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TRABAJO DE FIN DE GRADO

The Metaverse and Artificial Intelligence
applied to the buying and selling process

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INDEX OF CONTENTS

1. RESUMEN / ABSTRACT

La aparición de nuevas tecnologías como la inteligencia artificial (IA), la realidad virtual (RV) o el metaverso han provocado un cambio en cómo empresas y consumidores afrontan la experiencia de compra. La IA potencia las capacidades de la RV y, a su vez, la RV ofrece entornos inmersivos donde poder desarrollar las aplicaciones de la IA. En este contexto, cabe destacar que entre los objetivos de mi trabajo encontramos la definición e influencia que estas nuevas tecnologías tienen en el proceso de compraventa. Además, se verá de forma ejemplificada aportando casos reales de empresas que están incorporando estas tecnologías en sus actividades diarias. De la misma forma, se realizará un estudio empírico basado en un cuasiexperimento con gafas de realidad virtual y un posterior cuestionario donde se analizará el comportamiento de los individuos dentro del metaverso y la sensación de inmersión que se genera dentro de éste.

Palabras clave: Inteligencia Artificial; Realidad Virtual; Metaverso; Entorno virtual; Marketing.

The emergence of new technologies such as artificial intelligence (AI), virtual reality (VR) or the metaverse have caused a change in how companies and consumers approach the shopping experience. AI enhances the capabilities of VR and, at the same time, VR offers immersive environments in which to develop AI applications. In this context, it is worth noting that among the objectives of my work we find the definition and influence that these new technologies have on the buying and selling process. In addition, it will be exemplified by providing real cases of companies that are already incorporating these technologies in their daily activities. In the same way, an empirical study will be carried out based on a quasi-experiment with virtual reality glasses and a subsequent questionnaire where the behaviour of individuals within the metaverse and the feeling of immersion that is generated within it will be analysed.

Keywords: Artificial Intelligence; Virtual Reality; Metaverse; Virtual environment; Marketing.

2. INTRODUCTION

Over the past decade, we have been able to observe a rapid evolution at the intersection between technology, artificial intelligence, and virtual worlds. This phenomenon is materialized in the concept of metaverse, an immersive digital space where human interactions and virtual environments blend in unprecedented ways. Simultaneously, artificial intelligence (AI) has been fundamental in carrying this transformation, enabling the development of interactive and personalized environments within the metaverse. “Artificial intelligence is rapidly transforming every aspect of society, with growing public and scientific interest in the principles, policies, incentives, and ethical frameworks that can help society enjoy the benefits and opportunities created by AI while minimizing the risks associated with its adoption and use” (Fosso et al., 2021).

The general objective of this work is to deepen the understanding of the concepts of metaverse and artificial intelligence, along with their application in companies, specifically in the buying and selling process, and the perspective adopted by consumers.

The first specific objective covers the definition and understanding of concepts such as virtual reality, metaverse or artificial intelligence, with cases, studies, and statements of authors and experts in said field. Furthermore, the influence and impact that these technologies have within the buying and selling process will be explained, indicating the specific phases and how they are influenced, making a distinction between virtual reality and artificial intelligence.

The second objective is to capture how the emergence of these new technologies has influenced the current society, highlighting their impact after the global Covid-19 pandemic, which marked a turning point on the development of them. In order to make it closer to reality, real cases of companies that have already implemented these technologies in some of their daily activities will be explained.

The third objective is to deepen the principal variables or aspects valued by consumers when using these technologies within the buying and selling process. To do this, an empirical study will be carried out on a small sample of the population through a quasi-experiment with virtual reality glasses and a subsequent questionnaire. The purpose is to know how people perform and manage themselves within the metaverse.

The fourth and final objective consists of being able to compare and contrast the results obtained in the empirical study with the theories presented in the conceptual framework, and, with this, draw recommendations and conclusions after achieving the aforementioned objectives.

3. CONCEPTUAL FRAMEWORK

3.1. THE APPLICATION OF VR AND AI IN THE BUYING AND SELLING PROCESS

New technologies have been modifying the communications as we knew them decades ago. By introducing new technological devices and tools, we can gain a more immersive experience as well as a completely different perception of the world. In this context, virtual reality was created.

3.1.1. Virtual reality

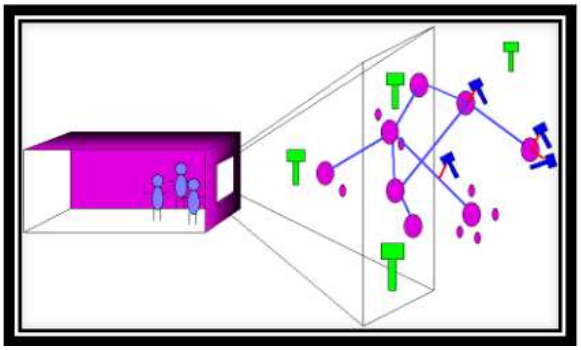
Virtual reality is an immersive technology that enables users to access a virtual environment or metaverse for an interactive, multisensory, real-time experience (Mishra et al., 2021). This virtual reality experiences aim to reinvent the consumption experience (Leveau & Camus, 2023) by creating a memorable experience (Hosany et al., 2022) as well as attachment (Pala et al., 2022) with the introduction of external devices that significantly modify the person´s field of vision (Cancino, 2019).

Another immersive technology that is transforming the way we interact with the digital and physical world is augmented reality. It "consists of combining the real world with the virtual world through a computer process, enriching the visual experience and improving the quality of communication" (Innovae, 2016). In other words, it is a new window through which the person can see the world enriched. The main difference between virtual and augmented reality is that virtual reality creates a completely new environment generated virtually and artificially. However, augmented reality maintains a real environment, and through the overlay of virtual elements, enriches the perception of the real environment with devices that are not specifically designed for it (smartphones, digital screens…).

Once virtual and augmented reality have been defined, it is convenient to define mixed reality. To do this, and according to Milgram & Kishino (1994), we will establish some limits or extremes. One extreme will be real reality, which is based on real objects that can be observed both with the sight and through screens. The other extreme will be virtual reality, which is based on virtual objects created with technological devices. In the middle of both extremes or concepts, there is mixed reality, which involves bringing together different spaces both virtual and physical by creating a transparent boundary between them (Benford et al, 1996).

To explain this better, I will use the example of an application called *The Internet Foyer*. Here, from a room (representing the real world) the user can see the virtual world, artificially created.

Figure 3.1. The Functionality of the Internet Foyer



Source: The Internet Foyer (1999)

Just as the main objective of virtual reality is to create immersive digital environments where users can interact and collaborate, the metaverse has a similar objective. The metaverse is a computer-generated world with a consistent value system and an independent economic system linked to the physical world (Wang et al., 2022) where the user will be the main character of the information because he/she will explore it in first person (Iab Spain, 2024). Giving a more complex and complete definition, metaverse is "a massive, interoperable network of 3D virtual worlds rendered in real time that can be experienced synchronously and persistently by an effectively unlimited number of users with a sense of individual presence, and with continuity of data, such as identity, history, rights, objects, communications and payments" (Ball, 2022). The term is a composed word formed of Meta (from the Greek, "beyond", "among" …) and universe.

Metaverses thus represent a strong new opportunity to promote and sell products and services (Leveau & Camus, 2023). A big potential that the metaverse represents is that each time more people, specifically, young people from 21 to 35 years, are interested on it. Additionally, the technological opportunities are much superior to those of a few decades ago, that along with the higher interaction between users and the millionaire investments for the research and improvements in this field, is making that many brands are focusing on it.

Moreover, many users are moving from having a passive attitude as spectators to having a more active attitude as consumers. Indeed, according to a survey, three out of five children in the USA are now buying *Minecraft* cards with their pocket money instead of saving it or spending it in other staff.

Linked with the term metaverse, the term *phygital* appears. According to Hollebeek et al. (2019) *phygital* marketing involves crafting a consumer journey that integrates physical and digital experiences in a seamless way, creating experiences that are only possible due to the rise of emerging digital technologies.

Its principal objective is to offer a more complete and attractive experience to consumers and users along with the introduction of new technologies to improve and enrich the physical experience.

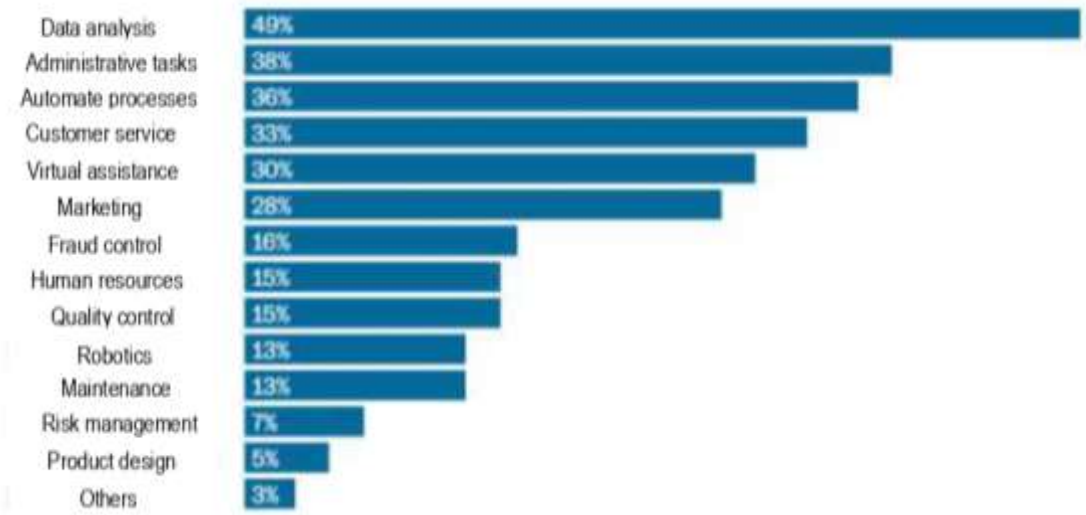
3.1.2. Artificial intelligence

The metaverse is closely linked to artificial intelligence in its ability to enhance and enrich digital experiences. Artificial intelligence is a very wide concept that has been defined by many experts. We can define it as "the ability of machines to use algorithms, learn from the data and use what is learned in decision making just like a human being would do" (Rouhiainen, 2018, p.7). In this way, artificial intelligence "will change the way of doing business by providing competitive advantages to companies seeking to understand and apply these tools quickly and efficiently" (Rouhiainen, 2018, p.18).

According to a study carried out by Randstand Research (2024), the 46% of the Spanish companies have been integrating artificial intelligence on a daily basis to perform both easy and complex tasks and functions. The emergence of artificial intelligence is still small, but it will be transversal, which means that it will reach all sectors of the economy.

Figure 3.2. Functions for which AI is used

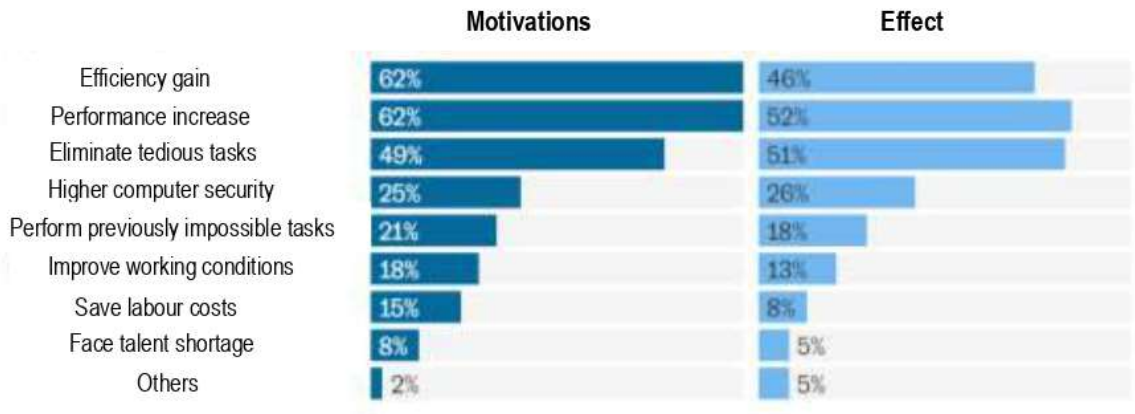
Among the companies that use it in %



Source: translated and adapted from: Randstad Research. El País (2024)

Figure 3.3. Motivations and effects of using AI

Among the companies surveyed that use it in %



Source: translated and adapted from: Randstad Research. El País (2024)

Furthermore, and taking into account that artificial intelligence and everything it represents is a new concept for society, the approval of a law that delimits it has been necessary.

On March 13, 2024, the European Parliament approved the first existing Artificial Intelligence law, called Artificial Intelligence Regulation. This law has two principal objectives, the first on is the protection of citizens, checking and ensuring that all artificial intelligence systems used and introduced into the European market are safe. The second objective is to encourage the investment and innovation in the field of artificial intelligence in Europe.

This proposal was approved in June 2023, two years after the initiative to develop this law by the European Commission began. Despite already being approved, it will not be until 2025 when it will come into force. As it is a Regulation of the European Union, it has direct and mandatory application in all its member states, and therefore, it will affect all applications, platforms, and member companies of the European Union.

Inside the first objective of the law, and linking it with the protection of consumers, consumer organizations, based on a report presented by Forbrukerrådet, the Norwegian association, called “Ghost in the machine: Addressing the consumer harms of generative AI”, have called for tougher laws for the protection and security of consumers from structural problems such as the manipulation of information or data or the risks that may have for the user, especially in the field of mental health. Incorrect or harmful information that artificial intelligence may provide can have serious consequences for consumers, who should not be used as a basis for experimenting with new applications or products.

Another key aspect claimed by the consumer organizations, as well as by experts in digital rights and privacy advocates, is the prohibition of facial recognition in public spaces. “Real-time” biometric identification will be sanctioned, with exceptional cases, for specific places and periods of time, such as the identification of missing persons or terrorists, but always with previous judicial or administrative authorization or consent.

The clarification of emotion recognition systems is another aspect that this law is asked to contemplate, since at the moment private companies are allowed to do so. Many companies, through video games or the metaverse, obtain this kind of information, which can be used against the user or consumer, thus, violating their rights and privacy, as well as the limitation of their ability to make autonomous decisions.

It is important to highlight that this is the first legislative proposal on Artificial Intelligence in the world, so it could be established as a global reference to regulate AI in other jurisdictions. This law marks a huge milestone in the regulation of artificial intelligence, seeking to balance innovation with the safety and rights of citizens.

3.2. HOW AND WHICH PHASES OF THE PURCHASING PROCESS ARE INFLUENCED BY VR AND AI

During the history, humanity has been adapting to the changes that have been emerging. In this context, and with the continuous change of the purchasing habits, e-commerce was born. This practice consists of the use of Internet and Web to transact business, specifically, the purchase, sale, order, and payment of products through the Internet, without physically seeing them. It allows users to express themselves and network with others (Laudon & Traver, 2010).

Although it was born in 1920, it was not until the last decades that it gained the importance that it has today, and the global pandemic was a key factor for the development of it to what we know it today.

Covid -19 marked a turning point and challenge for humanity, and in this way, we had to look for new alternatives to original trade. This online buying and selling method allow managers to enter in the new era of commerce so that they can cross borders, improving and streamlining their processes and grow in the market (Rodríguez et al., 2020).

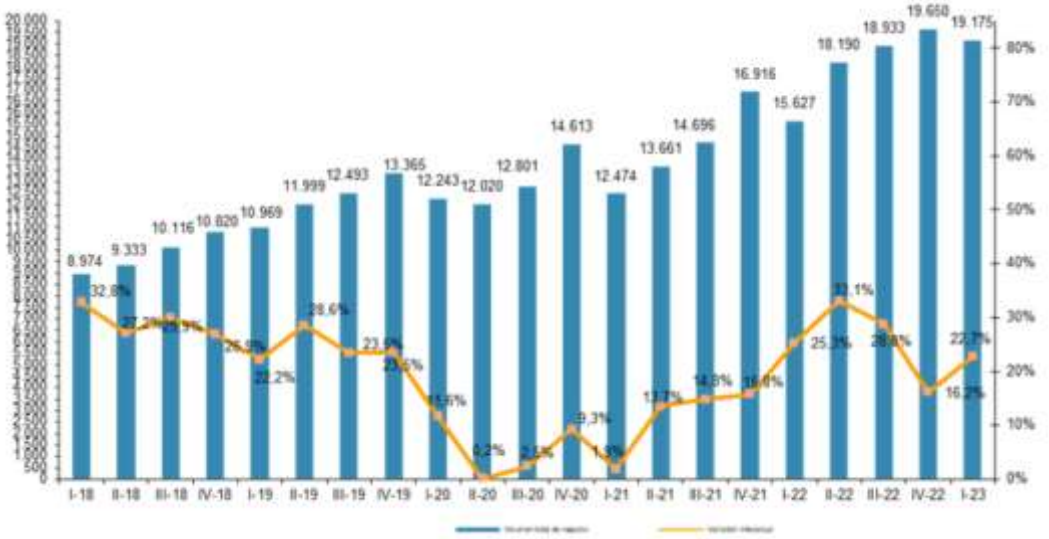
To simplify it, although companies and individuals had already begun to integrate new technologies in their lives and jobs, Covid was the trigger for the complete digitalization, connectivity, and immersion. This entire process has evolved to nowadays, where not only new technologies have been included, but many companies have entered the metaverse and have opted to introduce artificial intelligence as another tool.

"For both, retailers and consumers, the benefits of online shopping provisions, due to the Covid-19 pandemic, are, arguably, more prominent than they have been ever before, making online trading an essential revenue stream for many retailers." (Schnak, A. et al, 2021).

Indeed, "e-commerce worldwide is plagued with overwhelming advantages thanks to computer systems that host artificial intelligence instead of traditional commerce" (Buitrago-Rodríguez, 2023, p.5).

In fact, and according to the National Markets and Competition Commission (CNMC, 2023) "Electronic commerce in Spain exceeded 19 billion euros in the first quarter of 2023, 22.7% more than the previous year".

Figure 3.4. Quarterly evolution of the business volume of electronic commerce and interannual variation (millions of euros and percentage)



Source: CNMC (2023)

This increase has to be with the huge development of artificial intelligence and virtual reality that help to make the purchasing process a more complete and personalized experience. According to a study made by Pierre-Henry Leveau and Sandra Camus (2022) "recent research has emphasized the positive effects of virtual reality on behavioural intentions such as purchase decisions and willingness to pay".

Phillip Kotler (2000) is an American economist, specialised in marketing, who is considered one of the fathers of current marketing. He described the five different stages of the purchasing process. These were accepted globally, and it still serves as the central pillar of the popular consumer behaviour model. It includes the following:

1. Need recognition.
2. Information and Alternatives Search.

3. Evaluation of Alternatives.
4. Purchase Decision.
5. Post Purchase Behaviour.

3.2.1. Virtual reality

Virtual reality is a widely used tool in product design. With the emergence and evolution of new technologies, this phase has become more comfortable and cheaper. This process is crucial to determine all the other stages of the purchasing process and, thus, being able to carry it out with efficiency and effectiveness. On many occasions, this phase can be interrupted or limited by the costs or time involved in it, being virtual reality a great solution to these problems, as it allows to prove the design and the necessary changes or adjustments before the first prototype is produced. This will be useful when matching the quality of the product and the rendered standards.

Another advantage that virtual reality offers in this field is being able to view it holistically as it interacts with the "real world", allowing to evaluate conceptual alternatives for optimizing the functioning of the product in that context.

Moreover, virtual reality, as well as the metaverse, are involved in the communication with the consumer, specifically that carried out prior to the launch of a product or in the need recognition. When a user enters the metaverse and interacts both with other users and with brand´s advertisements or banners, they are showing their preferences, which might be used by the brands and designers to improve the satisfaction in the consumer´s needs. "Therefore, to establish effective communication between customers and the design team, it requires a mutual understanding of the future product; that is, that the customers and the design team have a shared conception of the product" (Söderman, M. 2007).

This communication can be affected by the differences in the background or the goals, but if the environment in which this communication occurs is one in which the consumer feels comfortable, such as the metaverse, these problems can be solved.

The second phase of the purchasing process is also influenced by virtual reality. This tool helps in the enhancement of the information research, since it allows the consumer to receive the product information in a more interactive and concrete manner than without this new technology. This will generate curiosity in the user to discover and want to try it. Furthermore, it created greater cognitive elaboration of the product information in comparison to a statical way of presenting the same kind of information.

3.2.2. Artificial Intelligence

According to a studio made by Omnicom Media Group (2021), called The Retail Revolution, the phase of the purchasing process in which artificial intelligence has more impact and importance is the Information and Alternatives Search one. This phase is characterized by the search for products or services by the consumers as a consequence of the acknowledgement of a necessity they may have and thus the need of satisfaction of it.

The head of Strategy in OMD Spain, talks about the two functions that artificial intelligence has on the research phase of the purchasing process.

On one hand, the enabler function of looking for information in a completely different way as a well as the personalization of the shopping experience. These aspects, that we consider daily nowadays, years ago were unthinkable or unbelievable as these technological innovations did not exist.

On the other hand, the simplification of all the search and comparative processes that this research phase involves. Related to this function, chatbots have a key performance. A chatbot is "a computer program capable of interacting with people using natural language, stimulating a coherent human conversation" (Brustenga et al., 2018). Applied to this stage of the purchasing process, chatbots are designed to help consumers to reduce the time spent on the research of alternatives and guide them towards the specific characteristics asked as they have access to larger databases.

3.3. KEY ASPECTS FOR THE CONSUMER IN THE SHOPPING WITH NEW TECHNOLOGIES

With the emergence of new digital technologies and the significant increase of online purchases and sales, new variables or aspects have become fundamental for both consumers and sellers, as these will highly influence and determine their shopping experience. In this context, the aspects that mostly influence the customer´s experience will be explored, taking into account that the sellers will be the ones who need to know what the consumers value in these new trading forms, how will they use them, and how all this will lead to the creation and improvement of shopping experiences that are attractive, safe, and satisfying for users. In the same way, consumers will also pay attention to these variables to establish what they demand.

These four key aspects or variables, which include embodiment, avatars, immersion, and social interaction, will be the ones employed in the empirical part of the project, where virtual reality glasses will be used, and the user experience and behaviour will be measured according to scales based on these key variables.

3.3.1. Embodiment

It translates a feeling of fusion between the human body and the virtual body (Tussyadiah et al., 2017). What we know about the world is embodied, it is constructed from patterns of energy detected by the body. When we walk or reach for an object in the virtual or physical world, we guide the senses in this exploration of the space in the same way that a blind man stretches out a white cane to explore the space while in motion (Biocca, 1997). Matching the physical contacts of the real body with the contacts of the virtual body provides the illusion of self-contact (Bovet et al., 2018). It is translated in having the illusion to actually be inside that virtual place and that what is happening inside of it can be felt in the reality.

Botvinick & Cohen (1998) developed an experiment called the Rubber Hand Illusion (RHI). It consisted of leaving your left hand on a table and covering it, so that you could not see it. That hand was "replaced" by a rubber one that is the hand the participant is seeing during the experiment.

With a brush, both hands (the real and the rubber one) were touched at the same time, until reaching a point where the participant began to feel that brush in the rubber hand. Furthermore, the rubber hand is hit by a hammer at the end of the experiment, and the fear and pain that the participants feel, is real. This illusion clearly demonstrates the relationship between what we see and what we feel.

Figure 3.5. The Rubber Hand Illusion

Source: X.com (2022)

3.3.2. Avatars

An avatar is a virtual entity (Abade, 2017) that is associated with a particular user for its identification in a video game, internet forum, etc. In other words, an avatar is the digital incarnation of an individual in a virtual world. Through databases, they are responsible for providing the most appropriate answers

according to the personality and preferences of everyone. In this way, the virtual experience will be much more attractive, effective, and realistic.

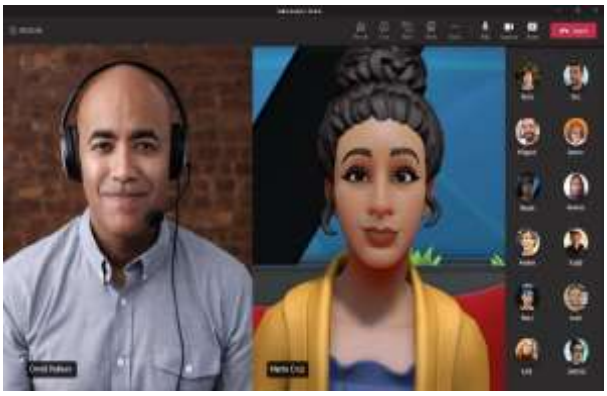
The use of avatars in virtual reality artistic experiences has a great capacity to expand the bodily and sensory experience of users. The avatars here allow the user to explore the virtual environment from the interaction. In this way, the connections of the immersed users with the avatars provoke reactions in the real bodies of those who experience it (Gárgoles, 2023). The reason for using them is because it allows the user to have access to information and to a virtual world through a unique experience, that can be modify or not depending to what extent the avatar fits the appearance of the real body or personality of the user.

There is a type of avatars called “dissimilar” avatars which are the ones that diverge from the real appearance of the user, not because of technological limitations but due to the preferences of the user. It has been proved that this kind of avatars have a positive impact on the user experience, especially in terms of interaction, perception, or behaviour (Cheymol et al., 2011). That is because the user has the freedom to voluntarily modify its body or personality, being able to become the best version of itself and the one wanted to be shown to the rest of the users. This will make users feel more confident and comfortable, allowing them to enjoy the virtual experience to the fullest.

Figure 3.6. Avatars

Source: LinkedIn (2023)

Figure 3.7. Dissimilar avatars



Source: Computer Hoy (2021)

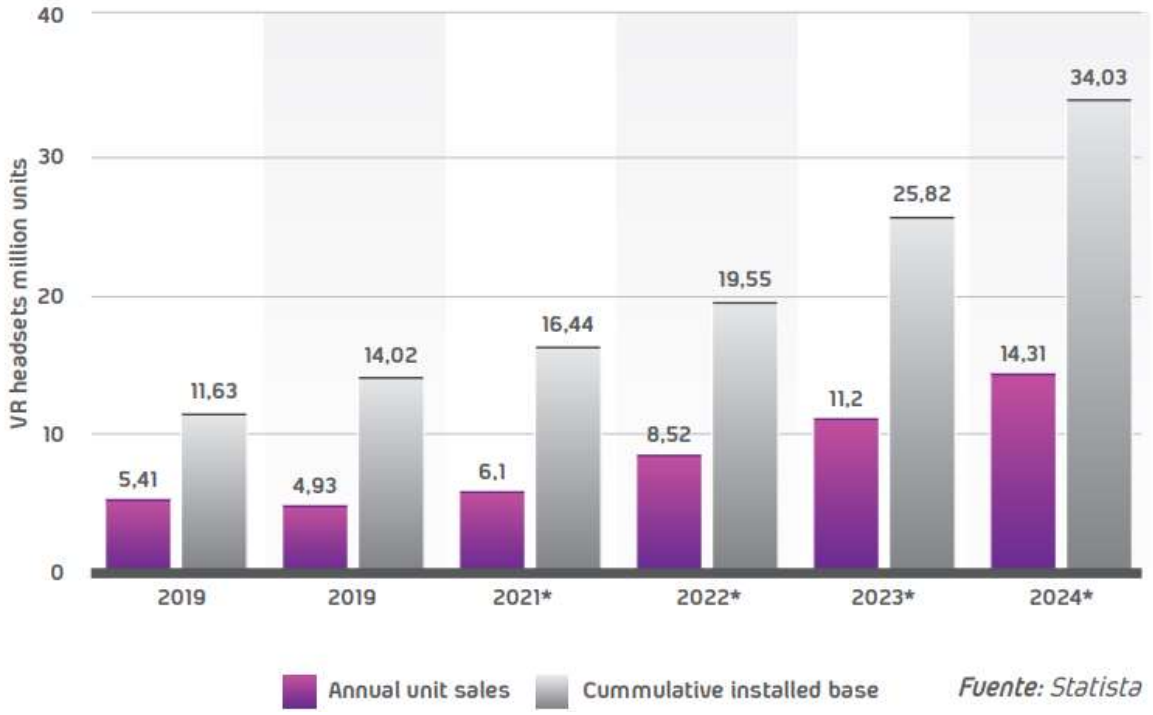
3.3.3. Immersion

As Biocca (1997) says “immersive virtual environments are places where vision and other senses are meant to be active, perceiving the structure of the virtual world in ways similar to the manner they construct the physical world”. Immersion requires mental effort from people engaged in the activity and is intended to be a dynamic process that evolves over time (Dwivedi et al., 2023), where the user goes beyond the

traditional barriers of the screen allowing the information to surround him/her completely or partially (Iab Spain, 2024).

To enhance and create a three-dimensional virtual experience, VR-HMD (Virtual Reality – Head Mounted Device) devices are used. These are placed on the head, close to the eyes, thus, to reduce the user´s field of vision of the real world to a minimum and maximizing the immersion within the virtual world, since only those images produced by the computer will be perceived and played by the HMD device. Thus, the users can immerse themselves in a virtual world and explore it as if they were physically present.

Figure 3.8. Cumulative sales of VR devices from 2019-2024



Source: Statista (2024)

Pallavicini et al. (2019) discovered that VR-HMDs tend to have a more palpable sense of presence compared to traditional two-dimensional (2D) displays. Indeed, the availability of HDMs has made immersive virtual reality systems a feasible alternative to 2D video conferencing.

Moreover, many specialists and authors have carried out studies with VR-HMD devices and they have analysed their effectiveness and level of immersion, reaching different conclusions. On one hand, Simeonov et al. (2005) used the screen virtual reality simulation (SSVR), and they observed that the immersion was not total. They verified this by carrying out a simulation of a rail of 9m high and its fall; and they perceived that the levels of anxiety, nerves and fear were similar to those experienced in the reality. However, these were not completely the same (the levels were lower) due to the visual limitations that this device presents in comparison to VR-HMD that offers a higher quality immersive experience.

On the other hand, Peterson et al. (2018) carried out a similar study. The simulation was similar, the participants had to walk through a wooden beam. The results showed that virtual reality allows the person to have an experience like that of real life. Besides, virtual reality is also associated with poorer physical and cognitive performance.

3.3.4. Social interaction

One of the most important aspects in the relationships between humans is social interaction and, more specifically, contact and communication. With the emergence of new technologies, it has been necessary to develop new forms of communication and interaction between users. Indeed, the metaverse is thought and it was created to be experienced in group, although it can be enjoyed individually too.

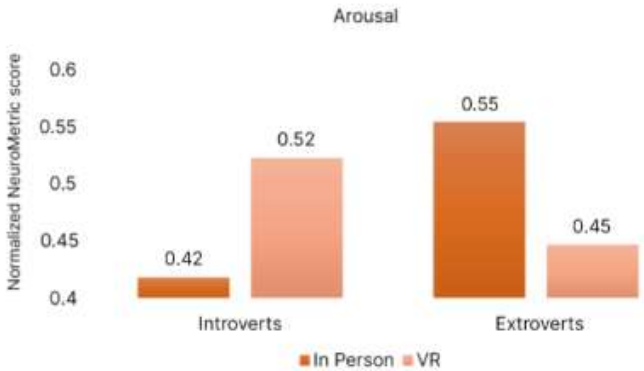
As Iab Spain (2024) quoted: "one of the virtues of this new spatial Internet is to favour the collaboration between people, breaking physical barriers. Is about an Internet in which is possible to go beyond the limitations of a two-dimensional screen and facilitate the exchange, interaction, and collaboration of people under the same space, real or imaginary".

At this point, the existence of virtual reality or metaverse allows users to achieve these interactions through avatars (mentioned before) making this a much more sensitive, enjoyable, and real experience.

Social interaction is defined as the "process of reciprocal influence exercised by individuals over one another during social encounters". Meaningful interaction between customers and service staff as well as between customers and other customers is of prime importance in the experience (Hudson et al., 2019).

Facebook made a study (2020) to discover the level of acceptance of social interaction between people through virtual reality. The results demonstrated that the commitment and feelings were similar to those experienced in real life. Indeed, the most introverted people were the most emotionally committed to the experiment.

Figure 3.9. Level of acceptance of social interaction between people through virtual reality



Source: Facebook (2020)

This, as well as many other experiments and studies made, help to demonstrate the power that virtual reality has and the advantages that it can offer both to consumers and sellers.

When we look to the future, it is obvious that our social lives will increasingly exist in social environments, which will definitely beneficiate those who are actually into it.

3.4. MARKETING EXPERIENCE CASES RELATED WITH NEW TECHNOLOGIES

Next, a series of selected real cases will be presented as they represent concrete and significant examples that allow to illustrate and analyse the theoretical concepts addressed in the conceptual framework; additionally, they show how there are already companies that are implementing these new technologies.

3.4.1. Lawsuit against Mango

In January 2024, the textile fashion company *Mango* was sued by VEGAP (Visual Entidad de Gestión de Artistas Plásticos) for using works of art made by three Spanish painters.

Mango, at the opening of a new store in the Fifth Avenue in New York, hired video artists and crypto artists to merge fashion and art. In this way, they used five paintings by these artists without prior consent from their relatives or heirs. *Mango* converted these paintings in NFTs (Non-Fungible Tokens). VEGAP sued them taking into account that they violated their copyright.

As the commercial court 9 of Barcelona (Spain), did not considered this act as a dishonest one, they ruled in favour of *Mango*, exempting the textile company from the payment of almost 1.4 million euros.

Figure 3.13. Fragment of the "crypto art" "clips" exhibited at the opening of the Mango store in New York

Source: El Español (2024)

Linked to this news and to better understand it, it is important to define NFTs. Non-Fungible Tokens are tokens that represent digital assets and have proof of ownership embedded. Each token is unique, inimitable, and distinctive from another, which has strengthened the security of assets and reinforced unique ownership.

These digital assets are representative of physical or digital creative work or intellectual property including music, digital art, games, gifs, video clips… (Rehman et al., 2021) and have potentiated the trade of digital assets of any kind, which is increasingly gaining importance and attention in recent months (Valeonti et al., 2021).

Indeed, Jack Dorsey, the founder of *Twitter*, sold his first tweet for 2.9 million USD as an NFT. This tweet was: "Just setting up my twttr" and it was published on the 21st of March 2006. Another example could be the case of Mike Winkelman, also known as Beeple. He is a designer and illustrator who dedicated himself to upload his own digital works to *Instagram*. In 2020, he discovered the existence of NFTs, and decided to create his own. The first one was auctioned for 66 thousand dollars, which then, months later, was resold for 6.6 million dollars.

These are clear examples of how NFTs have revolutionized the way we perceive digital property and how a simple tweet or graphic illustration can move such amount of people or money.

To simplify it, NFTs are crypto assets, any digital file that a person wants to register as his/hers on the blockchain, the most secure database nowadays. It is basically a certificate of ownership which says that a specific digital file is yours.

3.4.2. "entamAR"

EntamAR is an application which has as principal objective the introduction of augmented reality to the social projects implemented by hospitals. It is mainly aimed at children undergoing long-term hospitalizations, thus, to help them in the development of their creativity and imagination.

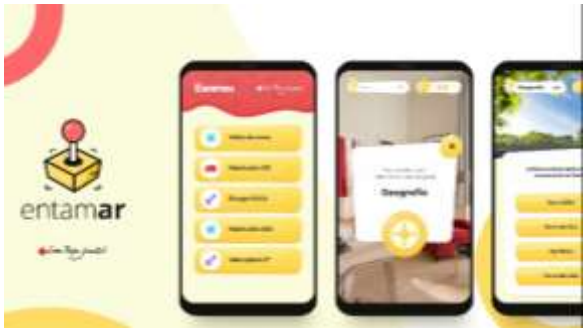
It was developed by *Onirix*, an augmented reality platform whose objective is the creation and publication of augmented reality experiences. This platform belongs to *Neosentec*, a company that is focused on the integration of technology in the society. *Cruz Roja Foundation*, along with *TECSOS Foundation* and *Vodafone Spain Foundation*, helped to become this idea a reality.

This new application has two principal functions or uses. On one hand, is focused on helping the approximately 2,000 volunteers which collaborate in these hospitals. With the development of videogames such as *Cluedo*, *Escape Room* or *Trivial*, which aim to entertain and enhance the learning of these kids. They are designed based on the different rooms and common areas of the hospital. On the other hand, the second use that this application entails, is focused on the development and enhancement of children´s creativity and imagination, allowing them to design and decorate their rooms as they want by introducing 2D and 3D elements.

Its first implementation and initial development began in 2019 at the HUCA Hospital in Oviedo (Asturias, Spain), completing the technical and validation adjustments at the Hospital de la Fe in Valencia (Spain). It has been expanding reaching more than 60 hospitals in Spain and helping more than 35,000 hospitalized kids.

This initiative has been acclaimed by both the families of these kids and the public, contributing to bring them a childhood equal to that of everyone, since, through augmented reality, they help to improve their mood with the creation of moments of fun and distraction in an environment that can be stressful and challenging. Additionally, they contribute to their recuperation, and promote the education and socialization among minor patients.

Figure 3.14. "entamAR" app



Source: Cruz Roja (2021)

Figure 3.15. Uses of "entamAR"

Source: Cruz Roja (2021)

3.4.3. Virtual makeup simulator

L'Oréal, one of the worlds´ leading companies in the cosmetics and beauty products industry, specially known for its investment in innovation, has been one of the pioneering brands in installing this innovation. It's about being able to try certain makeup products, specifically mascara, lipstick, blush, and eyeliner, to see if it fits with your tone. It can be tested both in a live simulation where the tool itself will recognize your features to adapt as much as possible to them, or by uploading a photo and testing the makeup on said photo.

Among the advantages that this tool offers, we include the convenience of being able to try many different shades of makeup from the couch at home and as many times as wanted, experimenting with many colours and saving the money that would be spent to buy it and if at the end it is not the right shade or it does not fit as expected.

However, many users agree that the precision and realism with which this tool works is not entirely reliable. Due to changes in light, the different qualities of the devices where being tested, or the texture of the skin, the result on the screen may differ from reality.

Figure 3.16. Makeup virtual simulator

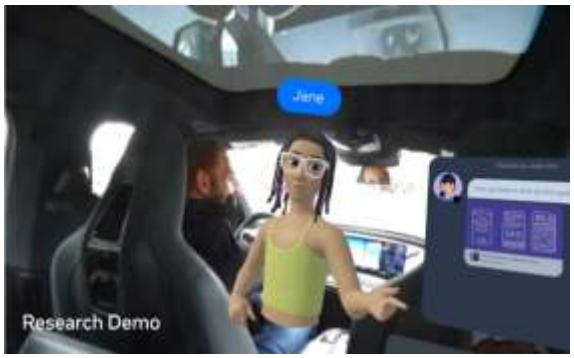
Source: L´Oréal (2021)

3.4.4. Mixed reality in cars

Traditionally, on long trips, we tend to watch movies, read books, or play on our cell phones. But what if we could enter the virtual world while we travel to our destination? This was exactly what *Meta* thought when this company decided to contact *BMW* and tried to install it in real life.

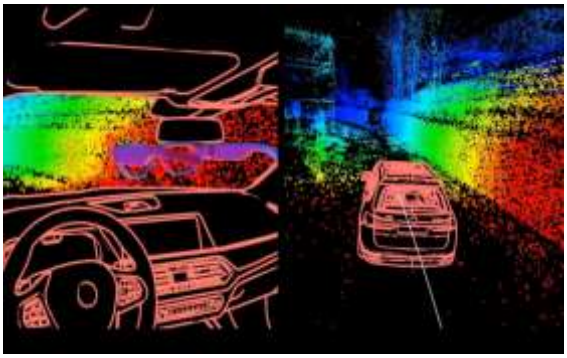
Through virtual reality glasses and using mixed reality, the traveller could play video games, work (with an assistant called Jane) and even turn the roof of the car into a 3D hologram. To achieve this, they transferred the data from the IMU (Inertial Measurement Unit) of the vehicle to the Quest 3. In this case, one of the two Quest 3 controllers was mounted on the rear footrest of a *BMW iX* and with this, it was possible to make it work.

Figure 3.17. Jane, the virtual assistant



Source: Meta (2023)

Figure 3.18. VR vision inside and outside the car



Source: Meta (2023)

Among the principal advantages that the installation of mixed reality in cars can bring, apart from entertainment, we also find others that are really valued by both the public and the designers of these cars:

- Safety: the implementation of mixed reality involves designing cars with the introduction of an advanced technological system, which can also help in the prevention of accidents as it contributes to reduce the risks associated with driving tests on real roads.
- Design optimization: as these cars must be designed according to "patterns" in which the videogame scenarios can fit, deficiencies in the initial design can be identified and corrected before starting the mass production phase.
- Time and cost savings: it allows the designers to test multiple driving scenarios without having to travel, while visiting each place would involve greater cost and time. Moreover, the adjustments that would have to be made to the initial prototype can be made virtually, without the need to adjust them in a physical version.

4. EMPIRICAL STUDY

The primary objective of this part is to present and discuss the findings derived from the study carried out, with the purpose of fulfilling the proposed objectives. This empirical analysis constitutes an essential step to compare the results with the conceptual framework and consists of a quasi-experiment inside the metaverse and a pre- and post-questionnaire to analyse the results.

4.1. SCALES TO MEASURE THE KEY ASPECTS FOR CONSUMERS IN THE SHOPPING WITH NEW TECHNOLOGIES

To begin, it is important to theoretically support the scales and questions that have been used in the questionnaires administered to the participants of the quasi-experiment.

Measurement scales are fundamental tools in research since they allow to quantify and classify phenomena or variables of interest in a systematic and precise way.

4.1.1. Embodiment

As embodiment is the illusion or feeling of physically being inside a virtual place and actually feel that what is happening inside of it is real, it can be measured by the Experience of Embodiment Scale (EES), which is a scale "used by researchers and clinicians to capture the individual´s ranges of experiences of living in their bodies, both positive and negative" (Piran et al., 2020).

Embodiment is explained around five dimensions, which include:

- Body connection and comfort: it is referred to the awareness, sensitivity, and attunement of one´s body and it involves being in touch with bodily sensations, emotions, and movements. It is the feeling of being comfortable and connected to one´s own body.
- Agency and functionality: together, they both highlight the dynamic interplay between our physical bodies, cognitive processes, and socio-cultural contexts. Agency involves being able to initiate actions, make decisions, and achieve objectives and it encompasses both the physical capacity to move and act, with the psychological sense of self-direction and autonomy. Functionality is referred to the efficiency and effectiveness of bodily movements in achieving desired outcomes and it involves the use of flexibility, coordination, and strength to perform those tasks or activities.
- Attuned self-care: it involves being aware of the needs and values that each person´s body has. In this way, each one will be listening to its body, knowing the needs it has, achieving them, and thus, reaching a state of well-being. It is about prioritizing one´s self, chasing those physical, emotional, relational, aspirational, and spiritual needs that each one will set in their lives. It is proved that cultivating and practicing attuned self-care improves resilience, vitality, and fulfilment in life.
- Experience and expression of bodily desire: it is about addressing connection to appetite and sexual desire by understanding and exploring our bodily sensations, cravings, and pleasures. It encompasses a complex interplay of physiological (neurological processes and bodily responses), psychological (attraction and pleasure), social, and cultural (norms, values, and expectations of the society) factors.
- Subjective immersion (resisting objectification): "it is about seeing ourselves as more than mere objects, valuing our unique experiences, and asserting our subjectivity" (Piran, 2019). Being objectified involves losing one´s autonomy, agency, and humanity towards the benefit or exploitation of others.

This variable is measured by the Likert Scale, which was developed by the American psychologist Rensis Likert in 1932, and that is a research method which uses a rating scale to find out people´s level of agreement and disagreement on a topic. This scale should range from:

Table 4.1. Range of the Likert Scale for Avatar Embodiment

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
(1)	(2)	(3)	(4)	(5)

Source: own elaboration with data from the article: Avatar Embodiment. A Standardized Questionnaire (2021)

4.1.2. Avatars

Avatars, within virtual reality, are the "physical" representations of the users who participate in it. In order for the results of the experiments to be usable and comparable, it is necessary that all of them are linked to a standardized measurement. The problem lies in the great subjective component that participates in these cases as the avatar is the representation of the user´s personality and each user is unique and different from all others. If the same measurement was not used in all experiments, the results would be biased since the relationship that humans have with their bodies is not a topic that is normally thought on a daily basis.

To fulfil this objective, Gonzalez-Franco and Peck (2008) developed the "Avatar Embodiment. Toward a Standardized Questionnaire", which consists of 16 universal questions for an embodiment questionnaire. At the beginning, there were a total of 25 questions, but through the 30 experiments made in this field, 9 questions were finally removed from the questionnaire due to the low relevance they had. These 16 questions will be used in the questionnaire of the quasi-experiment.

The questionnaire is built around six different recurrent themes in embodiment science, which include: body ownership, agency and motor control, tactile sensations, location of the body, external appearance, and response to external stimuli. The final result of how embodied the user, through its avatar, has been, is the sum of the six factors. This is closely related to the previous variable, embodiment, since in both cases it is measured the level of connection or disconnection the user feels from its body during the virtual experience; in the same way, it is measured how connected or disconnected the user feels from its virtual "physical" representation, that is, its avatar.

For having universally comparable results, the measurement used is also the Likert Scale, and it should also range from:

Table 4.2. Range of the Likert Scale for Avatar Embodiment

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
(1)	(2)	(3)	(4)	(5)

Source: own elaboration with data from the article: Avatar Embodiment. A Standardized Questionnaire (2021)

4.1.3. Immersion

Csikszentmihalyi (1990) was the first person who introduced the concept of flow, defining it as "a state in which individuals are so involved in an activity that nothing else seems to matter, they are deeply

immersed in the activity itself and feel the optimal experience". This has been closely related to immersion, as, at the end, it is referred to the same state of the human body.

There are two general approaches to measure immersion: the objective and the subjective. On one hand, in the objective approach, devices are used to measure body actions such as pulse rate or eye tracking. This can be seen as a barrier for the users since they must wear sensors in their bodies that may limit the freedom needed to live and feel the virtual experience to the fullest.

On the other hand, and unlike the objective approach, the subjective one is based on the use of questionnaires but has the disadvantage of risk of distortion caused by the own and personal opinion of each user.

Indeed, and inside both approaches, there are three stages or phases of immersion:

1. Engagement: it requires a high investment of time and to achieve it, is important that the virtual experience matches the preferences of the user. There are two barriers that can limit it: accessibility (since virtual reality devices generally have a high price and not all people can afford to get them); and time (because entering the virtual world requires spending a great deal of time to reach to understand and feel part of it).
2. Engrossment: to reach this phase, the user must accept its environment and eliminate all the possible external distractions. The two barriers that may limit it are the depth of the world (because the user is within a virtual world but similar or equal to the real world where they carry out day-to-day activities); and the distractions (since the activity will be carried out in a non-empty space with physical limitation as furniture that may affect the full concentration of the participant).
3. Total immersion: if the first two phases have been surpassed, the user would achieve a psychological sense of being in a virtual environment and a state of flow where nothing else matters. The limitation or barriers linked to this phase are the empathy (the user becomes addicted to entering inside this virtual world); and the awareness (involving the lack of awareness of time and the lack of awareness of the real world).

The best way to measure or evaluate immersion in this kind of experiments is through questionnaires, such as the one designed by Bouchard (chosen for the development of the quasi-experiment) in which participants are asked to carry out an activity inside the virtual reality and then being able to measure the level of immersion they have reached.

A scale useful in measuring the level of immersion should range from:

Table 4.3. Range of immersion

Nule immersion	Low immersion	Moderate immersion	High immersion	Maximum immersion
(1)	(2)	(3)	(4)	(5)

Source: own elaboration

4.1.4. Social interaction

It is related to the scales with which two disorders caused by social interaction between people are measured, which are the Social Interaction Anxiety Scale (SIAS) and the Social Phobia Scale (SPS). They were both developed by Mattick and Clarke (1998) due to the necessity of having an instrument to assess various commonly feared situations.

These scales are widely used in clinical settings and among social anxiety researchers but can be related to the interaction within virtual reality as people tend to feel less social anxiety when they "hide" behind a screen or an avatar; and it is convenient to analyse the behavioural changes experienced by the participants in the same situation but experienced in the real reality and in the virtual reality. Both scales have demonstrated satisfactory reliability through time.

Starting with the Social Interaction Anxiety Scale, it is a self-report scale that measures distress when meeting and talking to others, that is, it assesses social anxiety in interactional situations; and it is composed of 15 items.

Continuing with the Social Phobia Scale, it is a self-report questionnaire that assesses social anxiety in performance-related, routine situations, and activities. It is related to the anxiety people experiment when they are being observed by others, when they are actually observed, and when engaging activities in the presence of others. It is composed of 17 items that globally evaluate specific problems related to social phobia.

The measurement used in both scales is the Likert Scale, and, in this case, it should range from:

Table 4.4. Range of the Likert Scale for the SIAS

Not at all characteristic of me	Slightly characteristic of me	Moderately characteristic of me	Very characteristic of me	Extremely characteristic of me
(1)	(2)	(3)	(4)	(5)

Source: own elaboration with data from the article: Refining and validating the Social Interaction Anxiety Scale and the Social Phobia Scale (2009)

4.2. SELECTION PROCESS OF SAMPLE SUBJECTS

The selection process of the sample subjects was convenience-based on them being young people of similar ages, to homogenize the results as much as possible. Furthermore, there were a total of 21 participants on the quasi-experiment, half of them were women, and the other half were men, so that the results were measurable and comparable. Additionally, it was important to choose both subjects who had had previous experiences with virtual reality, as well as subjects who had not (approximately half and half of each condition) to compare their results, in order to analyse whether those who had previous experience did it better than those who did not have.

The sample chosen to carry out the quasi-experiment consisted of 21 people, being 11 of them men and the other 10, women. All of them, except for one person, were in the age range of 20 to 25 years, and they have preference for sports, social media or watching series as free time activities.

Table 4.5. Research technical sheet and description of the samples

Universe	Individuals over 18 years
Sampling procedure	Non-random convenience sampling by age and gender
Information collection	Quasi-experiment and personal survey
Scope	Burgos (Castile and Leon), Spain
Sample	21 individuals
Date of field work	April 10 and 15, 2024
Average duration of the quasi-experiment	15 minutes (1´ pre-questionnaire; 8´ experience; 6´ post-questionnaire)
Characteristics of the consumer sample	
Gender	Men 45%; women 50%; prefer not to say 5%
Age	Under 20 years 5%; 20-25 years 95%
Level of studies or main occupation	High-school 14%; university degree 72%, work 14%
Preferred free time activities	Sports 36%; videogames 14%; series or films 23%; reading 4%; social media 23%
Previous participation in similar activities[1]	Yes 45%; no 55%

Source: own elaboration (2024)

[1] Entering the metaverse

Figure 4.1. Level of studies or job

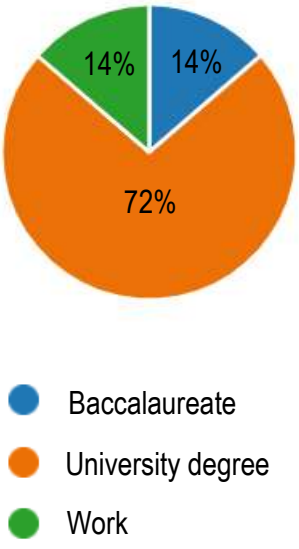


Figure 4.2. Gender

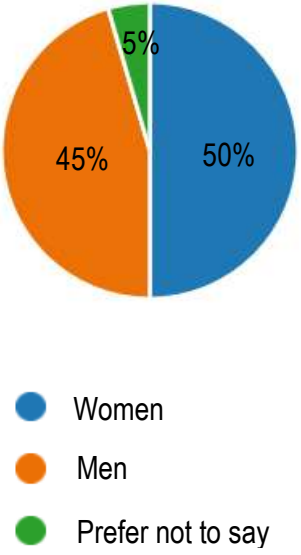
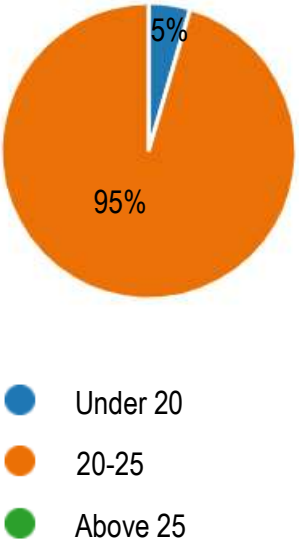


Figure 4.3. Age



Source: own elaboration (2024)

The quasi-experiment was carried out attending to a series of conditions in order to control it and, thus, avoid the appearance of biases.

Table 4.6. Bases of the quasi-experiment

1	Signing a consent to participate.
2	Start the experiment in the same position, facing the windows of the room.
3	All the participants were standing during the experiment.
4	Same virtual space and same activities for all participants.
5	Same duration of the experiment.
6	Prior and post realization of questionnaires.
7	Silence in the room during the development of each experience.
8	Participants did not talk to each other about the experience.

Source: own elaboration (2024)

4.3. HOW THE QUASI-EXPERIMENT WAS CARRIED OUT

The quasi-experiment was made up of three parts. The first part consisted of carrying out a survey prior to using VR glasses. In this survey, aspects about the age, gender, studies, and preferred free time activities of the participants were asked. In addition, they were asked about possible previous experiences using VR glasses or having entered the metaverse.

The second part of the quasi-experiment consisted of carrying out the activity itself. The virtual reality glasses used in the quasi-experiment were the Meta Quest Pro, a VR glasses from *Meta* that offer a premium experience in the field of virtual reality thanks to the 10 sensors included that track the users' hand, eyes, and face. These glasses allow the user to enjoy immersive virtual reality experiences.

Figure 4.4. Meta Quest Pro

Source: meta.com (2022)

Each subject was placed in a specific position with the device on. Once they were ready, the activity began, where they had a total of 8 minutes of experience, divided into 1 minute to play basketball and then they had another 7 minutes to explore to their preference the same metaverse in which the basketball game is played. They were able to see other users, play other games such as *Trivial* or cook hamburgers, as well as explore the entire room that included the game. All the experience was carried out inside the same metaverse, to promote the concentration of the participants.

While performing the activity, all users were standing, allowing them to move around the room as they pleased and, thus, feel that the experience was even more real. To guarantee their safety, and because there were tables in the room where the quasi-experiment was carried out, within the metaverse, safe areas were delimited so that the participants were not in danger. If any user went out of those limits, the glasses stopped functioning as a warning of danger. Once their 8 minutes of experience were over, each participant was asked about the position in which they considered they had finished the experience, to compare it with the position in which they had begun.

Figure 4.5. User using the virtual reality glasses

Source: own elaboration (2024)

Figure 4.6. User playing basketball

Source: own elaboration (2024)

The third and final part of the quasi-experiment was a survey after completing the activity, where they were asked about their experience within the metaverse. The survey, which estimated duration of response was of approximately 6 minutes, was divided into 4 parts or sections, based on the key aspects or variables for the consumer in the shopping with new technologies.

The first section was embodiment and avatars, which consisted of 16 questions based on the questionnaire “Avatar Embodiment. Toward a Standardized Questionnaire” created by Gonzalez-Franco and Peck (2008) to analyse the sense of identification, agency, and presence experienced by users when entering virtual environments.

Continuing by immersion, the questions were focused on investigating how immersed the participants felt during the activity. The final objective and the most interesting thing in this section, was to discover if they had reached the state of flow defined by Csikszentmihalyi (1990).

The following section was social interaction, where the aim was to compare the experience lived by the participants in the metaverse with what they would have lived in real life, to see if their level of social interaction was higher or lower.

Finally, the last section was made up of questions related to the purchase intention of goods or services within the metaverse or virtual reality. The intended objective was to analyse whether, after the experience, users decided to start or increase their purchases through virtual reality.

Figure 4.7. Participant in the basketball game

Figure 4.8. Trampolines game

Figure 4.9. Other avatar inside the metaverse

Source: own elaboration (2024)

5. RESULTS

Moving on to analyse the results obtained from the quasi-experiment designed to investigate how users behave within the metaverse, the data collected will be examined with brief interpretations and graphics in relation to the research questions posed.

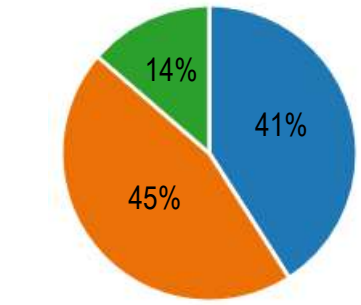
5.1. QUESTIONNAIRE PRIOR TO THE QUASI-EXPERIMENT

48% of those surveyed agreed with having knowledge of the functioning of virtual reality glasses but they had not used them, while 43% of them had used this kind of device. When they were asked about having previous experiences in similar activities, 48% of the participants confirmed having entered the metaverse.

Finally, none of the participants had previously bought products or services through virtual reality or the metaverse.

Figure 5.1.

Did you know how virtual glasses work?



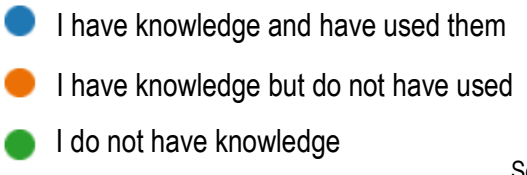


Figure 5.2.

Do you have any experience in similar activities?

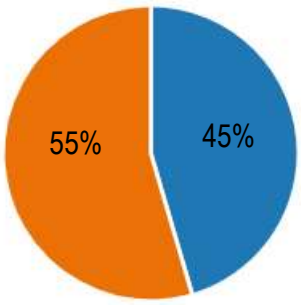
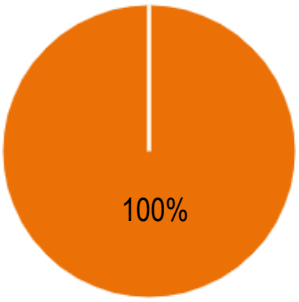


Figure 5.3.

Have you ever purchased through virtual reality or the metaverse?



Source: own elaboration (2024)

5.2. QUESTIONNAIRE POST QUASI-EXPERIMENT

Once the quasi-experiment was finished, the results obtained from the second questionnaire revealed the following results. As mentioned before, this questionnaire was divided into four sections, so the results will be analysed based on those four parts. [2]

5.2.1. Embodiment and avatars

To start with, talking about embodiment and avatars, overall, 62%[3] (see Figure 5.4.) of the participants reported feeling out of their own body during the quasi-experiment. Specifically, and regarding the movements that the avatar made, 72% felt that their virtual body was their real body; and 81% (see Figure 5.5.) actually felt that the movements of the virtual body were caused by their own movements, along with the sensation that their body was going to the same place where the avatar was going (by 66% of the participants). Furthermore, 47% believed that their own body could be affected by what the avatar was doing. This sensation was also increased by an activity that consisted of jumping on trampolines, causing some participants a real sensation of vertigo.

[2] The reference of all the results can be consulted in annex IV.
[3] The percentages are based on the sum of the individual percentages of answer 4 and 5 (positive answers).

Figure 5.4. During the quasi-experiment, there were moments in which "I felt out of my body"

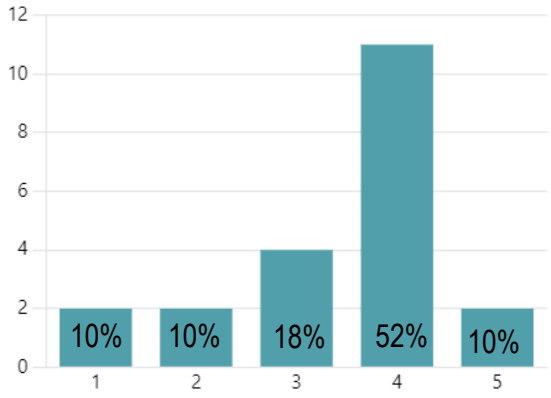
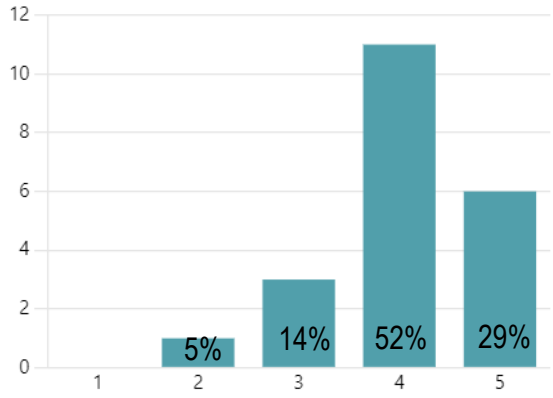


Figure 5.5. During the quasi-experiment, there were moments in which "I felt as if the movements of the virtual body were influencing my own movements"



Source: own elaboration (2024)

In terms of the position of the avatar, 48% (see Figure 5.7.) of the participants felt that their body was placed in the same position as the avatar, thus, having control of it. In addition, 48% of the participants agreed having the sensation of being physically touching the surface which was touched by the avatar.

Figure 5.6. During the quasi-experiment, there were moments in which "I felt as if the virtual body was my own body"

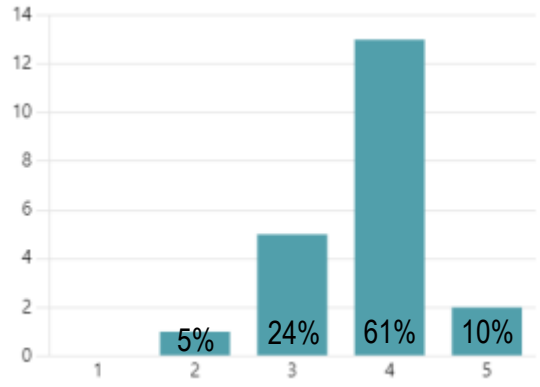
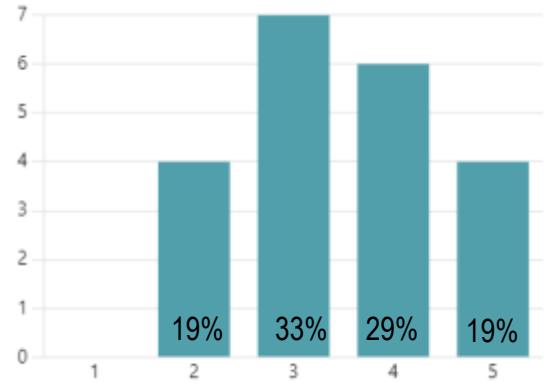


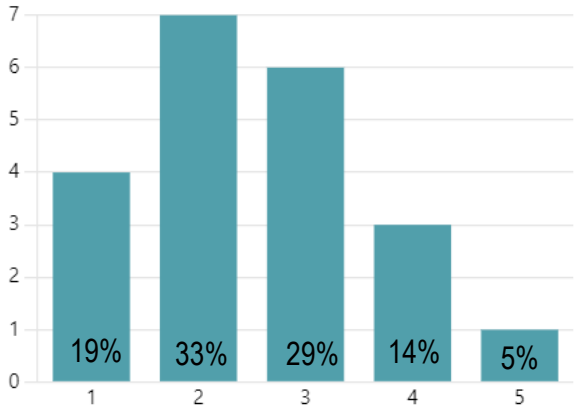
Figure 5.7. During the quasi-experiment, there were moments in which "I felt like I could control the virtual body as if it was my own body"



Source: own elaboration (2024)

Finally, and talking about the physical appearance of the avatar, the participants could only virtually see their hands, which meant that, in general, they did not feel as if their body was transforming into that of the avatar or as if they had changed their clothes or skin tone. Therefore, only 19% (see Figure 5.8.) of the participants felt that their real body was looking like their virtual body.

Figure 5.8. During the quasi-experiment, there were moments in which "I felt as if my body had changed"



Source: own elaboration (2024)

5.2.2. Immersion

Continuing by immersion, 90% (see Figure 5.9.) of the participants said they felt absorbed by the quasi-experiment, even forgetting about the real environment that was surrounding them (67%) and possible external distractions (81%). Furthermore, 72% of the participants agreed on having felt a distortion in time while carrying out the activity. Indeed, a large part of those surveyed thought that the time elapsed within the activity was about 5-6 minutes, when it was in fact 8 minutes. Finally, 57% (see Figure 5.10.) of the participants approached the so-called state of flow.

Figure 5.9. During the quasi-experiment, I felt absorbed by the activity

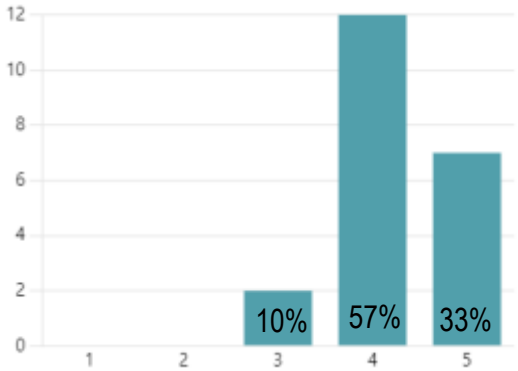
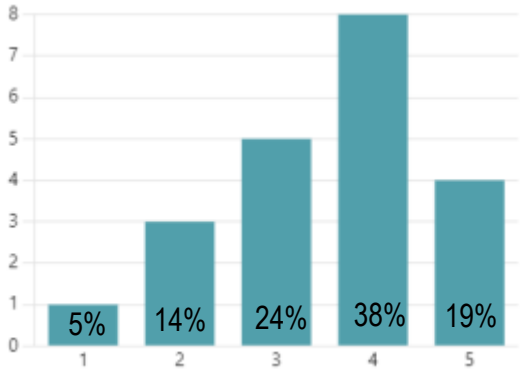


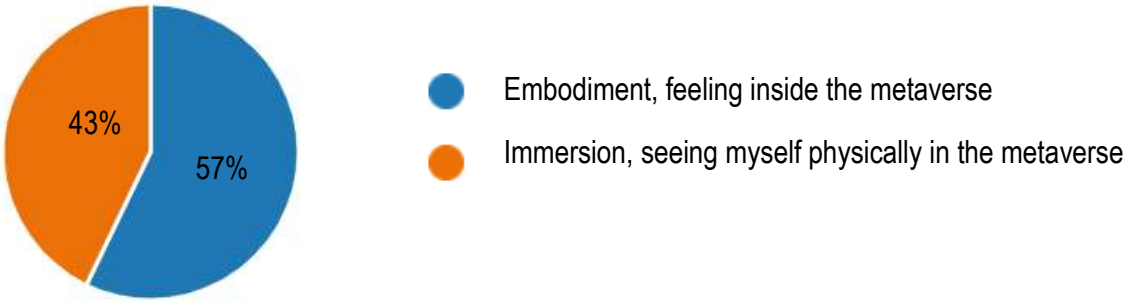
Figure 5.10. During the quasi-experiment, I consider that I reached a state of flow



Source: own elaboration (2024)

Participants were also asked whether if they valued more feeling physically inside the metaverse (embodiment) or if, to the contrary, they preferred to see themselves physically in the virtual world (immersion). 57% (see Figure 5.11) stated preferring to feel inside the metaverse.

Figure 5.11. Which have you valued the most: embodiment or immersion?



Source: own elaboration (2024)

5.2.3. Social interaction

Thirdly, in the social interaction section, the results could have been affected by the short duration of the quasi-experiment and the impossibility to communicate with other users; this explained why 86%[4] (see Figure 5.12.) of the participants feel more comfortable in the real world. Analysing the results, 71% (see Figure 5.13.) confirmed being more sociable in the real world than inside virtual reality; in addition to feeling less embarrassed (58%) performing activities in the real world than within the metaverse. Finally, only 14% felt frustrated for not being able to handle themselves well.

Figure 5.12. Globally, I feel more comfortable virtual reality than in the real world

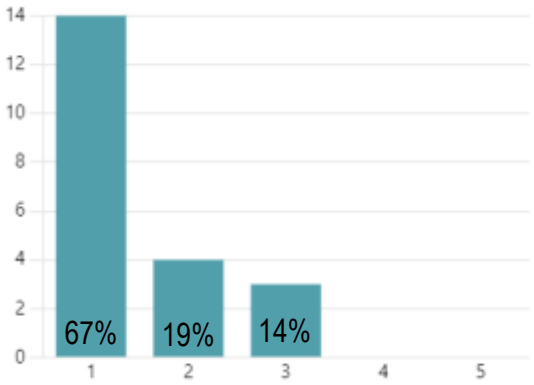
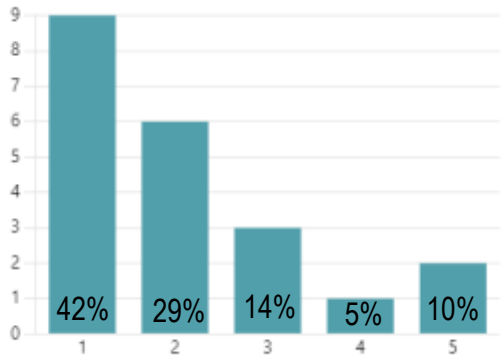


Figure 5.13. I think I can be more sociable in virtual reality than in the real world



Source: own elaboration (2024)

5.2.4. Final questions

The final section was about the purchase intentions after the experiment. 76% stated that they would buy virtual reality glasses; in addition, 43% (see Figure 5.14.) would buy products related to virtual reality,

[4] For social interaction, the percentages are based on the sum of the individual percentages of answers 1 and 2 (negative answers).

however, 57% would not buy them due to the high price of said products. Additionally, and as it is still an unknown concept to the majority of the population and without large amounts of information, 71% of the participants would not buy products from a brand through the metaverse. Finally, and among the products that benefit the most from purchasing through virtual reality, the participants indicated that the most benefited is the entertainment sector (70%), followed by automobiles (10%), fashion (10%), and decoration (10%) (see Figure 5.15.).

Figure 5.14. Would you buy products related to virtual reality?

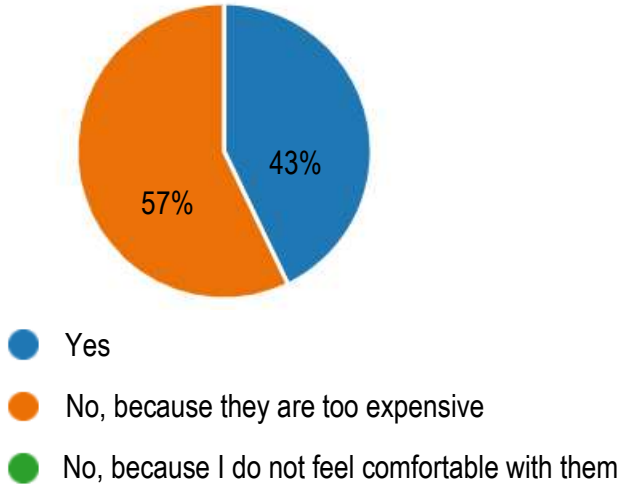
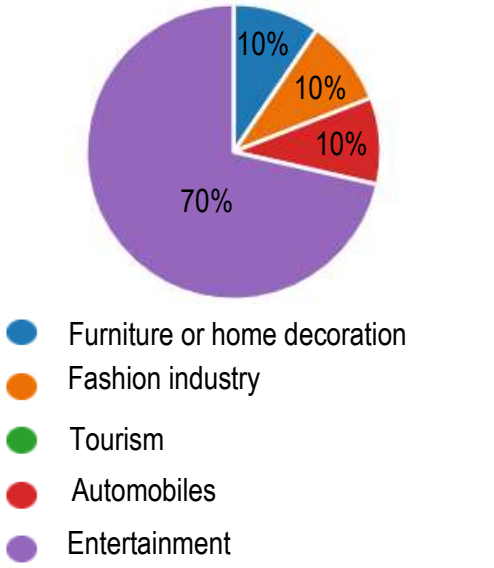


Figure 5.15. Which products do you think benefit most from virtual reality as shopping platform?



Source: own elaboration (2024)

6. CONCLUSIONS

The main relationship between artificial intelligence, virtual reality, and the metaverse is the way in which they enhance lived experiences, and at the same time, they enhance each other. The relevance acquired by these technologies has exponentially increased in the last decade thanks to the innovation and investment that has been allocated to it. Indeed, Pedro Sánchez, President of the Spanish Government, and Brad Smith, President of Microsoft, have signed and agreement that "plans to quadruple investments in artificial intelligence in Spain during 2024 and 2025, reaching 2.1 billion dollars" (El País, 2024).

Among the objectives set at the beginning of this research work, we found the definition and understanding of concepts such as virtual reality or artificial intelligence, as well as the influence that these new technologies have had on companies, highlighting their impact after the Covid-19 pandemic. Furthermore, another objective was to establish the variables or aspects most valued by consumers when

purchasing with these new technologies. Finally, an empirical study was carried out through a quasi-experiment and a questionnaire to analyse the behaviour of the participants within the metaverse.

Moving on to compare the results obtained in carrying out the quasi-experiment with what is established in the conceptual framework, the following conclusions can be drawn:

Starting with embodiment, that is, the sensation of being physically within the metaverse, it can be observed how the activity performed with the virtual reality glasses induced in the participants a feeling of fusion between their own body and the avatar, being the 72% of the participants, the ones who felt as if their virtual body was their own body. This was what Tussyadiah et al. (2017) described as the fusion between the real and the virtual body.

Additionally, Biocca (1997) and Bovet et al. (2018) described what for them where the fundamental principles of embodiment as the feeling that the movements made by the avatar are influenced by the movements produced by the person in the real world, just as the participants felt during the experience. Furthermore, with the Rubber Hand Illusion, developed by Botvinick & Cohen (1998), it was possible to observe how there is a real connection between what the person sees and feels, clearly related to the feeling of self-contact and immersion that the participants experienced within the virtual world.

Continuing with the avatars, Gárgoles (2023) expressed the enhancement that comes with the use of avatars within virtual reality, which could be observed with the interaction that the participants described with respect to their avatars. Indeed, the use of avatars not only enhances the experience, but also allows the users to interact with other people and live virtual experiences as real. Additionally, the concept of "dissimilar" avatars, those that diverge from the user´s real appearance, which Cheymol et al. (2011) described, reflects the comfort and enjoyment felt by the participants. Therefore, it can be concluded that the quasi-experiment effectively induced a feeling of presence and immersion in the virtual environment, with nearly half of the participants (48%) feeling that their real body was touching the virtual environment; together with the 90% of the participants feeling absorbed by the activity and the 67%, forgetting about the real environment surrounding them.

Following with immersion, it is important to emphasize the dynamic process of immersion described by Dwivedi et al. (2023), as well as the maximum elimination of field of vision (Biocca, 1997) as key aspects to enhance the immersion experienced by the participants. Indeed, in the quasi-experiment, a VR-HMD device was used, which, according to Pallavicini et al. (2019) contributes to create three-dimensional virtual experiences and allows participants to explore the virtual world to their preference, being able to feel the virtual world and the experiences lived within it, as if they were real (Peterson et al., 2018).

Furthermore, it can also be concluded that despite immersion being a key aspect in virtual reality experiences, there is a clear preference by the participants (57% of them) for the feeling of physically being inside the metaverse, that is, a preference for embodiment towards immersion.

Regarding social interaction within the metaverse, it can be concluded, contrasting it with the experiment carried out by Facebook (2020), that in my case, social interaction within the metaverse is not more important than in the real world. This could largely be due to the limitations encompassed by the quasi-experiment, which will be discussed later. Therefore, it can be concluded, as emphasized by Hudson et al. (2019) that social interaction is not a determining factor in enhancing the overall virtual experience.

Lastly, and speaking about the purchase intentions of the participants after having carried out the quasi-experiment, it can be concluded that there is a positive reception of these new technology´s potential benefits, as 76% of the participants would buy virtual reality glasses and the 43% of them would buy products related to virtual reality. As Rodríguez et al. (2020) described, Covid-19 was a catalyst for the adoption of new technologies and online shopping methods, pushing companies and individuals towards digitalization, connectivity, and immersion in virtual environments.

As has been seen, artificial intelligence, the metaverse, and virtual reality represent a great business opportunity, due to the exponential growth and potential that they represent. It is essential that companies invest in research and development to explore how these technologies will improve customer experiences as well as business performance. Furthermore, I believe that they should focus on the personalized and customer-focused experience, since, as could be observed in the quasi-experiment, what is most valued is the sensation of feeling that virtual experience as if it was real.

Moreover, and taking advantage of the rapid adoption that these technologies have experienced after the pandemic and the great acceptance they are having by consumers, I would recommend that companies continue investing on it and digitalizing their daily activities and tasks, offering new experiences to consumers. Also, and due to the continuous change and innovation suffered by new technologies, it is recommended that companies stay up to date with market trends and consumer behaviours and preferences.

Finally, the limitations that have encompassed the realization of the quasi-experiment are exposed. The first was the small sample of participants available to carry out the experience; perhaps if the sample had been larger, more conclusions could have been drawn. Furthermore, another limitation was the short duration of the quasi-experiment, which, although it allowed clear conclusions to be dropped from the behaviour of individuals within the metaverse, with a longer duration, it could have been investigated more thoroughly. The third limitation was that the quasi-experiment was carried out in a non-empty space, which

had physical limitations such as furniture, that could have limited the experience lived by the participants. The last limitation was that I had to carry out a quasi-experiment, instead of an experiment, which main differences are that in the quasi-experiment the selection of the sample subjects is not random; and that the results have greater external validity, that is, can be generalized to real-world situations.

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ANNEX I. CURRICULAR SUSTAINABILITY

The best way to encompass sustainability is by referring to the Sustainable Development Goals (SGD), which are 17 goals that were stablished in 2015 by the United Nations to address social, economic, and environmental aspects for human development. In this context, virtual reality plays a fundamental role in aspects such as sustainable design and planning, the promotion of research and development, and the education and awareness of the society. All this framed within the 2030 Agenda for Sustainable Development, whose objective is the fulfilment of the aforementioned objectives for a period of 15 years, thus trying to achieve a more sustainable and equitable future for all citizens.

Starting with sustainable design and planning and the promotion of research and development, SGD 9 “Industry, Innovation and Infrastructure” aims to build resilient infrastructure, promote sustainable industrialization, and encourage innovation. Furthermore, SGD 11 “Sustainable cities and communities” has the goal to make cities and human settlements inclusive, safe, resilient, and sustainable.

Directly related to both objectives, smart cities are defined as “those cities that utilize information and communication technologies with the aim of increasing the quality of their dwellers, while providing sustainable development”. (Jamei et al., 2017).

Its creation involves the combination of innovative technologies with urban development strategies. Within this framework, virtual reality plays a key role by allowing the dynamic representation of virtual environments, where architects, builders, and consumers could interact. This will permit the creation of a sophisticated real world, but with the advantages of being able to evaluate and modify errors or changes before proceeding to the effective construction of said smart city.

The use of a tool that lets to the evaluation of the possible environmental and social impacts that the creation of a city would entail, is the key for achieving a sustainable and resilient urban design. In this way, visualization in urban design provides three main advantages, including the understanding of the consequences derived from it; the provision of information for its design; and the communication between all the parties involved in the process (Hudson-Smith et al, 1998).

Talking about the education and awareness of the society, SGD 4 “Quality education” aims to guarantee inclusive and quality education, as well as promote learning opportunities for all. Related to this, we will talk about an application called Google Cardboard, which is a simple and cheap virtual reality platform developed by Google in 2014. To use it, the user needs both cube-shaped virtual reality glasses, where the mobile phone is inserted, and an application for the smartphone, thus allowing immersive experiences to be lived in an easy and affordable way. It was developed with a low-cost system to encourage interest and development of virtual reality applications.

Among the advantages and opportunities offered by education through virtual reality, we find the possibility of carrying out immersive and interactive experiences, where both teachers and students could travel to past historical periods, as well as dissect organs or animals and travel to space without having to move from the classroom.

Furthermore, and related to the high levels of school failure that have been recorded in recent decades, virtual reality could enhance curiosity in learning, thus encouraging students to continue their studies and see education as something fun and entertaining, and not as something compulsory.

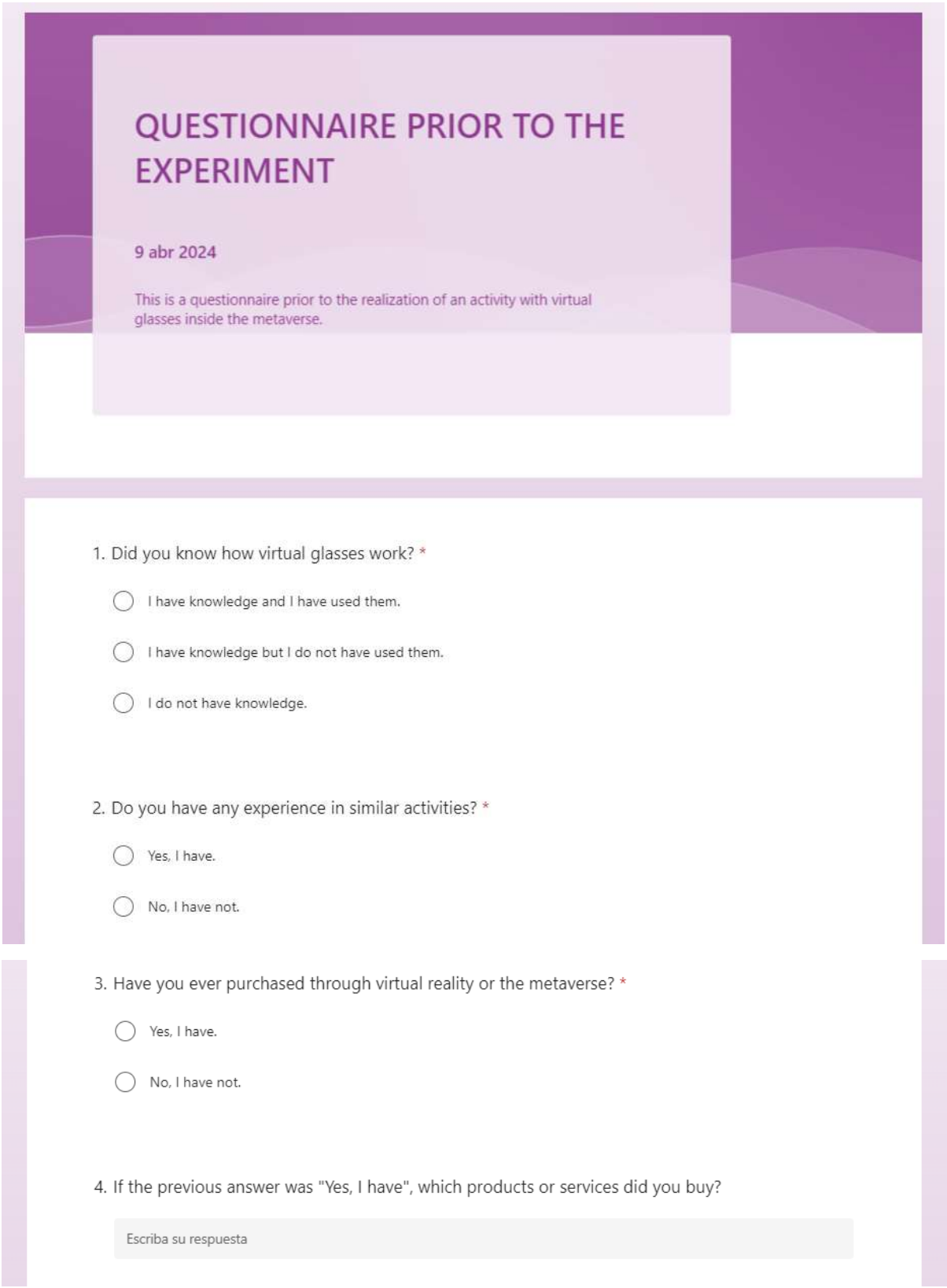
Accessibility is also one of the main advantages to take into account, allowing people of different ages and of all physical conditions to access quality education. Furthermore, and especially after the Covid-19 pandemic, these new technologies have been valued much more, as they allowed and continue to allow nowadays quality teaching in all situations.

All this leads to determine that education through virtual reality will make this a much more entertaining, motivating, dynamic, and explorative task, thus encouraging students and revolutionizing the concept of education as it has traditionally been known.

In conclusion, all these examples show that the integration of virtual reality and sustainability presents an innovative and promising approach, and thus, a great opportunity to address the economic, environmental, and social challenges that the United Nations is trying to achieve. At the same time and creating immersive experiences that not only inform but also inspire, they instil in citizens the need of

awareness and action regarding these issues, thus turning them into agents of positive change in the search for a more sustainable and promising future.

ANNEX II. PRE-QUESTIONNAIRE



QUESTIONNAIRE PRIOR TO THE EXPERIMENT

9 abr 2024

This is a questionnaire prior to the realization of an activity with virtual glasses inside the metaverse.

1. Did you know how virtual glasses work? *

- ◯ I have knowledge and I have used them.
- ◯ I have knowledge but I do not have used them.
- ◯ I do not have knowledge.

2. Do you have any experience in similar activities? *

- ◯ Yes, I have.
- ◯ No, I have not.

3. Have you ever purchased through virtual reality or the metaverse? *

- ◯ Yes, I have.
- ◯ No, I have not.

4. If the previous answer was "Yes, I have", which products or services did you buy?

Escriba su respuesta

5. Which level of security does the device used in this experiment transmit to you? *

- ◯ Very safe
- ◯ Safe
- ◯ Neutral
- ◯ Not very safe
- ◯ Not safe at all

6. Which is your favourite recreational activity? *

- ◯ Sports
- ◯ Videogames
- ◯ Films or series
- ◯ Reading
- ◯ Social media

7. Level of studies or job: *

- ◯ High-school
- ◯ University degree
- ◯ Work

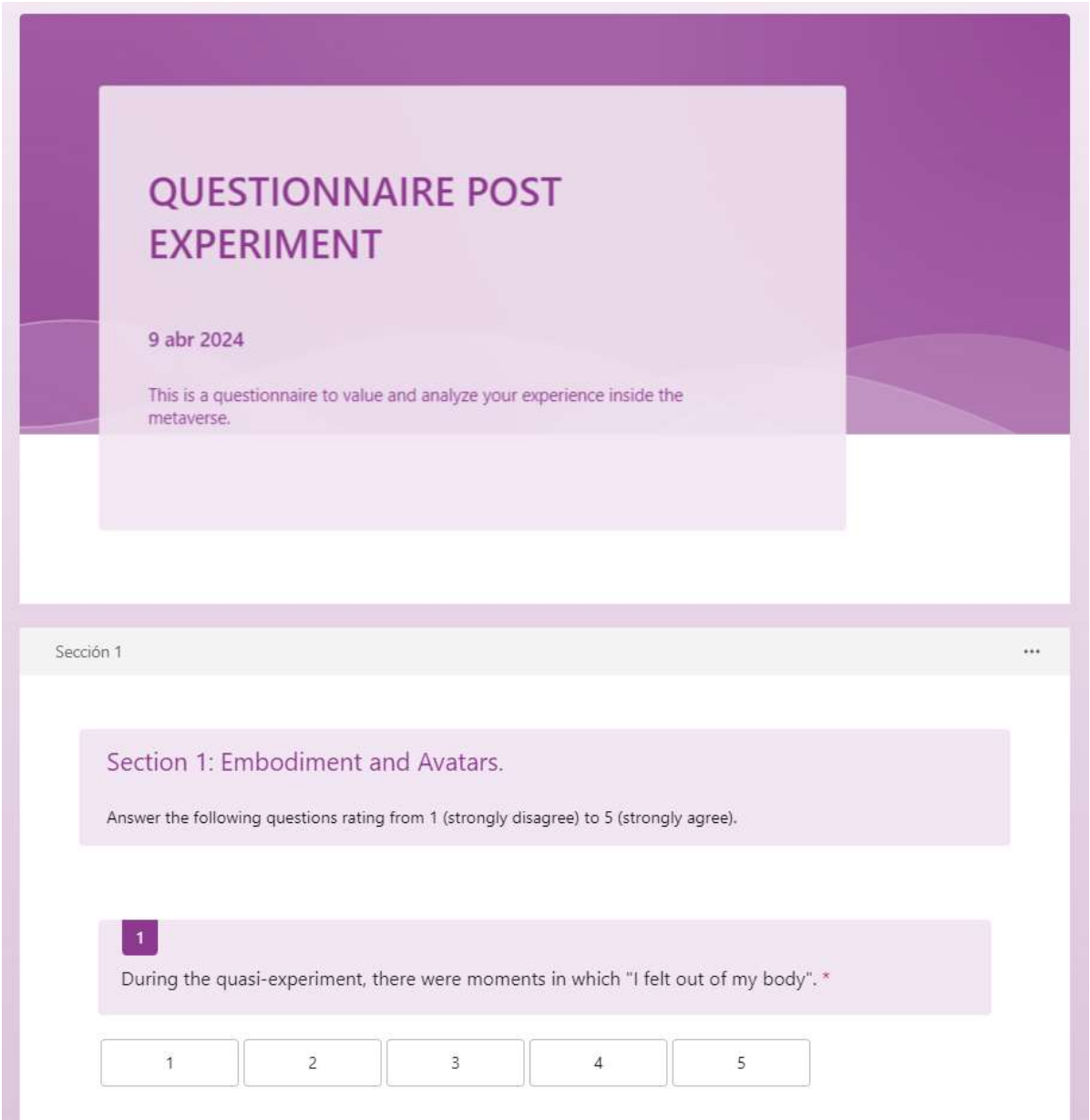
8. Gender: *

- ◯ Woman
- ◯ Man
- ◯ Prefer not to say

9. Age: *

- ◯ Under 20
- ◯ 20-25
- ◯ Above 25

ANNEX III. POST-QUESTIONNAIRE



QUESTIONNAIRE POST EXPERIMENT

9 abr 2024

This is a questionnaire to value and analyze your experience inside the metaverse.

Sección 1

Section 1: Embodiment and Avatars.

Answer the following questions rating from 1 (strongly disagree) to 5 (strongly agree).

1

During the quasi-experiment, there were moments in which "I felt out of my body". *

1 2 3 4 5

2

During the quasi-experiment, there were moments in which "I felt as if my real body was drifting toward the virtual body or as if the virtual body was drifting toward my real body". *

1 2 3 4 5

3

During the quasi-experiment, there were moments in which "I felt as if the movements of the virtual body were influencing my own movements". *

1 2 3 4 5

4

During the quasi-experiment, there were moments in which "I felt as if my real body was turning into an avatar body". *

1	2	3	4	5

5

During the quasi-experiment, there were moments in which "I felt as if my real body was starting to take on the posture or shape of the virtual body that I saw". *

1	2	3	4	5

6

During the quasi-experiment, there were moments in which "I felt like I was wearing different clothes from when I came to the experiment". *

1	2	3	4	5

7

During the quasi-experiment, there were moments in which "I felt as if my body had changed". *

1	2	3	4	5

8

During the quasi-experiment, there were moments in which "I felt a strange sensation when I saw my body inside the virtual reality". *

1	2	3	4	5

9

During the quasi-experiment, there were moments in which "I felt that my own body could be affected by what was happening inside the virtual reality". *

1	2	3	4	5

10

During the quasi-experiment, there were moments in which "I felt as if the virtual body was my own body". *

1	2	3	4	5

11

During the quasi-experiment, there were moments in which "I felt that the virtual body was resembled by my real body, in terms of shape, skin tone or other visual features". *

1	2	3	4	5

12

During the quasi-experiment, there were moments in which "I felt as if my body was located where I saw the virtual body". *

1	2	3	4	5

13

During the quasi-experiment, there were moments in which "I felt like I could control the virtual body as if it was my own body". *

1	2	3	4	5

14

During the quasi-experiment, there were moments in which "it seemed as if I felt the touch of the surface in the location where I saw the virtual body touched". *

1	2	3	4	5

15

During the quasi-experiment, there were moments in which "it seemed as if the touch I felt was caused by the body touching the virtual world". *

1	2	3	4	5

16

During the quasi-experiment, there were moments in which "it seemed as if my own body was touching the virtual world". *

1	2	3	4	5

Section 2: Immersion.

Answer the following questions rating from 1(nule immersion) to 5 (maximum immersion).

17

During the quasi-experiment, I felt absorsed by the activity. *

1	2	3	4	5

18

During the quasi-experiment, I forgot about the real environment around me. *

1	2	3	4	5

19

During the quasi-experiment, I became completely involved in the task, forgetting about external distractions. *

1	2	3	4	5

20

During the quasi-experiment, I perceived a distorted sense of time. *

1	2	3	4	5

21

During the quasi-experiment, I consider that I reached a state of flow, understood as a state in which you are so immersed that nothing else matters. *

1	2	3	4	5

22

Embodiment and immersion are similar aspects but with nuances. While embodiment is referred to the physical sensation of being inside the metaverse; immersion is referred to see yourself inside the metaverse. Which have you valued the most? *

- ◯ Embodiment, feeling inside the metaverse.
- ◯ Immersion, seeing myself physically within the metaverse.

Section 3: Social Interaction.

Answer the following questions rating from 1 (not characteristic of me) to 5 (extremely characteristic of me).

23

I think I can be more sociable in virtual reality than in the real world. *

1	2	3	4	5

24

I feel less embarrased doing an activity (sport) in virtual reality than in the real world. *

1	2	3	4	5

25

I have felt frustrated by not being able to handle myself within the metaverse. *

1	2	3	4	5

26

Globally, I feel more comfortable inside virtual reality than in the real world. *

1	2	3	4	5

Section 4: final questions.

27

Would you buy virtual reality glasses? *

- ◯ Yes, I would buy them.
- ◯ No, I would not buy them.

28

Would you buy entertainment products related to virtual reality? *

- ◯ Yes, I would buy them.
- ◯ No, because they are too expensive.
- ◯ No, because I do not feel comfortable with them.

29

Would you buy products from a brand through the metaverse? *

- ◯ Yes, definitely.
- ◯ No, because I do not have enough knowledge of how it works.

30

Which products do you think benefit most from virtual reality as a shopping platform? *

- ◯ Furniture or home decoration
- ◯ Fashion industry
- ◯ Tourism
- ◯ Automobiles
- ◯ Entertainment

End

ANNEX IV. RESULTS OF THE POST-QUESTIONNAIRE

All the questions are ranged according to the Likert Scale. For answers with a number, this is the average of all participants´ answers. In the case of percentages, the majority response of the participants is indicated.

- Section 1 (Embodiment and Avatars: questions from 1 to 16), range from 1 (strongly disagree) to 5 (strongly agree).
- Section 2 (Immersion: questions from 17 to 22), range from 1 (nule immersion) to 5 (maximum immersion).
- Section 3 (Social Interaction: questions from 23 to 26), range from 1 (not characteristic of me) to 5 (extremely characteristic of me).
- Section 4 (Final questions: questions from 27 to 30), are based on the percentages of the answers of the participants.

1	During the quasi-experiment, there were moments in which "I felt out of my body".	3.43
2	During the quasi-experiment, there were moments in which "I felt as if my real body was drifting toward the virtual body or as if the virtual body was drifting toward my real body".	3.62
3	During the quasi-experiment, there were moments in which "I felt as if the movements of the virtual body were influencing my own movements".	4.05
4	During the quasi-experiment, there were moments in which "I felt as if my real body was turning into an avatar body".	2.67
5	During the quasi-experiment, there were moments in which "I felt as if my real body was starting to take on the posture or shape of the virtual body that I saw".	3.00
6	During the quasi-experiment, there were moments in which "I felt like I was wearing different clothes from when I came to the experiment".	2.10
7	During the quasi-experiment, there were moments in which "I felt as if my body had changed".	2.52
8	During the quasi-experiment, there were moments in which "I felt a strange sensation when I saw my body inside the virtual reality".	3.43

9	During the quasi-experiment, there were moments in which "I felt that my own body could be affected by what was happening inside the virtual reality".	3.24
10	During the quasi-experiment, there were moments in which "I felt as if the virtual body was my own body".	3.76
11	During the quasi-experiment, there were moments in which "I felt that the virtual body was resembled by my real body, in terms of shape, skin tone or other visual features".	2.48
12	During the quasi-experiment, there were moments in which "I felt as if my body was located where I saw the virtual body".	3.38
13	During the quasi-experiment, there were moments in which "I felt like I could control the virtual body as if it was my own body".	3.48
14	During the quasi-experiment, there were moments in which "it seemed as if I felt the touch of the surface in the location where I saw the virtual body touched".	2.76
15	During the quasi-experiment, there were moments in which "it seemed as if the touch I felt was caused by the body touching the virtual world".	2.43
16	During the quasi-experiment, there were moments in which "it seemed as if my own body was touching the virtual world".	3.33
17	During the quasi-experiment, I felt absorbed by the activity.	4.24
18	During the quasi-experiment, I forgot about the real environment around me.	3.95
19	During the quasi-experiment, I became completely involved in the task, forgetting about external distractions.	3.95
20	During the quasi-experiment, I perceived a distorted sense of time.	3.86
21	During the quasi-experiment, I consider that I reached a state of flow, understood as a state in which you are so immersed that nothing else matters.	3.52
22	Embodiment and immersion are similar aspects but with nuances. While embodiment is referred to the physical sensation of being inside the metaverse; immersion is referred to see yourself inside the metaverse. Which have you valued the most?	57%[5]

[5] Embodiment, feeling inside the metaverse.

23	I think I can be more sociable in virtual reality than in the real world.	2.10
24	I feel less embarrassed doing an activity (sport) in virtual reality than in the real world.	2.43
25	I have felt frustrated by not being able to handle myself within the metaverse.	1.81
26	Globally, I feel more comfortable inside virtual reality than in the real world.	1.48
27	Would you buy virtual reality glasses?	76%[6]
28	Would you buy entertainment products related to virtual reality?	57%[7]
29	Would you buy products from a brand through the metaverse?	71%[8]
30	Which products do you think benefit most from virtual reality as a shopping platform?	71%[9]

[6] Yes.
[7] No, because they are too expensive.
[8] No, because I do not have enough knowledge of how it works.
[9] Entertainment.