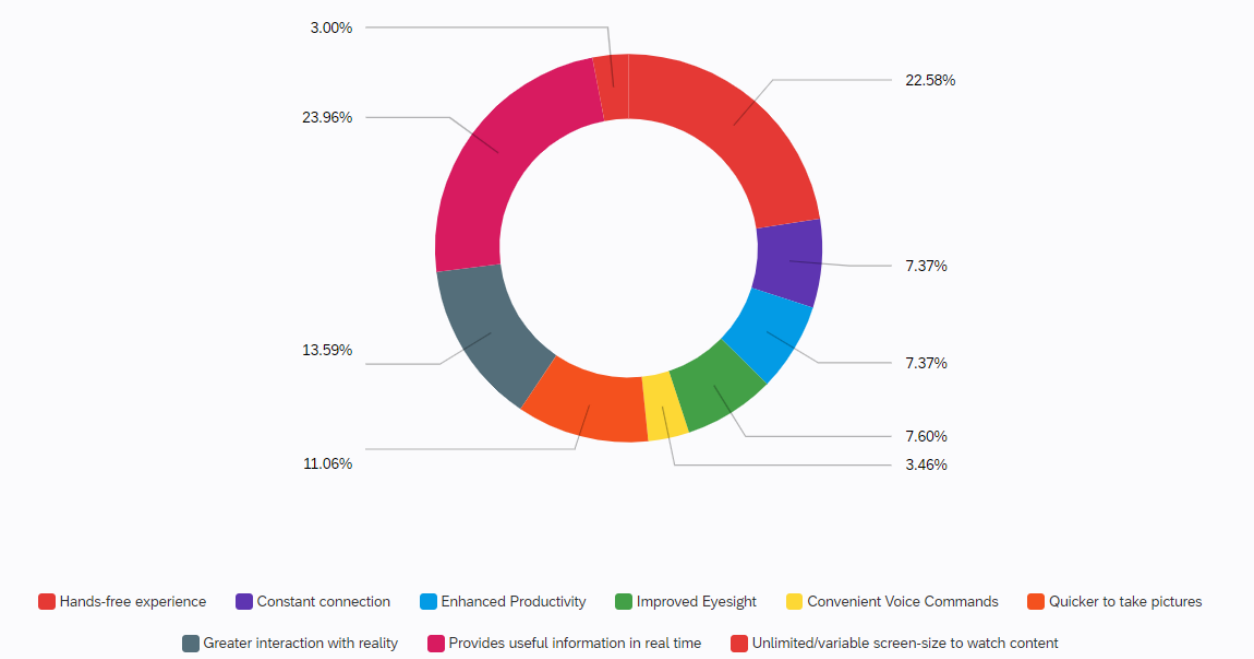

Figure 17: Main benefits of using AR Smart Glasses over a smartphone (Own Development)

On the contrary, the least selected options by respondents were related to the provision of convenient voice commands and variable screen-size to watch content. To truly understand the reason for the lack of interest in these alternatives more research must be conducted, but the results continue to point to a lack of interest in new ways of consuming media. Consumers are either satisfied with voice commands in their smartphone or are uninterested in using voice commands at all. According to the expert interviews, these reactions might be due to consumers' lack of understanding of the potential of AR Smart Glasses and their use cases.

When assessing the primary disadvantages of utilizing AR Smart Glasses over a smartphone, respondents were concerned about the influence that such a gadget may have on their comfort and perception of reality. As such, the difficulty of focusing on reality was the most selected option, the possibility of headaches or pressure in the eyes was second, and privacy concerns were third. On the other hand, being less intuitive to use compared to a smartphone, fashion preferences, and being more challenging when editing content, were the least selected options by respondents. Such findings may demonstrate that consumers are willing to overcome more technical challenges, and that price, which is not among the top three most important considerations, may not be the most significant barrier to purchasing AR Smart Glasses.

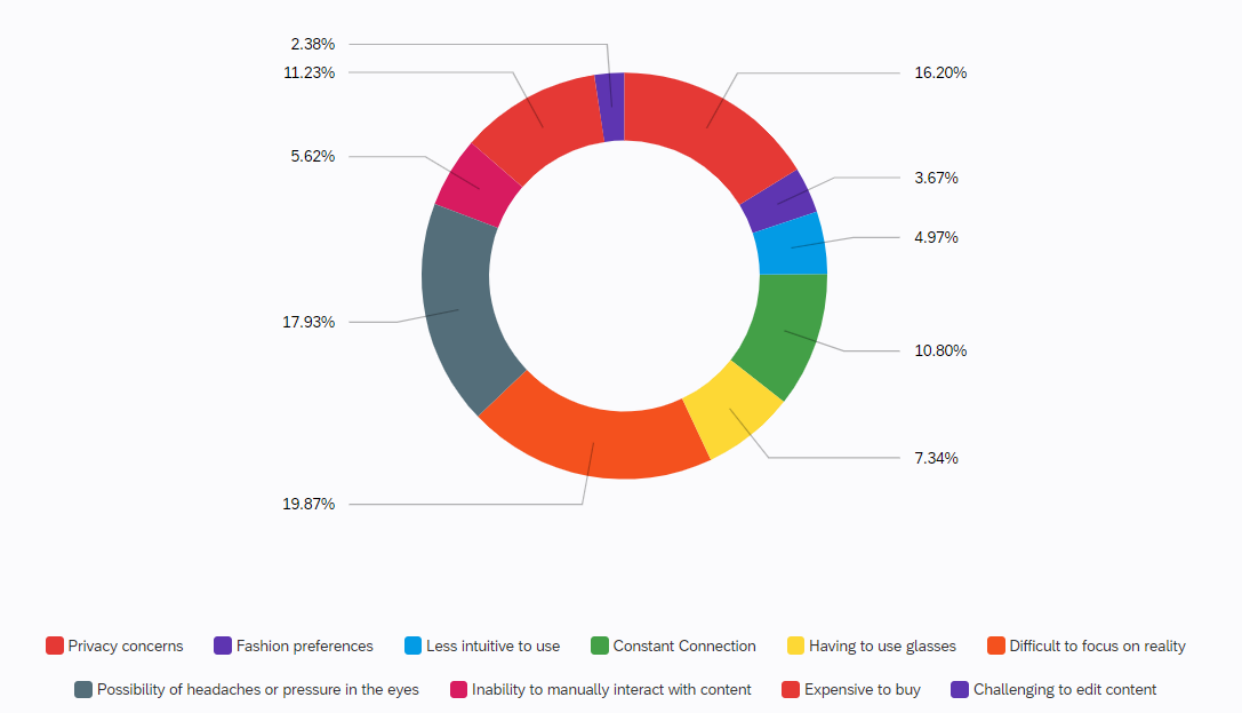

Figure 18: Main drawbacks of using AR Smart Glasses over a smartphone (Own Development)

4.2.2. Possible Future Impact of AR Smart Glasses on Smartphone Usage and Design

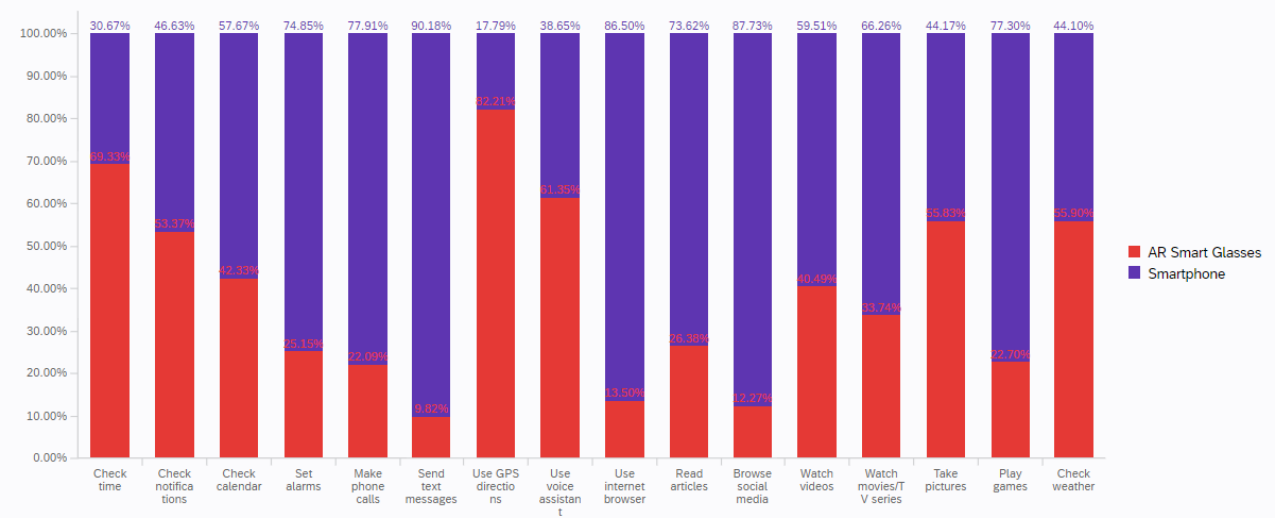

Figure 19: Preferred tasks on AR Smart Glasses and on a smartphone (Own Development)

When respondents were asked which tasks they would prefer to complete on AR Smart Glasses versus a smartphone, it was possible to analyze future preferences between the two and understand the impact AR Smart Glasses may have on smartphone usage. The smartphone was the preferred device for most tasks, such as checking the calendar, set alarms, make phone calls, send text massages, use an internet browser, read articles, browse social media, watch videos, watch TV series or movies and play games. AR Smart Glasses were preferred in tasks such as checking time and notifications, using GPS directions, using voice assistants, taking pictures and checking weather. The majority of the findings are consistent with previous research, in which AR Smart Glasses are used to consult simple pieces of information, while smartphones are preferred for more complex tasks that require a higher level of engagement. However, given that the majority of respondents considered themselves to be somewhat or very unfamiliar with AR technology and AR Smart Glasses, it's conceivable that their preference may shift once they gained better understanding of AR Smart Glasses' potential and various use cases.

However, the respondents' preference to take pictures with AR Smart Glasses was an unexpected result. If it holds true for consumers in general, it might have major repercussions for the smartphone industry. With smartphones' limited year-over-year innovation, consumers were increasingly less enthusiastic and willing to acquire a new smartphone regularly, and the trend is

for them to maintain their existing gadget for longer periods of time before acquiring a new one (Ng, 2019).

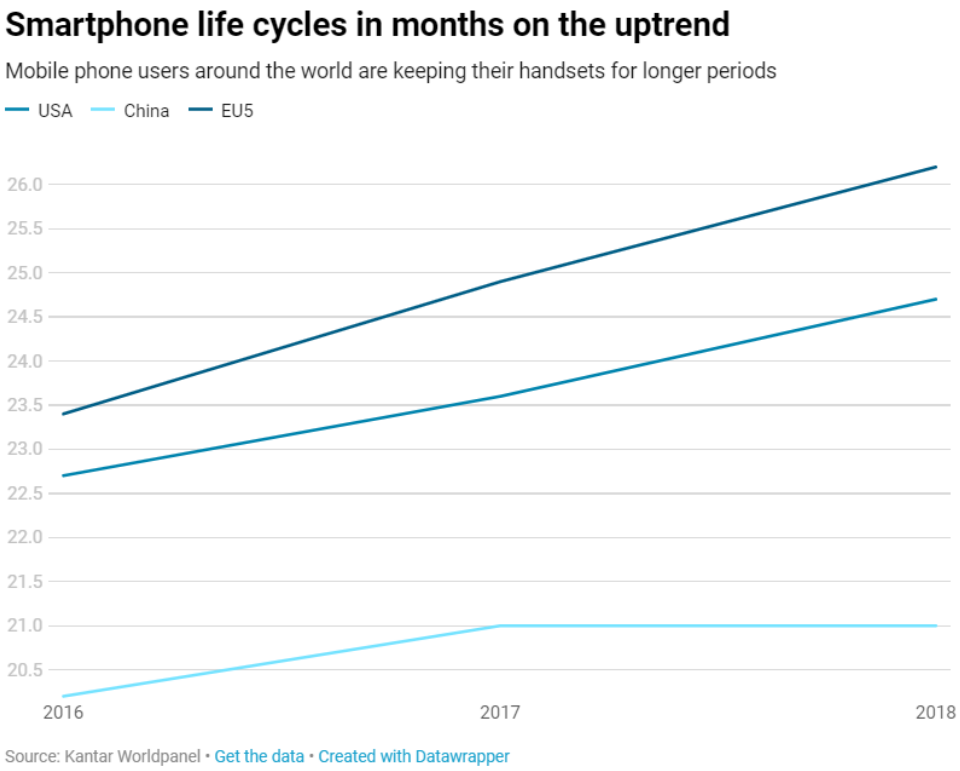

Figure 20: Number of months for which consumers keep their smartphone (Ng, 2019)

Currently, one of the features that drives consumers the most to update their smartphone, is its camera, along with more storage, better charging capabilities and a more powerful processor (Buckle, 2019); (Appendix 7). As a result, it's reasonable to assume that if AR Smart Glasses can support high-quality cameras, consumers might gravitate towards them, and smartphones may lose an important feature that was previously exclusive to them: a personal camera that is portable, practical, and produces high-quality images.

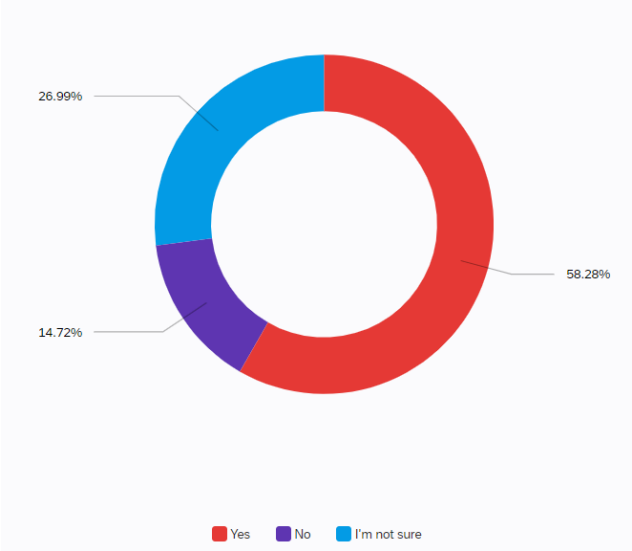

Figure 21: Impact on the design of the smartphone (Own Development)

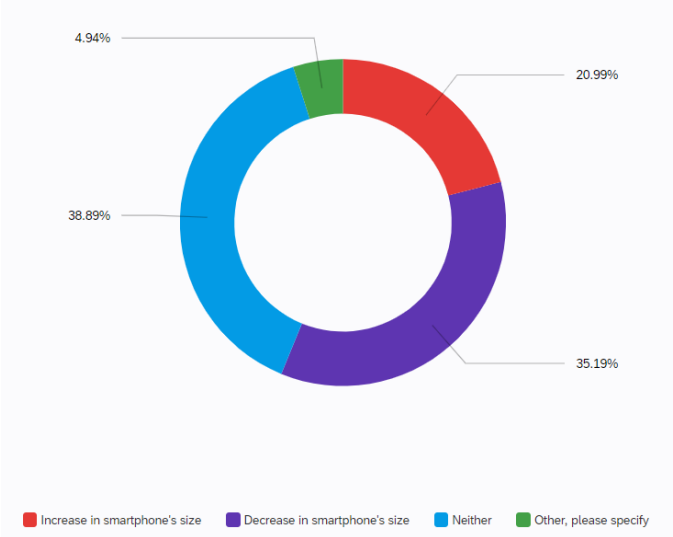

Figure 22: Most likely impact (Own Development)

Regarding the impact of AR Smart Glasses on current smartphone design, the majority of respondents agreed that it would have an impact. When asked which outcome would be most likely, between the increase or decrease of the display size, most respondents think that neither one is likely, but the second most selected option was a decrease in size. Thus, experts and respondents agreed that AR Smart Glasses would have an impact on smartphone design. In the case of such impact, there was also agreement that between an increase or decrease in display size, the latter is most likely to take place. The few who chose "Other, please specify" said that the

smartphone may get new display technologies and that, similarly with what experts said, device integration will be the most crucial factor. Because the majority of respondents chose "Neither" and did not specify which design change they had in mind, it is impossible to know which design change they consider most likely.

4.2.3. Likelihood of Smartphone Substitution

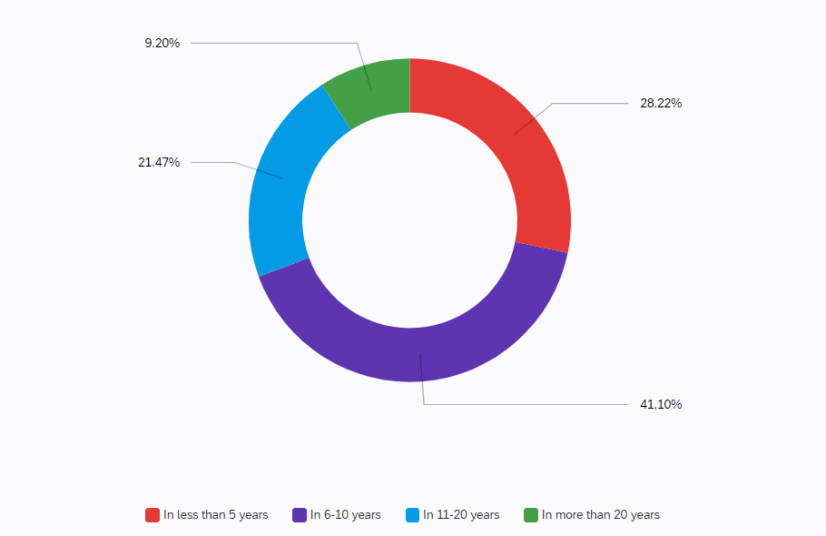

Figure 23: Likely time frame (Own Development)

When asked “When would you say that AR Smart Glasses could become a popular product that is bought by most people?”, respondents displayed a similar perception as the experts. Almost half of the respondents believed that AR Smart Glasses will reach the mass market in 6 to 10 years, while the second most selected option showed that other respondents thought that it will happen even sooner, in less than 5 years.

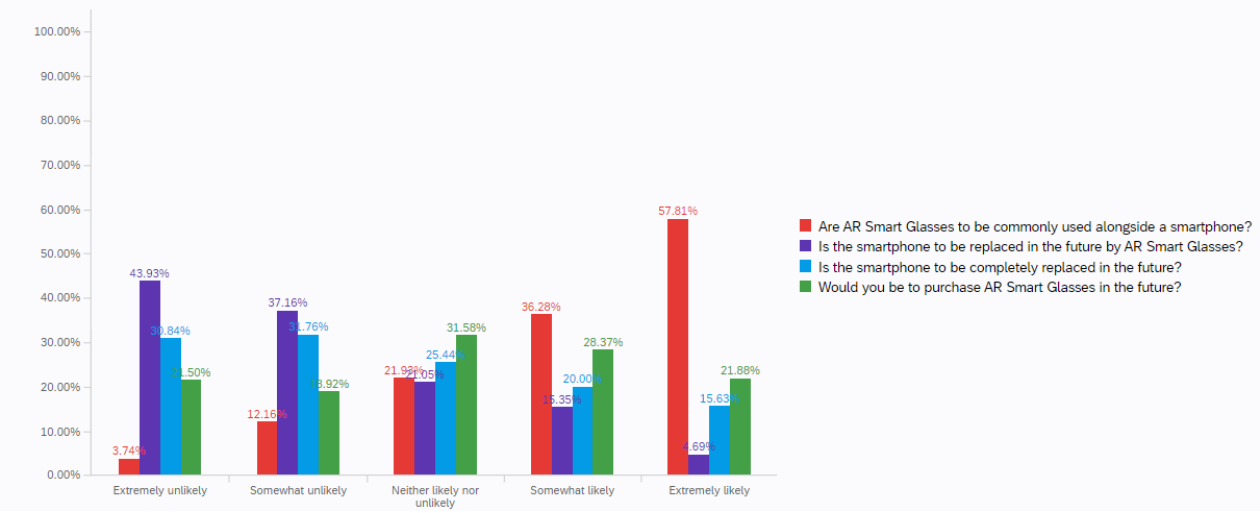

Figure 24: Likelihood of different variables (Own Development)

Regarding the likelihood of future smartphone substitution, four different questions were asked. Firstly, how likely are AR Smart Glasses to be commonly used alongside a smartphone, to which most respondents answered that it was extremely likely, showing that consumers can see themselves in a not-so-distant future incorporating such device into their routines, in a similar way as they incorporated smartwatches or other wearables.

They were then asked how likely the smartphone is to be completely replaced in the future, and respondents were torn between extremely unlikely and somewhat unlikely, which shows that consumers cannot see a future in which the smartphone will not be a part of their lives. This finding supports the idea that humans, in general, create and like to preserve habits because the familiar is more comforting than the unknown (Newby-Clark, 2009). Respondents were then asked how likely the smartphone is to be replaced by AR Smart Glasses in the future, and the results were even more negative, with almost half of the respondents stating that it was extremely unlikely, which follows the same logic as the reaction to the previous question. This result contradicts the opinion of experts who believed that AR Smart Glasses have the potential replace the smartphone. Finally, when asked how likely they would be to purchase AR Smart Glasses in the future, respondents were somewhat positive, in which most were split between stating that they were neither likely nor unlikely, somewhat likely and extremely likely to do so. These findings indicate that customers are intrigued by this new device and are prepared to give it a try in the future.

4.3 Scenario Planning

To have a clearer idea of what the industry's future may look like, evaluating several potential outcomes is useful. Even if most aspects are challenging to predict, scenario planning "attempts to compensate for two common errors in decision making – underprediction and overprediction of change" (Schoemaker, 1995), allowing researchers to develop a middle ground between both. To develop the scenarios, it is important to define the time frame of events, identify the major stakeholders, basic trends and key uncertainties (Schoemaker, 1995).

Time Frame

For every scenario, the time frame most commonly pointed out by experts (5 to 10 years in the future) was the benchmark time interval used. A common time frame allows for more consistent predictions among scenarios, and a shorter time frame allows for more tangible predictions, whereas predictions become increasingly challenging as time progresses.

Major Stakeholders

It is necessary to evaluate who will be interested in this industry and who will be affected by it in order to build more detailed scenarios. Consumers (of smartphones and communications services), industry competitors, suppliers, employees, and investors would all be affected in the smartphone and wearable industries.

Basic Trends

The most important trends to consider pertain to the growth of AR, the increase in popularity of SW, companies' in the smartphone market interest in entering the AR Smart Glasses industry (Apple and Xiaomi), the decrease in innovation of smartphones, the widening of the time consumers take to purchase a new smartphone, the dissemination of 5G connectivity (and availability of streaming), the growth of the gaming industry, increase of privacy concerns, AR Smart Glasses adoption in business settings, efforts in creating smaller and more power efficient processors, consumer dependency on the smartphone, push for the Metaverse from Big Tech

companies, development of AR smart contact lenses, the influence of Covid-19 lockdowns and the search for more engaging technology, decrease in AR Smart Glasses prices, tendency for AR Smart Glasses to become less bulky and more comfortable, no need for external displays since AR Smart Glasses will allow users to see content in variable display sizes, and consumers may become more and more aware and knowledgeable on the potential of AR, which might influence their opinion and availability to adopt it.

Key Uncertainties

The development of AR technology itself is a key uncertainty. The technology has been seen as having immense potential for quite some time but it has not yet been able to take off. Consumer willingness to use AR Smart Glasses in the way that companies intend to, the economic impact of the pandemic and how it might influence consumer dispositions to buy new product categories are drivers that could significantly affect the future of the smartphone industry and the possible future impact of AR Smart Glasses.

After going through these factors, three separate scenarios may be developed. Initially, each scenario will have a 33.33% probability of occurring, which will be revised when experts' and survey respondents' specific feedback is considered. The experts' input will be weighted at 70%, as they are more knowledgeable on the issue. Therefore, the input of survey respondents will be weighted at 30%, since, despite their relatively uninformed opinions on the issue, they represent the likely future consumers of these industries, whose perceptions and attitudes may have a big impact on their success.

4.3.1. Scenario Nº1 - Mass Adoption, Fast Smartphone Substitution

In this scenario, smartphone companies such as Apple would launch their own versions of AR Smart Glasses. Telecommunication companies would be eager to sell AR Smart Glasses to consumers by linking them with their 5G services. Powerful marketing campaigns would be launched with this purpose in mind, and consumers will have little trouble incorporating AR Smart

Glasses into their daily routines, as they become informed about the significant potential of AR. At the same time, AR developers will be able to improve their graphic and processing capabilities, delivering optimal performance that allows consumers to use AR Smart Glasses as efficiently as has been envisioned. This will increase the rate of AR adoption in multiple sectors, such as in business, retail and advertising. It will also lead to a valuable experience for consumers when using AR Smart Glasses that will blend optimally with their needs. The result would then be mass adoption of the device and a rather fast abandonment of the smartphone, which will be regarded as a limited device in comparison. As a result, AR Smart Glasses would have a massive impact on smartphone usage and design in the future, as consumers would largely stop using smartphones or would only use them for very specific reasons. Smartphones would shrink in size to avoid bothering consumers having to carry them, eventually disappearing.

This scenario depicts an optimistic future for AR, as well as what would occur if all existing trends and projections materialized. While most experts believe AR Smart Glasses will meaningfully impact the smartphone industry, only 3 (21.43%) consider it will occur at such pace. On the other hand, only 3.84% of respondents firmly believe that AR Smart Glasses will replace smartphones in the near future. As a result, the probability of this scenario to occur is 16.15%, making it the least likely scenario (Appendix 9).

4.3.2. Scenario Nº2 - Mass Adoption, Smartphone Complement and Slow Substitution

The same patterns as before would take place in this scenario, but on a more grounded level. Therefore, smartphone companies would succeed in the launch of their new AR Smart Glasses and telecommunication companies would also market them to their consumers by association with 5G. Massive marketing campaigns would be launched to educate consumers on why they need this device. Consumers, on the other hand, will continue to prefer using their smartphones for the majority of tasks with AR Smart Glasses serving as a complement similar to how they currently use other wearables. Simultaneously, developers succeed in developing and optimizing AR for usage with AR Smart Glasses, although the results are modest in the early years and do not fully meet users' expectations. As a result, AR Smart Glasses would reach the mass market, but not every consumer would buy one. Most people would still be hesitant to invest in this product category. As a consequence, consumers will appreciate using AR Smart Glasses for

certain tasks at which they excel but will continue to rely heavily on the smartphone's capabilities, resulting in a split between the two. Furthermore, consumers would be unable to live without their smartphones since they have become attached to them. Hence, while they will be able to imagine a future without smartphones, that reality remains a long way off. Regarding changes in design, smartphones would begin to play an even more important role as a control and processing center. They would maintain their overall dimensions and functionalities as it is in smartphone companies' best interests to keep their versatile format.

This scenario represents intermediate expectations as it would allow for AR Smart Glasses to thrive and play a significant role in the portfolio of technology companies. The devices would still have significant potential for further growth and even for smartphone substitution, but maybe not 5 to 10 years into the future. In a B2B setting, however, AR Smart Glasses would continue to be very successful and would completely replace the smartphone or other gadgets.

According to 11 experts (78.57%), this is the most likely scenario, since most anticipate that AR Smart Glasses would act as a complement to smartphones in the foreseeable future, but that AR will eventually take over and increasingly render the smartphone redundant. 29.79% of respondents to the survey generally agree that this outcome is more plausible than the former, but most remain skeptical about its impact on smartphone's dominance. As a result, the probability of this scenario to occur is 63.94% (Appendix 9), making it the most likely scenario.

4.3.3. Scenario Nº3 - No Mass Adoption, Augmented Reality Fails to Take Off

Finally, this scenario begins identically to the previous ones. Smartphone companies would introduce their AR Smart Glasses, and telecommunications companies would advertise them alongside their 5G services and through extensive marketing efforts to entice consumers to acquire them. However, due to a lack of improvement in AR technology, these headsets would not attain widespread acceptance. Only innovators and early adopters would be enthusiastic about using them. This will result from the fact that AR Smart Glasses use cases are not well defined or seem redundant relative to features that smartphones already provide and its cumbersome navigation and interface functionalities serve as barriers to wider consumer adoption.

In this scenario, for the foreseeable future, AR Smart Glasses would continue to be a niche product for adventurous consumers and will continue to be optimized for corporate uses. This represents a more pessimistic future outcome to which experts strongly disagreed, but most survey respondents (66.37%) thought this would likely take place. As a result, the probability of this scenario to occur is 19.19% (Appendix 9).

4.4 Answer to RQ1: How will AR Smart Glasses impact the Smartphone industry?

According to the findings, there's a good chance that AR Smart Glasses will eventually replace smartphones, even if there is still a considerable level of uncertainty. The most likely scenario when combining views of the experts and respondents is that AR Smart Glasses will first function as a complement to smartphones, similar to other wearables. But as AR technology improves, AR Smart Glasses will begin to become customers' preferred device in around 10 years.

4.5 Answer to *RQ2:* What will be the future result of such impact on the Smartphone industry as we know it?

It is possible to determine that the second scenario “Mass Adoption, Smartphone Complement and Slow Substitution” is the most likely to occur, implying that the smartphone as we know it may undergo a design change over time, such as its transformation into a control and processing center for other devices, with a greater emphasis on its CPU. Usage would drop dramatically as consumers would only use them for very specific tasks. Big Tech companies like Apple, Microsoft, Meta, and other smartphone manufacturers would also gain from this new technology. Eyewear firms, additionally, may be heavily involved, since they could play a key part in the creation of a superior device form factor, which would lead to greater consumer adoption. As a consequence, AR Smart Glasses may progressively become the most essential product in any tech company's portfolio in the not-too-distant future.

5. Conclusions

5.1 General Conclusions

While researching this subject, it became clear that AR still has a great deal of untapped potential. Although AR has been around for a long time, technology has only recently given solutions or tools that can fully realize its promise. With 5G, the technology may see a significant increase in consumer acceptance with the potential to transform a wide range of businesses, not just the smartphone industry. Nevertheless, there is still a lot of room for improvement when it comes to AR content and how it is displayed to users in their unique contexts.

When it comes to AR Smart Glasses in particular, it's clear that there's still a lot of work to be done on their potential future influence on the smartphone industry. The majority of information on AR Smart Glasses is now centered on corporate usage, as this has been the area in which it has seen the most acceptance owing to its utility for task specific worker use cases. The largest roadblocks and uncertainties appear to be users' mindsets and predispositions to incorporate such gadgets into their daily routines which is consonant with the insights of the Technology Acceptance Model alluded to in the Literature Review. Consumers still have a limited understanding of AR's potential and what they would experience when using AR Smart Glasses. To address this, marketing campaigns, as well as an appropriate pricing strategy are critical. Consumers must be educated on what the devices are capable of, as well as shown how and why they need AR Smart Glasses.

It was feasible to discern a difference in perspective between experts and respondents, with experts believing that AR Smart Glasses will increase our interaction with reality and reduce social alienation, whilst survey respondents felt the reverse. The public view of AR Smart Glasses appears to be similar to that of VR headsets in which users are shown a "fake" representation of reality.

In terms of the potential future impact of AR Smart Glasses on smartphone usage, it was possible to conclude that consumers would prefer to carry out most tasks on their smartphones rather than in their hypothetical AR Smart Glasses at the moment. But this may change dramatically once they have had the opportunity to personally experience those tasks in such a device. Despite this, most notably users have claimed that they would prefer to take pictures with

AR Smart Glasses, which might lead to a significant change in the existing design of the smartphone, which is heavily centered on its cameras.

Finally, given how customers are accustomed to using smartphones, it was reasonable to determine that the smartphone will be difficult to replace in the near future. Experts were quicker to forecast that smartphones will be phased out than survey respondents who appeared to be virtually certain that the smartphone would not be replaced. As a result, it is plausible to conclude that AR Smart Glasses have the potential to have a significant influence on the smartphone industry in the near future, such as within the next 10 years, but that they will most likely function as a complement in the meantime. AR Smart Glasses may someday replace smartphones with smart contact lenses and brain implants following in the far future. But given that such technology is still to be fully developed and because it is more intrusive, it may take longer to be embraced.

5.2 Limitations

While the current dissertation contributes to the field of research, it has certain limitations. With the exception of two Brazilians who worked in Portugal, the interviews were conducted solely with Portuguese experts. Except for two, all of the experts were directly tied to AR, and only one worked with mobile technology such as smartphones. More experts from smartphone and telecommunication companies were contacted, but most did not respond. This is likely to have led to a bias in the experts' comments since it is reasonable to believe that because they deal with AR on a daily basis, they have higher hopes for the future of AR and AR's Smart Glasses. The sole expert who worked in a telecommunications firm and who dealt more directly with customers and the mobile industry had the gloomiest prognosis regarding AR Smart Glasses. This further points to confirmation biases and how disparities in viewpoints relate to domain expertise.

Similarly, the majority of respondents to the survey were Portuguese, which may skew findings on AR Smart Glasses versus other demographics due to economic and cultural differences. With respect to age, the majority of respondents were between 20 and 35 due to the fact that this age group was most readily accessible as survey participants. The survey also had limitations in terms of its lines of questioning. A greater focus could be given to interrogating other

dimensions pertaining to consumer propensities to use Smart Glasses in the future, as well as how such changes in AR technology would influence how individuals currently use their smartphones. The fact that most respondents were unfamiliar with the potential use cases of AR Smart Glasses and never had the opportunity to utilize them may have influenced their responses and lead to incorrect findings. Furthermore, no correlations between variables could be found that would allow for the creation of consumer profiles, such as determining whether consumers who consider themselves tech savvy or who wear glasses were more likely to adopt AR Smart Glasses in the future, since none were significant (sig.<0.05) or strong (close to -1 or 1).

In terms of sample sizes, a larger number of participants in both the interviews and the survey would have provided more representative findings, allowing for more confidence when interpreting and drawing inferences from the data.

The interviewer's lack of expertise may have caused questions to be framed in both the interviews and the survey in ways that further skewed results. This might have also have led to bias in data interpretation, confirming the researcher's preconceived opinions on the subject by highlighting information that supported that view and discarding data that was not deemed important. Nonetheless, by following a specified interview script and through the documentation and analysis of all the most mentioned topics by experts, this bias was mitigated to the maximum extent possible.

The absence of prior studies was also a limitation since a literature review is an important aspect of any research project that helps to determine the breadth of previous work in the field. When there is minimal extant research on the topic it is more challenging to adequately establish a research focus and develop the scope and depth of analysis.

5.3 Future Research

This dissertation paves the way for more studies discussing the novel subject of AR Smart Glasses and their bearing upon smartphones. Further research could be carried out in the future to better understand consumer attitudes and predispositions to utilize AR Smart Glasses. Experiments and trials could be conducted to obtain this information and to better understand how consumers

interact with the devices. After personal and direct experiences with the product consumers could be questioned about specific tasks for which they would use the devices leading to stronger conclusions about smartphone substitution effects.

If AR Smart Glasses reach the mass market, research could be carried out with the goal of better understanding the management implications of AR Smart Glasses and their influence on the smartphone industry. Aspects such as revenues and investments could be assessed.

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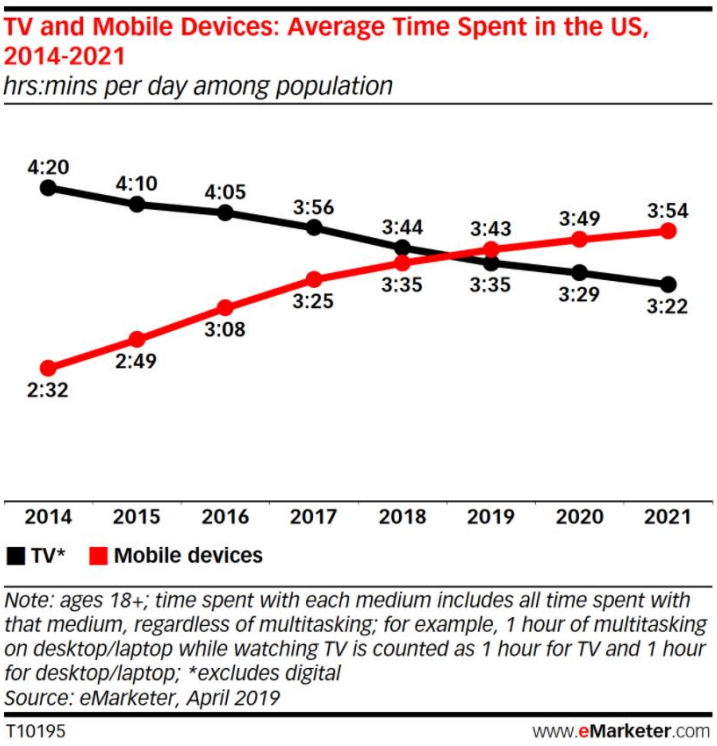
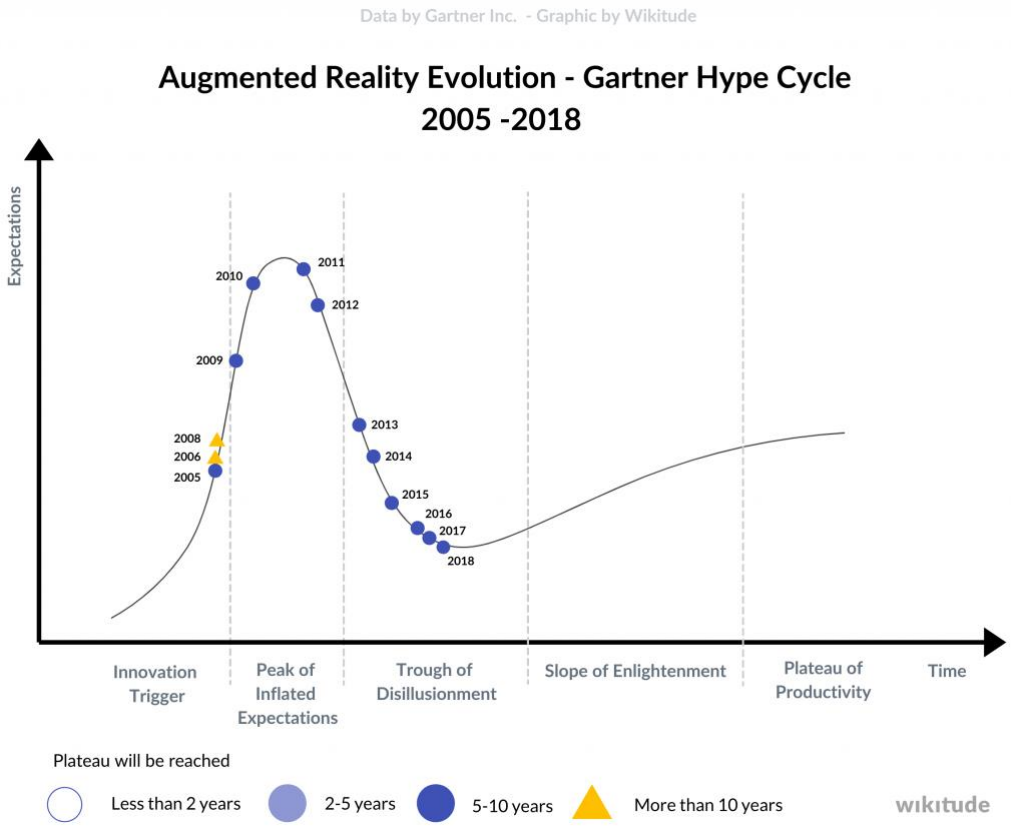
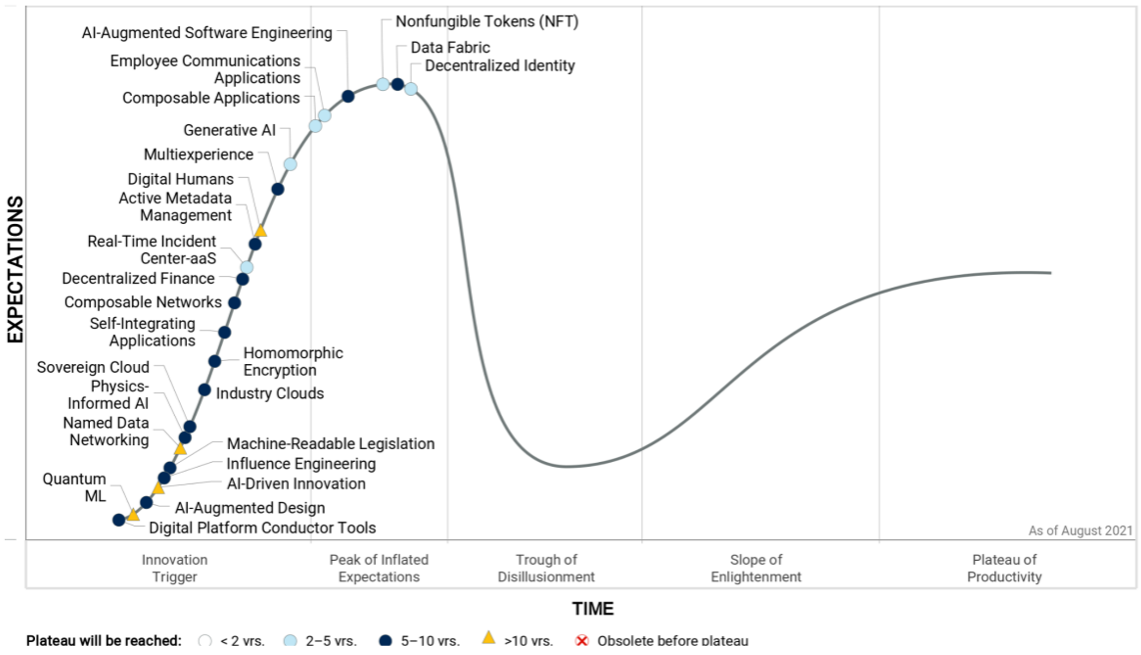
Appendix



Appendix 1: Average time spent in TV and Mobile devices in the US, 2014-2021 (Zalani, 2021)



Appendix 2: Augmented reality evolution in the Gartner Hype Cycle from 2005 until 2020 (Herdina, 2020)

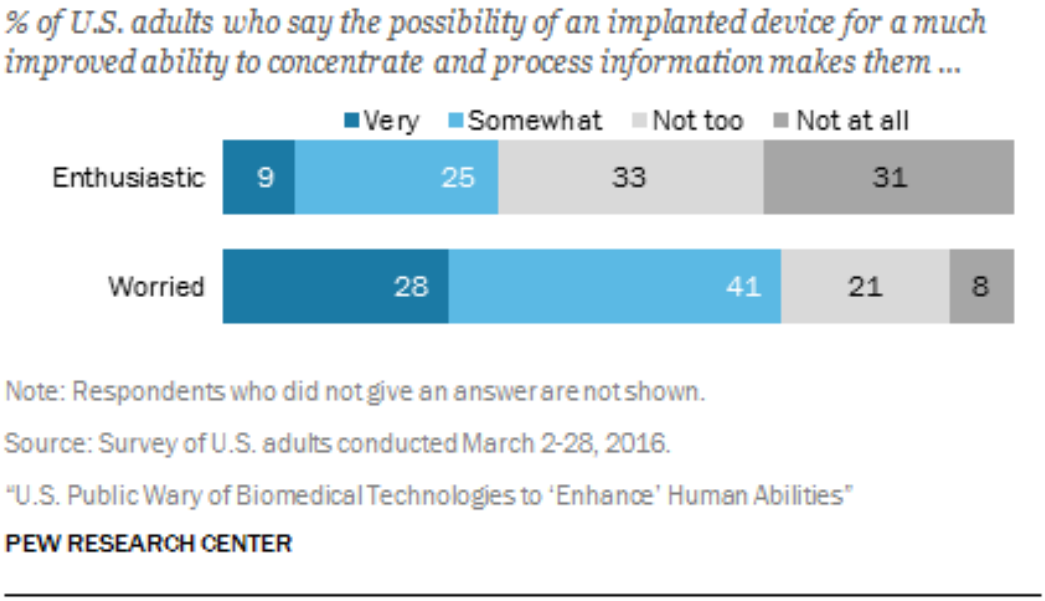


Source: Gartner (August 2021)

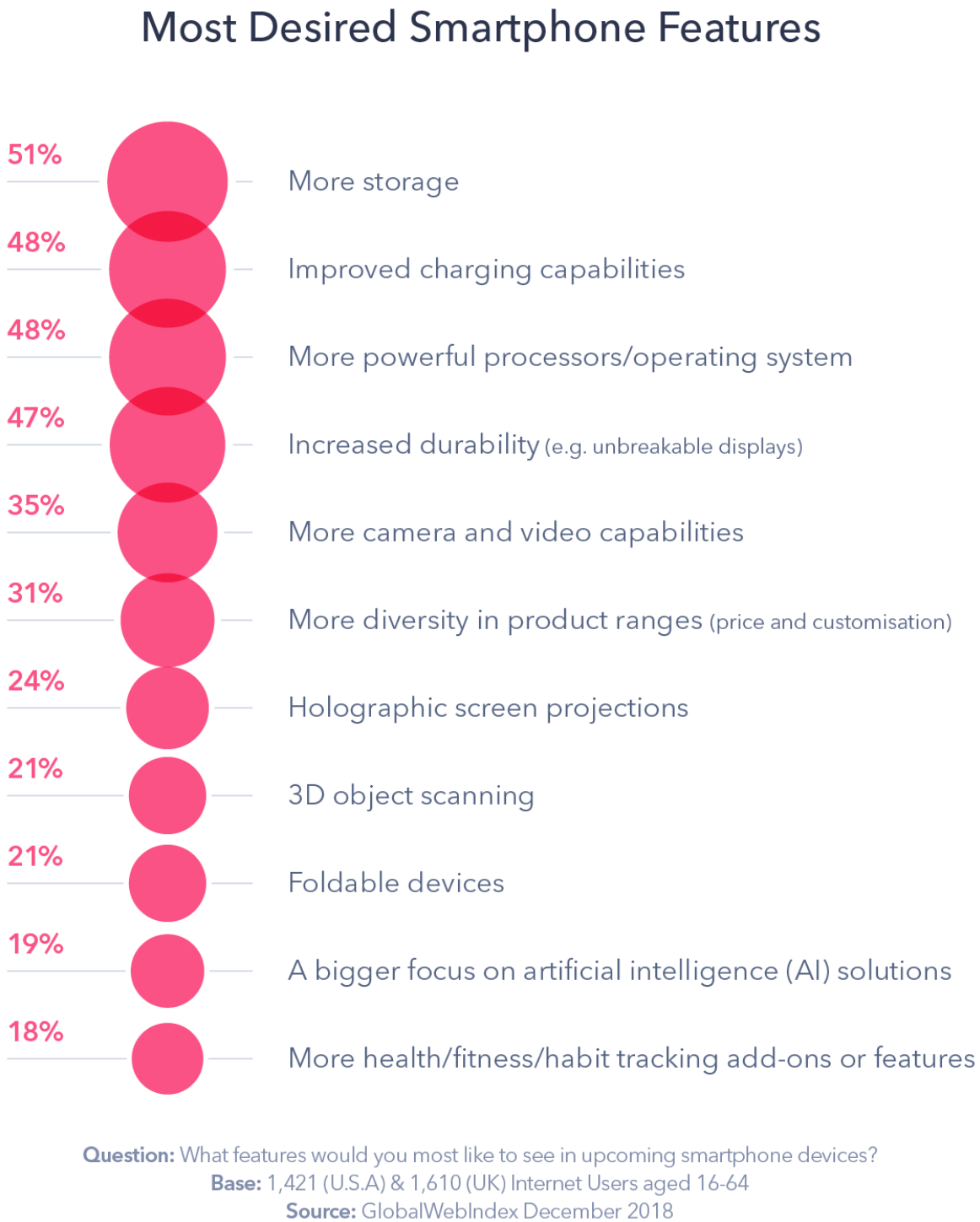
Appendix 3: Hype Cycle for Emerging Technologies (Gartner, 2021)

Appendix 4: Xiaomi's Technology Concept of Smart Glasses (2021)

Appendix 5: NOS Christmas Campaign regarding 5G and VR (NOS, 2021)



Appendix 6: Americans are more likely to be worried than enthusiastic about implanted computer chips (Funk et al, 2016)



Appendix 7: List of features that consumers are interested in (Buckle, 2019)

Research Questions

- How will AR Smart Glasses impact the Smartphone industry?
- What will be the future result of such impact on the Smartphone industry as we know it?

Ice-breaker Question

- Could you tell me a bit more about what you do?

Transition Questions

- Considering what you know about the smartphone industry, what would you say that are its **biggest weaknesses**?

Key Questions

- What are, in your opinion, AR's **biggest strengths and weaknesses**?
- What are the **main obstacles** for successful implementation of AR Smart Glasses?
- And what are the **main enablers** for AR Smart Glasses to reach the mass market?
- H**ow many years** would be required until AR Smart Glasses could reach the mass market?
- How would AR Smart Glasses compare to smartphones?
- How will consumers' **smartphone usage** change while adopting AR Smart Glasses?
- How will AR Smart Glasses impact the **smartphone's design**?
- How **likely** is the smartphone to be completely replaced in the future? Could AR Smart Glasses become a **substitute product** to the smartphone?
- Which **companies** could have a better **performance** in the AR Smart Glasses market? Why?
- Would you say that there is any other **innovative product** that may have a bigger impact on the smartphone industry?

Final Question

- Finally, would you like to add anything else to the topics that we've been discussing?

Appendix 8: Interview Script (Own Development)

Scenario Nº1:	$70\% \times 21.43\% + 30\% \times 3.84\% = 16.15\%$
Scenario Nº2:	$70\% \times 78.57\% + 30\% \times 29.79\% = 63.94\%$
Scenario Nº3:	$70\% \times 0\% + 30\% \times 66.37\% = 19.18\%$

Appendix 9: Scenario Probabilities

Expert Nº1	
Smartphone industry **biggest weaknesses**	Must be hand-held; Screen size limit to maintain portability
AR's **biggest strengths and weaknesses**	**Strengths**: Transformative power of how reality is perceived; Practical user experiences for tourism, entertainment, learning, social. **Weaknesses**: Strengths are also a challenge, as different perceptions of reality can lead to negative outcomes, giving more meaning to the "fake news" phenomenon and different perceptions of reality and relative "truths".
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Less than ideal connection speeds; Bulky and strange form factor; Access to AR content is not seamless. **Enablers**: Ability to combine design and processing capabilities in one device; Having a lot of practical, relevant and entertaining use cases (health, education, corporations); Telecom companies' interest in promoting valuable use cases for their 5G capabilities, such as AR; New push from companies such as Meta in the Metaverse, which will invest billions in AR/VR technology; Social media use of filters, that show that consumers are available and interested in using AR.
How **many years** until mass market	In tech, it's difficult to tell past 5 years, but it should happen in this decade.
Impact on **smartphone usage**	Smartphone usage has adapted to a lot of changes in the last decade, so it will continue to do so. With a better voice assistant interface, smartphone use will decrease (Google and Apple have a clear intention of improving their voice assistants with this purpose).
Impact in **smartphone design**	No relevant change.
Likelihood of **smartphone substitution**	In B2B: AR Smart Glasses already replace other devices, as there is no need for complex communication and user identity does not matter as much, it's just a tool. In B2C: AR Smart Glasses will be complementary, at least at first, to smartphones (smartphone producers won't give away such an important element of their business that soon). But in the future, in high-end categories, there will appear standalone AR Smart Glasses options.
Companies with **best performance**	Tech companies with considerable funding, namely Big Tech and smartphone producers. However, producers of "regular" glasses will also want to be involved and play a big part in this industry (AR tech can improve users' sight and they wouldn't be required to constantly change lenses).
Other innovative products	Innovation will come more from new and improved ways of integration between different devices, which will make the smartphone an even more important control center.

Appendix 10: Expert Nº1 Interview (Own Development)

Expert Nº2	
Smartphone industry **biggest weaknesses**	Privacy concerns, as user data can be shared without his/her consent; Limited battery capacity
AR's **biggest strengths and weaknesses**	**Strengths**: Professional aid to teams through quicker and in real-time information access, which allows the worker to be more effective in his role; Very valuable in marketing, as it allows for more customizable and immersive experiences. **Weaknesses**: Users' lack of experience, and therefore the challenge of teaching them AR's potential; AR requires a lot of computing power, so it drains the smartphone's battery quicker, making it less enjoyable and practical to use.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: High price; Education of the consumer; The lack of interest of a good number of consumers in adopting new technologies; Consumers and people in general are not prepared for such level of constant connection and information, so a transition period would be required. **Enablers**: Price reduction; Meeting consumers "in the middle" through a trial period: AR Smart Glasses could be better received by consumers if they get the chance to try it without needing to invest in it. AR Smart Glasses would be available in companies, museums, supermarkets and other places so that consumers could try them in a controlled environment (as a way to assure that a better experience is given).
How **many years** until mass market	New technologies have advanced and been adopted at a very high speed, so AR Smart Glasses should reach a wider user base in around 2 years.
Impact on **smartphone usage**	Most of the features in smartphones could migrate to AR Smart Glasses, such as taking phone calls or using apps.
Impact in **smartphone design**	It might even disappear.
Likelihood of **smartphone substitution**	Highly likely, not in 2 years, but somewhere in the future, and AR Smart Glasses could become the replacement.
Other innovative products	Brain chips, but those would have a much slower adoption due to a lot of resistance from consumers.

Appendix 11: Expert Nº2 Interview (Own Development)

Expert Nº3	
Smartphone industry **biggest weaknesses**	Very dynamic industry that is challenging to keep up with.
AR's **biggest strengths and weaknesses**	**Strengths**: New, fun and immersive experience for consumers to interact with. **Weaknesses**: Demanding technology that requires a lot of data usage.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Higher pricing, bulky design and need recognition from consumers. **Enablers**: Marketing campaigns to teach consumers why they need the product; Desire for hands-free experience; Desire for new and more immersive ways to consume content; Better design; Lower prices; 5G technology.
How **many years** until mass market	More or less 10 years.
AR Smart Glasses **vs.** Smartphones	**AR Smart Glasses**: New and more immersive ways to consume content in real dimensions; Hands-free experience. **Smartphones**: More versatile (can be used in any situation discreetly); better battery consumption; AR Smart Glasses could become uncomfortable for the user due to weight or heating issues.
Impact on **smartphone usage**	AR Smart Glasses will complement the smartphone similarly to the smartwatch.
Impact in **smartphone design**	None.
Likelihood of **smartphone substitution**	Not likely at all, smartphone will remain the consumers' main device at least in the next 50 years.
Other innovative products	Speakers for some use cases, but none other that could truly impact the smartphone industry.

Appendix 12: Expert Nº3 Interview (Own Development)

Expert Nº4	
Smartphone industry **biggest weaknesses**	Durability, since performance lags after some years; Less year over year innovation, so consumers take more years to buy a new smartphone.
AR's **biggest strengths and weaknesses**	**Strengths**: Big potential for many use cases; Enriches the real world unlike VR; New possibilities of entertainment and engagement. **Weaknesses**: Technically challenging, has to adapt to unlimited different scenarios and it is difficult to deliver exactly what the content creator intended; Advances in AR will depend on smartphones' capability and the availability of consumers to purchase more powerful smartphones; Lack of consumer education on the technology.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Consumers are not educated on AR and use cases for Smart Glasses; AR tech still struggling do adapt to every single different situation; The nonexistence of powerful and small processors that can handle the tech, fit in a small space, not overheat and bring discomfort to users; Strange form factor that inhibits users from using it, as they fear judgment/unwanted attention; Limited connection speeds for streaming. **Enablers**: Pandemic accelerated the need for more engaging technology; Social media got consumers used to AR through filters; 5G brings better connection and streaming opportunities that will enhance performance; Lower pricing; Need recognition from consumers through the gain of digital literacy; New technology that allows for individuals without knowledge in coding to create AR content (in a similar fashion as WordPress and Wix).
How **many years** until mass market	It will depend on the market, but in North America, Europe and Asia, AR Smart Glasses should start to become popular in the next 3 years.
AR Smart Glasses **vs.** Smartphones	Hands-free experience, we'll stop having one occupied hand; Humans will go back to looking up instead of down, which can have different effects such as in social relationships, in health and in consumer behavior. Smartphones forced us to look away from the world and to connect with others, with AR Smart Glasses we'll be able to amplify our sight through different use cases such as safety.
Impact on **smartphone usage**	Will be used less and for more specific reasons.
Impact in **smartphone design**	Low impact, its changes will be ongoing and dependent on consumers' usage in general.
Likelihood of **smartphone substitution**	Low likelihood, the devices will complement each other.
Companies with **best performance**	Big tech companies, since they acquire smaller innovative companies.
Other innovative products	Not products, but rather the importance of new and improved ways of integration between different devices.

Appendix 13: Expert Nº4 Interview (Own Development)

Expert Nº5	
AR's **biggest strengths and weaknesses**	**Strengths**: Immense potential for the evolution of Mankind, which is closer to becoming a "machine" **Weaknesses**: Technology not fully developed yet and consumers still don't know how to take advantage of it.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Form factor and consumers' perception of useful use cases. **Enablers**: Big entertainment companies will introduce Smart Glasses to consumers.
How **many years** until mass market	Between 5 to 10 years.
Impact on **smartphone usage**	Smartphone will be used less..
Impact in **smartphone design**	Smartphone will become smaller.
Likelihood of **smartphone substitution**	Highly likely. AR Smart Glasses will be complementary in the beginning, but might replace them in the future.
Companies with **best performance**	Big tech and hardware companies that have already signaled their entrance in the market, such as Lenovo, Facebook and Microsoft.
Other innovative products	Contact lenses and brain implants, that will lead us into becoming ourselves a machine.

Appendix 14: Expert Nº5 Interview (Own Development)

Expert Nº6	
Smartphone industry **biggest weaknesses**	Not attached to our heads (form factor not optimal for accessibility); Lack of sustainable practices in the industry; Screen breaks easily.
AR's **biggest strengths and weaknesses**	**Strengths**: Hardware that support AR still not evolved; Very limited field of view in headsets. **Weaknesses**: Human beings will be "augmented", next step of human evolution; access to constant information immediately.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Hardware and software limitations; big expectations from consumers that are challenging to deliver. **Enablers**: Bigger scale production will lead to lower prices; Big Tech companies will invest a lot of effort into the technology such as doing enormous marketing campaigns to persuade users to buy the headsets.
How **many years** until mass market	10 years, and people will use smartphones less and less.
AR Smart Glasses vs. Smartphone	We'll be constantly connected, which is an advantage and disadvantage; We'll feel compelled to always use AR Smart Glasses because we'll feel inferior without them as well as dependent to carry out social and professional interactions. This might lead to a big loss of balance in our lives (worse than with the smartphone) and psychology; Advantage of not requiring other physical screens for computers, tablets and TVs since it would be accessible from the AR Smart Glasses, which could have a big future impact on the environment.
Impact on **smartphone usage**	Will be used less and less until they are replaced by AR Smart Glasses.
Impact in **smartphone design**	Will be designed to complement AR Smart Glasses as a processing power device that can be connected to the headset. Display size will decrease since it is not as required.
Likelihood of **smartphone substitution**	Very likely, almost certain.
Companies with **best performance**	Apple will succeed in launching their headset; Facebook/Meta will make considerable investments in this segment; and other companies that are already in the market, such as Nreal.
Other innovative products	None come to mind.

Appendix 15: Expert Nº6 Interview (Own Development)

Expert Nº7	
Smartphone industry **biggest weaknesses**	Unnatural form factor that we have to hold; Requires the use of both hands; Limited battery capacity.
AR's **biggest strengths and weaknesses**	**Strengths**: Doesn't require specialized equipment, can be used through a smartphone. **Weaknesses**: Expensive and challenging to develop visual content up to consumers' standards; Expensive equipment.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: High price; Software is not well developed to provide quality experiences to consumers; Form-factor not ideal: uncomfortable, big and heavy, cannot be used for an extended period of time, processor gets hot. **Enablers**: Potential for many use cases and how practical they will be to use.
How **many years** until mass market	Around 5 years, depends on the launch of Apple's AR Smart Glasses.
AR Smart Glasses vs. Smartphone	AR Smart Glasses may pose a bigger privacy concern; Allow a hands-free experience; Take advantage of the consumers' wider field of view, unlike the smartphone, which is limited to the small rectangle we hold in our hands; Have a sound advantage that will allow for a much more immersive experience.
Impact on **smartphone usage**	Will be used less and in conjunction with AR Smart Glasses.
Impact in **smartphone design**	Not much of an impact, they will evolve separately, but the smartphone display might get smaller.
Likelihood of **smartphone substitution**	Unlikely. It will complementary.
Other innovative products	No product, but rather greater integration between devices, in which the smartphone will remain our main control center.

Appendix 16: Expert Nº7 Interview (Own Development)

Expert Nº8	
Smartphone industry **biggest weaknesses**	Limited form factor, not seamless for human use.
AR's **biggest strengths and weaknesses**	**Strengths**; Contextual information in real-time; Good for productivity. **Weaknesses**: Social issues regarding privacy.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Consumers are uncomfortable with cameras; Their value proposal is still not clear; Consumers are not educated on its potential; Consumers feel inhibited to use them due to fear of social exclusion. **Enablers**: Powerful marketing campaigns; Change of consumer perception that it is an evasive device; Higher and easier level of accessibility; Social media; Gaming industry; Pandemic; 5G.
How **many years** until mass market	Hard to say, but between 5-10 years.
AR Smart Glasses **vs.** Smartphones	AR Smart Glasses are not seamless to interact with, yet.
Impact on **smartphone usage**	Would drop a bit because it would be split between both devices.
Impact in **smartphone design**	Not necessarily a direct impact, but current design is not ideal, so it will evolve. It might become more focused on its processing power, and innovation regarding battery technology might have a stronger effect on its design.
Likelihood of **smartphone substitution**	Very likely in 15 to 20 years, and AR Smart Glasses will be involved in what replaces them. The smartphone can be put aside if what replaces it offers the same value proposition, which is real-time communication and access to the digital, and AR has the potential to do so.
Companies with **best performance**	Big tech companies such as Facebook, Microsoft, Google and Amazon.
Other innovative products	Possible brain chips in more than 10 years from now, and they might be integrated with other devices such as headphones and Smart Glasses.

Appendix 17: Expert Nº8 Interview (Own Development)

Expert Nº9	
Smartphone industry **biggest weaknesses**	User data handling and privacy.
AR's **biggest strengths and weaknesses**	**Strengths**: Next big technologic evolution; Merge of the real and virtual space; Greater interaction; Access to information in real-time and effortlessly. **Weaknesses**: Very demanding technology; Very dependent on other devices.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: High prices; Privacy concerns; Dependent on the smartphone or too bulky; No clear use cases for consumers. **Enablers**: Tech development in edge detection and side rendering; 5G connections; Sales and marketing applications; Business applications.
How **many years** until mass market	In 5-10 years.
AR Smart Glasses **vs.** Smartphones	In the beginning users will be frustrated with the user interface of AR Smart Glasses; AR Smart Glasses are better to consume media.
Impact on **smartphone usage**	Will be used as a complement to AR Smart Glasses and use cases will become more specific.
Impact in **smartphone design**	No relevant impact. The smartphone will remain a versatile device.
Likelihood of **smartphone substitution**	Highly likely. It has only been around for 15 years and can be replaced in a similar timespan.
Companies with **best performance**	Apple has the most potential, followed by Meta and other big tech companies.
Other innovative products	Augmented reality will be part of that innovation, but the future will be around an evolution of AR Smart Glasses, namely through smart contact lenses.

Appendix 18: Expert Nº9 Interview (Own Development)

Expert Nº10	
Smartphone industry **biggest weaknesses**	Alienates consumers from real life; Smartphone dependency; Format is not ideal, will become more digital;
AR's **biggest strengths and weaknesses**	**Strengths**: It's the future of digital content; Big potential and utility; Adds bigger context to information; New and improved way to visualize concepts in real-time that before we had to imagine (such as for interior design or architecture); Expansion of knowledge; Demonstration of concepts in an immersive, immediate and easy to understand way. **Weaknesses**: We're still in an early stage of the technology, not fully developed yet.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Consumers are not fully aware of its potential; Expensive tech; Not available for consumers in general; Privacy concerns; Consumers' fear of such disruption in reality. **Enablers**: Campaigns to educate consumers; AR social media filters; Entertaining and educational use cases; Price reduction.
How **many years** until mass market	In 5 years, maximum 10.
AR Smart Glasses **vs.** Smartphones	When AR Smart Glasses navigation and use becomes more practical and seamless, consumers will gravitate more towards it. Until then, they will prefer the smartphone.
Impact on **smartphone usage**	Consumers will eventually stop using them and prefer AR Smart Glasses.
Impact in **smartphone design**	It will impact the design; the screen might get smaller and the smartphone might evolve to complement the AR Smart Glasses in some way.
Likelihood of **smartphone substitution**	Highly likely, in 10 to 15 years. The smartphone has not been around for that long.
Companies with **best performance**	Apple, Google, Meta/Facebook, Amazon, Samsung, Xiaomi, Huawei, and HP and Asus for more corporate use.
Other innovative products	AR Smart Glasses are a transition product until contact lenses are a viable option. Later on, brain implants.

Appendix 19: Expert Nº10 Interview (Own Development)

Expert Nº11	
Smartphone industry **biggest weaknesses**	Not ideal for contextual information provided in real-time; It's not natural to hold them and point them to what we are seeing; Cannot handle AR graphics ideally because they were not designed specifically for it.
AR's **biggest strengths and weaknesses**	**Strengths**: Better communication and in a more immersive way; It can help consumers to be more present, since they don't need to look down on their smartphones; Allows for greater appreciation of our surroundings; Greater information in real-time and tailored to our surroundings. **Weaknesses**: Tech is still not fully developed; Challenging to apply to different situations.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Privacy concerns (constant presence of cameras); Pricing; Limited functionalities; Consumers are not aware of AR's potential; lack of components; interaction with content is still limited and inconvenient; Limited field view. **Enablers**: Transition period where consumers can experiment with AR; clear offer of value.
How **many years** until mass market	Maybe in 10 years, but it's an optimistic prediction.
AR Smart Glasses **vs.** Smartphones	Consumers would likely always prefer to use social media in a smartphone; AR Smart Glasses could be preferable to listen to music; Smartphones are now much more comfortable to use and navigate; AR Smart Glasses will be preferable for gaming.
Impact on **smartphone usage**	Smartphone will be a control center, but at some point will cease being used in favor of AR.
Impact in **smartphone design**	As a control center, its design will likely change.
Likelihood of **smartphone substitution**	Likely, in 15 years.
Companies with **best performance**	Microsoft, Meta and Apple.
Other innovative products	Something related to AR; Development of an advanced voice assistant.

Appendix 20: Expert Nº11 Interview (Own Development)

Expert Nº12	
Smartphone industry **biggest weaknesses**	Nothing to point out.
AR's **biggest strengths and weaknesses**	**Strengths**: A lot of potential. **Weaknesses**: Technology and devices still not capable of delivering an optimal experience; Too high expectations.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Pricing; Inability to be produced and sold in mass, Bulky for factor. **Enablers**: Lower pricing; Lighter form factor; Gaming; Mobile AR use cases; First iterations with limited AR technology might help pave the way; Better computing power; Opportunities for consumer to experience AR Smart Glasses in supermarkets, for example.
How **many years** until mass market	In 2 years, there will be conditions for widespread adoption.
AR Smart Glasses **vs.** Smartphones	AR Smart Glasses will eventually replace smartphones; AR Smart Glasses interaction/navigation will be challenging in the beginning; Consumers might get fatigued more easily by AR Smart Glasses.
Impact on **smartphone usage**	Will be used less and less, eventually completely replaced.
Impact in **smartphone design**	Will eventually become useless since AR Smart Glasses will display variable sized screens.
Likelihood of **smartphone substitution**	Highly likely, in 5 years. AR Smart Glasses would also replace all other physical screens.
Companies with **best performance**	Different companies would take advantage of these devices: entertainment, marketing and science.
Other innovative products	Nothing comes to mind.

Appendix 21: Expert Nº12 Interview (Own Development)

Expert Nº13	
Smartphone industry **biggest weaknesses**	Alienates consumers from their surroundings and social interactions; Not ideal to read documents or books since it's not as memorable as in its physical format; Not ideal for complex writing; Not ideal for precise toggles and tasks.
AR's **biggest strengths and weaknesses**	**Strengths**: Overlap of digital content over the real world; Potential for the creation of immersive scenarios, that will allow for more emotional and memorable experiences. The perception of space and closeness to the subject allows for emotional experiences. **Weaknesses**: Inconvenient accessibility, users need to install apps, use smartphone storage and internet to access AR content; Lack of relevant and interesting content.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Pricing; Consumer willingness to adopt the technology; Form-factor; Privacy concerns. **Enablers**: Power and influence of big tech companies over consumers; Effective marketing campaigns; Appealing form factor that doesn't draw attention.
How **many years** until mass market	Hard to say, but maybe in 5-10 years.
AR Smart Glasses **vs.** Smartphones	Once consumers get used to navigating AR Smart Glasses, and realize some tasks are easier and quicker to do in them, they will quickly start to prefer AR Smart Glasses; Consumers will prefer to use voice assistants rather than typing, since it's much more natural and intuitive to the human being to speak to communicate.
Impact on **smartphone usage**	It will decrease since consumers will start to prefer to use AR Smart Glasses; Some consumers will start to use AR Smart Glasses and other will feel peer pressured to to the same.
Impact in **smartphone design**	There will be an impact for sure, but I can't say what precisely.
Likelihood of **smartphone substitution**	Very likely, but hard to say when. AR Smart Glasses will replace them, but smartphones will still exist and some people will continue to use them exclusively (similarly to how some people still use phones); Substitution will depend according to country and culture.
Companies with **best performance**	Apple, Snapchat, Facebook/Meta, Magic Leap, Microsoft, Samsung.
Other innovative products	Neural devices such as headbands and implants that monitor focus and emotions, and can be interacted with through mind control (but will experience a slower adoption).

Appendix 22: Expert Nº13 Interview (Own Development)

Expert Nº14	
Smartphone industry **biggest weaknesses**	High demand and different industry players lead to a lack of standardization of software and app development.
AR's **biggest strengths and weaknesses**	**Strengths**: Adds layers of knowledge over the ordinary reality that we can currently perceive through our senses; Offers new opportunities for education and productivity; It functions as a kind of personal assistant. **Weaknesses**: Technology's progress is still lacking; AR is very challenging despite many years of study and testing.
AR Smart Glasses **biggest obstacles and enablers**	**Obstacles**: Limited hardware (bulky form factor, inefficient batteries and processor heating issues); Users might fear judgement when using such devices that attract unwanted attention; Lack of specific use cases that justify the investment; Lack of AR iterations that improve the users' experience. **Enablers**: Lower pricing; form factor more suitable for everyday use, and that blends in with other "regular" glasses; Industrial usage; Big tech companies' eventual launch of their own AR Smart Glasses.
How **many years** until mass market	Interesting proposals may appear in 5 years, and in 10 years they might become part of the mass market.
AR Smart Glasses **vs.** Smartphones	Smartphones are not practical to carry around; Sensory experiences will be preferably experienced in AR Smart Glasses.
Impact on **smartphone usage**	Smartphones will continue to be preferred for more tactile experiences such as typing and some mobile games, but users will tend to gravitate to AR Smart Glasses for many other tasks such as GPS directions.
Impact in **smartphone design**	It will become a processing unit and will continuously shrink, to the point of maybe being carried in wallets.
Likelihood of **smartphone substitution**	Highly likely that the smartphone is replaced, but not necessarily directly by AR Smart Glasses. With will rather transform into something more practical to carry and use.
Companies with **best performance**	Apple, Microsoft and Google, as well as other smaller companies such as start-ups, but those would be bought by the bigger players.
Other innovative products	Neurological devices such as headbands or implants, namely Neuralink's.

Appendix 23: Expert Nº14 Interview (Own Development)