Disruptive Innovation: Proposition Of A Metaverse To Optimize The User Experience (UX) Applied To The Automotive Sector

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Abstract: *The metaverse is an emerging technology that has gained remarkable prominence in recent years, as it provides a virtual universe where people can interact and relate in real time, through technologies such as virtual and augmented reality. With the continuous advancement of new technologies, the metaverse has become increasingly accessible and powerful, allowing the creation of immersive virtual environments that enable users to experience sensations and interactions that are almost real, with the potential to revolutionize various sectors of society. In this context, this article aims to study the possibility of enhancing the user experience with metaverse technology, applying it in the automotive context. To achieve this goal, research was conducted on articles published in the Capes journal, as well as with the public and an expert in the field, along with the use of Bardin's content analysis. As a result, it was possible to observe that the use of the metaverse can bring a more immersive and personalized experience to the user, as well as enabling the simulation of different vehicle scenarios and configurations, having potential in enhancing the user experience in the automotive sector.*
Keywords*: Metaverse; Technology; User Experience; Automotive; Virtual Reality.*

I.   Introduction

Disruptive innovation refers to the introduction of new technologies or business models that change the way products or services are produced, distributed or consumed in an established market. In this context, the automotive sector has faced a growing challenge to optimize the user experience (UX) and remain competitive in the face of changes in consumer behavior and digital technologies.

Currently, the demand for artificial intelligence-based solutions has increased significantly, as innovation has increasingly become a crucial point in the global market. The use of artificial intelligence for entertainment purposes has become an area of great investment for technology companies, especially after the announcement in late 2021 by Mark Zuckerberg about the Metaverse of the company Meta, formerly known as Facebook.

In addition to the entertainment sector, artificial intelligence has been applied in several other areas, such as healthcare, finance, transportation, manufacturing, retail and many others. Companies and governments have invested in AI-based solutions to optimize processes, improve efficiency, increase security, reduce costs and increase the quality of products and services offered.

With this, artificial intelligence is able to process and analyze large amounts of data in real time, identify patterns and provide valuable business insights. For example, in the automobile industry, the creation of virtual models of cars, which can be used to simulate the vehicle's performance under different conditions, allowing engineers to test and adjust the design before building a physical prototype. Additionally, the Metaverse can be used to create immersive test-drive experiences, allowing users to experience the feeling of driving a car before purchasing it.

In this way, Metaverso is a virtual reality platform that aims to create a shared simulation of the real-world using technologies such as virtual reality, augmented reality and the Internet, providing an immersive experience that simulates a collective and virtual space, allowing users to interact In real time. With that, assuming the great power of the Metaverse, the guiding question of this work is: Can the concept of metaverse, in the automotive sector, be currently applied in view of the challenges that need to be overcome to make it an increasingly viable reality? In order to answer and study this question, this article aims to study the possibility of improving the user experience with Metaverso technology, applying it in the automotive context.

With specific objectives, we have: I.) study the concept of Metaverse; II) analyze how the metaverse presents itself in society and in the automotive sector; III) to show if the Metaverse presents itself as a viable reality. Among the main justifications for the elaboration of this work, the following can be mentioned: market niche little studied; opportunities for innovation in personal marketing; study of a technology on the rise; and relevance of artificial intelligence in the world. At first, this article will develop from its theoretical framework, then the methodology used will be presented, preceding the sections on the results and discussions found and, finally, the final considerations of this study.

II.   Literature review

One of the main sources of distribution of content and services today is the internet, in which the user has been transforming and becoming, more and more, an important consumer and supplier. In addition, the current process of technological transformation expands, strongly, due to its ability to form an interface between different technological fields in the face of a common digital language, since the internet is conducive to changing the forms of social interaction and that technological means begin to play an important role in this new dynamic. For Lee, Braud, Zhou, Wang, Xu, Lin, Kumar, Bermejo & Hui (2021) technologies are the facilitators that drive the transition from the current internet to the metaverse, which makes it essential.

Therefore, according to López-Díez (2021), metaverse is a term widely used to refer to digital virtual worlds that coexist with other terms such as virtual reality, virtual worlds and certain types of cyberspaces. On the other hand, for Ning et al. (2021), the metaverse has three main basic characteristics: multitechnology, to achieve an immersive experience and build an economic system based on blockchain technology; sociability, as it is a new form of social interaction; and hyperspace-time.

Furthermore, according to Reuters (2021), the metaverse is a broad term that generally refers to shared virtual world environments that people can access via the Internet. It refers to digital spaces made more realistic through the use of virtual reality or augmented reality. Thus, according to the study by Suh and Ahn (2022), It is mentioned that, over time, with the metaverse as a communication technology, graphics, computing, virtual reality and artificial intelligence, it became possible to configure a virtual space that is similar to reality, not being a new term, but one that, had already been mentioned previously, as shown in figure 1.

Figure 1: Timeline on the development of the metaverse involving key events from 1989 to 2021.
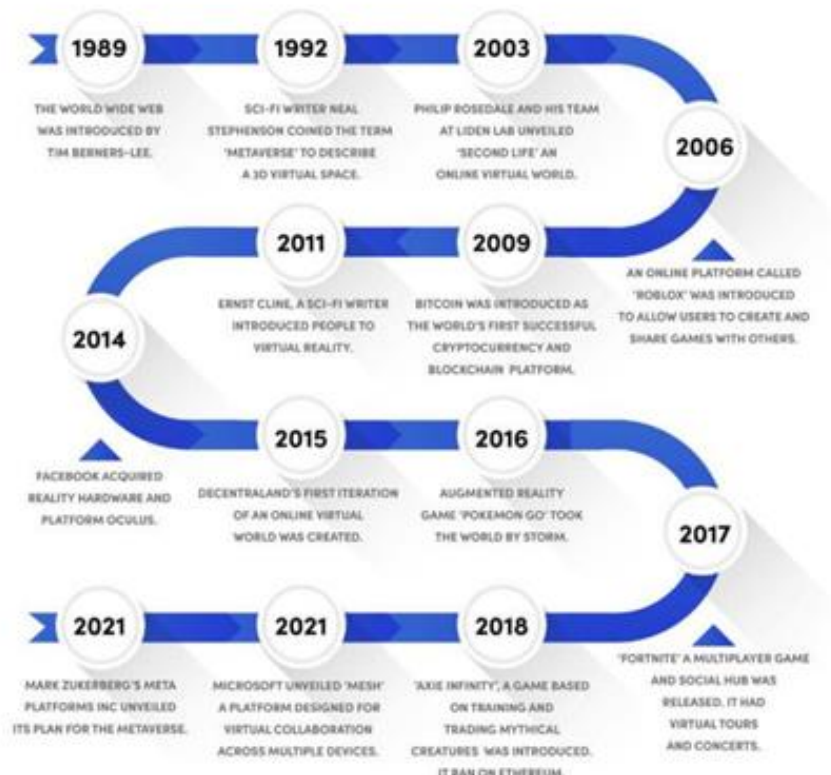
Source: Trade Brains, (2022).

Figure 1 demonstrates how the idea of the metaverse was built over time and its development involving key events, ranging from the early days of the birth of the internet to the mention of the metaverse platform by Mark Zukerberg's company Meta.

Nowadays, large technology companies such as Microsoft, Facebook and Apple have invested a lot of financial, intellectual and technological capital to popularize the virtual world. (LOPEZ-DÍEZ, 2021). Thus, John Radoff (2021) states that Meta (Facebook), Apple and Microsoft are "the three incumbents with the most stakes in the metaverse", and Hatzis (2021) states that "Apple's App Store is the closest thing we have of a metaverse". Likewise, the research team at the financial services corporation Morgan Stanley concluded that "Apple must be the real catalyst for the metaverse to take off" (MARTINS, 2021). Other authors such as Williams (2021) and Lovejoy (2021) consider Fortnite, by Epic Games, a current metaverse, which started as games in 2017, but later became a virtual world that hosts concerts, such as that of singer and actress Ariana Grande. , or events like some relating to the Marvel Universe.

From a different perspective, investor Matthew Ball, in his article Framework for the Metaverse (2021), notes that the metaverse must be differentiated from: virtual worlds –like Second Life, virtual reality – "the sense of presence in a digital world does not Metaverse" –, a game – Fortnite, according to Ball, is not a metaverse because its scope is too narrow – or just a new user-generated content platform.

In this way, the different perspectives demonstrate how the metaverse subject can be characterized and mapped in several ways, since the possibility of covering information is enormous, as shown in figure 2.

**Figure 2: Metaverse market map.**

Source: The Shift, (2021).

Interest in shared virtual worlds has grown in recent years and it is necessary to view the metaverse as a network of interconnected experiences and applications, devices and products, tools and infrastructure. A market that already attracts a growing number of companies, as shown in figure 2, created by Jon Radoff, CEO of Beamable, for the publication Building the Metaverse.

According to a study by Marino et al. (2022), Facebook is currently the most used social network with about 2,900 million monthly active users in June 2021 and about 350 million photos daily, which makes Facebook a strong influencer in the behavior of current societies and, therefore, it highlights Mark Zuckerberg's interest in entering the world of the metaverse, which is in constant development, as seen in figure 3.

Figure 3: Development of the Metaverse.
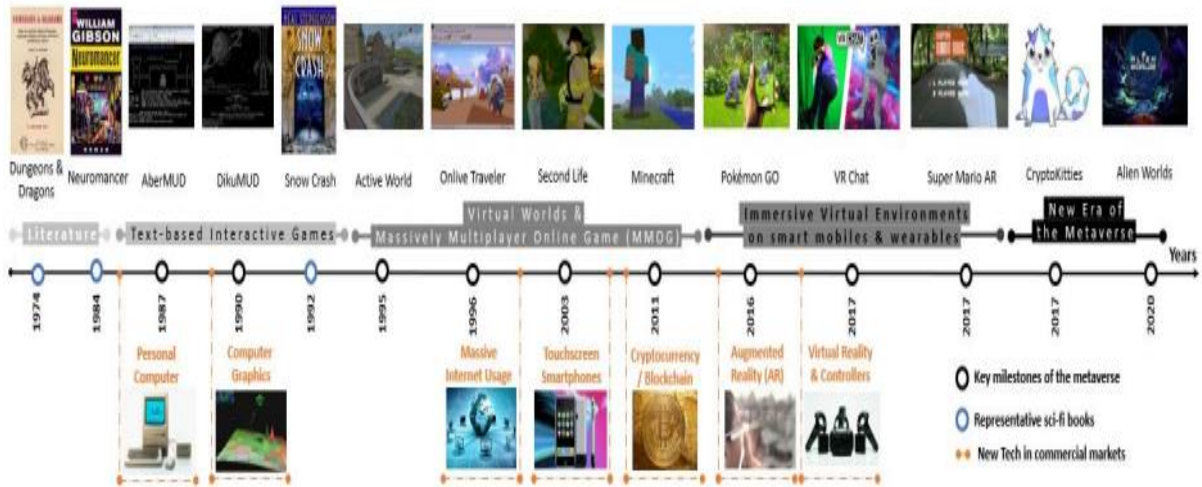
Source: Lee et al., (2021. p. 5).

Thus, figure 3 shows a timeline of Metaverse Development from 1974 to 2020, demonstrating the evolution and understanding of the Metaverse as new technological infrastructures are introduced over the years. As the state of the metaverse evolves, one can observe more enriched media – text, graphics, 3D virtual worlds. Recently, AR apps, augmented reality, demonstrate a highly immersive digital experience such as Pokémon GO and Super Mario AR, while VR apps (eg VR Chat) allow users to be fully immersed in virtual worlds for social gatherings. The landscape of the metaverse is dynamic, as crypto assets (e.g. CryptoKitties) have appeared as in-game trading (LEE, BRAUD, ZHOU, WANG, XU, LIN, KUMAR, BERMEJO & HUI, 2021).

In addition, according to the study by Park and Kim (2022), Roblox is a representative platform for online videogames in the metaverse world, since it presents stories such as: the creation of 3D virtual worlds, different online social interaction controls and allows the possibility for its players to trade or exchange wearables (elements or accessories to wear), emphasizing the possibility of the existence of a virtual reality ecosystem.

On October 28, 2021, at Facebook's Annual Connect Conference, Mark Zuckerberg announced to the world Facebook's stage shift towards a new goal; that is, the incursion of its companies into the world of the metaverse. It will be the next step on the internet. All this generated a great impact in different media around the world (TAYLOR, 2022). Mark's basic idea with this announcement was to pose to Facebook users and followers that the new line of business will be covered strictly in a world with immersive virtual reality interfaces and a series of possibilities to share with different users in real time; also launched the promise that Meta will build technologies that help connect people, find communities and grow businesses (ZUCKERBERG, 2021).

In addition, it concretizes in Table 1, as shown in Figure 4, the main characteristics of this new reality. Being them:

Table 1 – Characteristics of the Metaverse

Feature	Definition
Sense of Presence	Users will really feel like they are with other people.
avatars	3D images that represent the user, being able to choose different forms with photorealistic, stylized or fantasy images.
house spaces	The personal space of each user, created and developed by themselves.
teleportation	Users will teleport to other spaces by clicking on a link.
Interoperability	It refers to the possibility of using goods or objects that users create in different spaces and platforms, as they are owned by users.
privacy and security	To secure these rights in the metaverse. For example, having the option to block people.
virtual goods	Things (photos, videos, books, games, …) can be brought from the physical world to the metaverse. Other physical objects, such as screens, will be holograms. And digital objects will be brought into the physical world like holograms and augmented reality.
natural interfaces	Instead of keyboards and screens, interaction will be more natural, using gestures and having a sense of presence rather than looking at a screen.

Source: LÓPEZ-DÍEZ (2021).

In this way, there is a great investment in the generation and development of technologies for the metaverse designed with the use of virtual reality, since companies in the technology segment, mainly focused on

games, social networks and financial institutions, assess an enormous potential for generation of wealth in the metaverse. On the other hand, the metaverse is related to the internet itself, which no company owns, but we are all users. Technologies will be the first enablers to drive the transition from the current internet to the metaverse. The ecosystem will allow people to live and have fun in an immersive and shared environment (LEE et al., 2021).

III.   Metaverse in the automobile industry

It is important to note that the metaverse is a complex system that relies on a myriad of supporting technologies. As a result, according to Pengyuan Zhou (2021), in recent years the automotive industry has also been experimenting with VR - Virtual Reality - (*Virtual Reality*), aimed at the customer, whether in terms of in-car entertainment or for viewing vehicle models in immersive environments.

The metaverse in the automotive industry can revolutionize the way companies relate to their customers, allowing dealerships and automakers to offer more immersive and personalized experiences.

One of the main applications of the metaverse in the automotive sector is the possibility of offering customers the opportunity to virtually experience cars, allowing them to test drive in a simulated environment, without having to go to a physical dealership. This can make the buying process easier and more accessible to a wider audience.

In addition, the metaverse can be used for training and capacity building for industry professionals, allowing them to learn about new technologies and processes in a more efficient and interactive way. It can also be used to improve production line efficiency and quality, allowing employees to work safer and more efficiently.

However, there is still a long way to go for the implementation of the metaverse in the automotive industry, especially regarding the infrastructure needed to support the technology. But it is undeniable that the metaverse offers a series of opportunities to improve the relationship between companies and their customers, improving the experience and consumer satisfaction and, consequently, brand loyalty.

The metaverse "opens the door to a whole new world," said Nils Wollny, CEO and co-founder of Holoride, an entertainment technology startup that works with Audi, Ford, Mercedes-Benz, Hyundai and Porsche. Holoride's VR technology, combining navigation and car data to create immersive, location-based experiences using lightweight, more adaptive headsets, is working on expanding its vehicular entertainment, currently focused on games, to allow developers to create content more easily for your platforms.

With this, using the artificial environment to experiment with new ways of building cars will make the experience of going anywhere easier and more fun, however, despite a strong industry involvement in VR for vehicular applications, it is perceived that academic research is still remains limited.

IV. Material and methods

In order to answer the question about how the metaverse can contribute to the automotive business in São Bernardo do Campo, as well as expand its functionality to the region, this project comprises a set of methodologies to be used in order to maintain academic rigor, to know:

● Search for articles published between 2018 and 2022, in CAPES Journals database aimed atthe words"metaverse", "metaverse and "metaverse and car". Following a rigorous research protocol considering only peer-reviewed journals published in excellent quality academic journals, building a theoretical framework and raising the bibliographic frontier.

● The research was initiated by the already mentioned capes journals, where when the word "metaverse" was inserted in the search tab, exactly 179 articles related to the chosen theme were found. Selected the peer-reviewed filter,they were handed out46 works related to the subject in question and after refining the search, 15 articles were delivered (written between the years 2018to 2022)and with these 15 articles, the work in question began.

● In order to give more breadth in the development of the research, the word "metaverse" was also searched on the capes journals platform, in which 2046 articles related to the topic in question were presented, when going to the peer-reviewed tab, 428 documents were shown and the As of 2018, 326 works on the subject were presented. After that, the term "metaverse and car" was also searched in the search tab, in which exactly 11 articles were presented, which, like the previous ones, were also collected for study and analysis.

● The use of research results in the field, contacting a professional in the area and directing questions in order to obtain other opinions on the subject studied and recover knowledge about.

● Research with statistical understanding effort with the consumer target audience to be verified by means of a five-point Likert scale, where one is the worst experience and five is the excellence of the method.

V.   Result Searches

In view of the analysis of the contents referring to the Metaverse and its presence in the automotive area, three questions were elaborated with the objective of rescuing an opinion on the subject studied, which were questioned and directed to the professional who works in the field and has direct contact with the industry, possessing great experience and knowledge, focusing on field research.

The first question was about the definition of metaverse from the interviewee's perspective. He responded quickly and spontaneously that the metaverse is something innovative and brings people closer to the product, bringing ease and a different experience to the user.

The second question was about how the metaverse can impact the user experience with the increasing integration of digital technologies. The interviewee stated that the user is one of the key parts of the company and that the metaverse totally influences the first contact with the person, making the customer more comfortable. He also highlighted that the metaverse takes the dealership to the customer, which has a lot of impact and is very important when selling a product.

Finally, the third question was about the possibility of the metaverse becoming a reality in the automobile industry, according to the interviewee's experience. He replied that the metaverse is already a reality today, not only in the sale of products, but also in training to professionalize people on the assembly line. However, he observed that the metaverse is still moving forward in Brazil in relation to sales and after-sales as a whole, mainly in the automotive sector.

After knowing and digitizing the answers, Bardin's content analysis was used to categorize them, applying the methodological technique and exploring the material presented, using the Word Counter software to identify the keywords of each answer and, thus, assemble a table with the result.

Table 2 – Content Analysis

| Answers	Content Analysis Categories
First	People. User. Ease. Experience.
Second	Contact. Client. Make yourself comfortable.
Third	Reality. Sale. At the moment. Relationship.

Source: Prepared by the author.

On the other hand, in order to obtain another analysis about the Metaverse, a form was assembled with some questions for the general public, to measure an effort of statistical understanding through the five-point Likert scale, which it was possible to form graphs and discussions on the topic.

The first question represents the age of the target audience, showing the majority between 18 and 30 years old, being 75.3% of the interviewees.

Quantos anos você tem?
89 respostas

- Menos de 18 anos
- 18 - 30 anos
- 31 - 45 anos
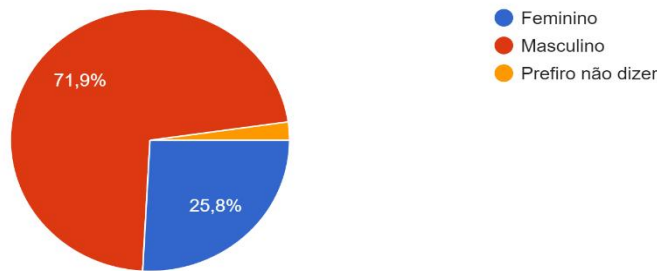- 46 - 60 anos
- Mais de 60 anos

13,5%

75,3%
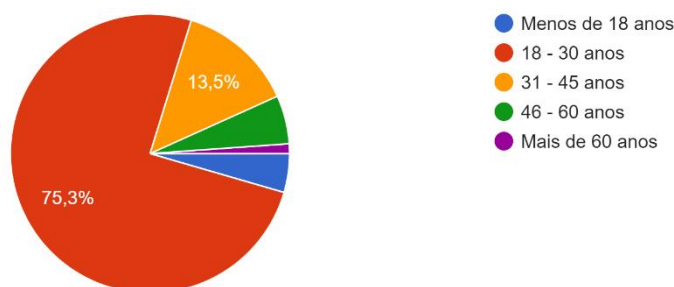
Source: Prepared by the author.

The second question induces a male majority in the responses, obtaining 71.9% of respondents identifying themselves as male.
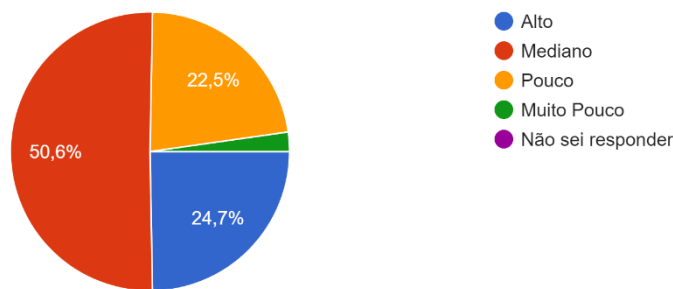
Qual seu sexo?
89 respostas

Source: Prepared by the author.

The third question demonstrates that most people are even reasonably interested in new technologies, with 50.6% having a medium level of interest, 24.7% a high level and 22.5% having little interest.

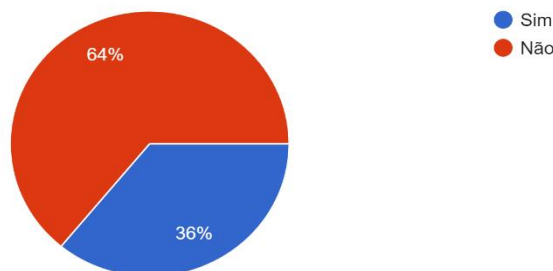Qual seu nível de interesse diante das novas tecnologias?
89 respostas

Source: Prepared by the author.

The fourth question shows that even though most of them are interested in new technologies, more than half have never used virtual reality.

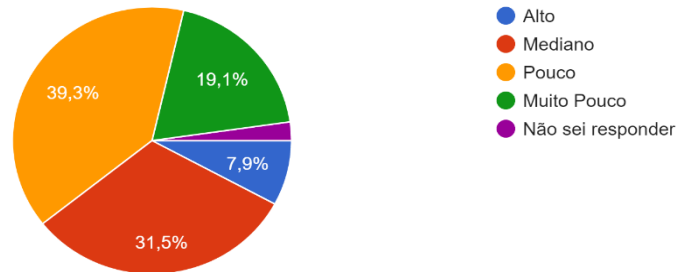Você já fez uso de alguma realidade virtual?
89 respostas

Source: Prepared by the author.

The fifth question emphasizes the little or medium knowledge when the subject is Metaverse, being together 70% of the interviewees.

Qual seu nível de conhecimento em relação ao Metaverso?
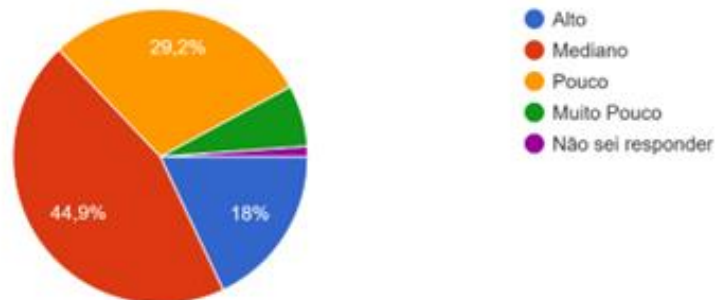89 respostas

Source: Prepared by the author.

The sixth question aims to find out the interviewees' relationship with the automobile industry, obtaining that 44.9% are interested.

Qual seu nível de interesse em relação ao ramo automobilístico?
89 respostas

Source: Prepared by the author.

The seventh question relates the idea of the Metaverse to the automotive industry, emphasizing that almost all respondents find the subject Interesting or Very Interesting.

O que você acha da ideia de utilizar um ambiente virtualizado para conhecer melhor as funcionalidades de um automóvel e até dirigir o mesmo?

89 respostas
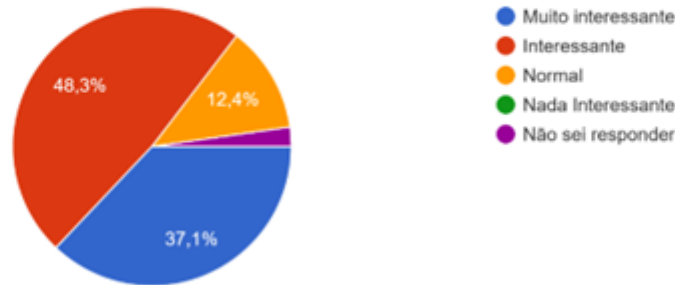
Source: Prepared by the author.

VI. Results and discussions

Judging by the readings of the metaverse articles, although they are not numerous, it was highlighted in the research that the problems discussed in the articles are largely limited to theoretical approaches. Therefore, it is believed that there is still room to idealize the concept and definition of the term "metaverse", since the final product needs performance and technological advancement to integrate virtual environments, users and the real world, thus allowing interaction with society as a whole, that is, the spread of the metaverse. In this way, in the view of the portrayed authors, we seekthe conceptualization of the term metaverse, according to table 2:

Table 3 - Definition of Metaverse

Author	Definition Metaverse
Lopez-Diez, (2021)	A widely used term to refer to digital virtual worlds that coexists with other terms such as virtual reality, virtual worlds and certain types of cyberspace.
Ning et al., (2021)	Defined through three main basic characteristics: multi-technology, to achieve an experience; sociability, as it is a new form of social interaction; and hyperspace-time.
Reuters, (2021)	A broad term that generally refers to shared environments of the virtual world that people can access over the Internet, referring to digital spaces made more realistic through the use of virtual reality or augmented reality.
Suh and Ahn, (2022)	Defined as communication technology, graphics, computing, virtual reality and artificial intelligence, making it possible to configure a virtual space that is similar to reality.
Mark Zuckerberg, (2021)	A new line of business that will be covered strictly in a world with immersive virtual reality interfaces and a series of possibilities to share with different users in real time.

Source: Prepared by the author.

In order to understand and define the structure of the metaverse, relying on the theoretical basis of the selected articles and analyzing the integration of technologies aimed at the virtual and real environment, in the attempt to build and describe the characteristics of this structure, table 3 is presented:

Table 4 – Characteristics of the Metaverse

Author	Features of the Metaverse
Matthew Ball, (2021)	Metaverse should be differentiated from: virtual worlds, virtual reality and a game or just a new user-generated content platform.
Nils Wollny, (2021)	It opens the door to a whole new world.
(LEE et al., (2021)	The ecosystem will allow people to live, play in an immersive and shared environment
Lopez-Diez, (2021)	Users will really feel like they are with other people.
Mark Zuckerberg, (2021)	Technologies that help connect people, find communities, and grow businesses.

Source: Prepared by the author.

On the other hand, based on the responses of the automotive professional, it is possible to conclude that the metaverse is considered an innovative and promising technology that benefits both companies and customers. It brings the customer closer to the product and offers a differentiated experience, making the first contact more pleasant and personal.

VII. Relating Results

Although the metaverse is already being used in other modalities, such as training for professionalization, there is still a long way to go in the automotive industry, especially in sales and after-sales. However, it is clear that the metaverse is consolidating itself as an important tool for the sector, with the potential to improve customer satisfaction and increase brand loyalty.

In addition, the personalization of the customer experience and ease of access to the product are aspects highlighted by the professional, highlighting the potential to be improved by the metaverse and differentiating it from a common technology. Regardless of the market in which they operate, customers expect a positive and personalized experience, which increases brand trust and loyalty.

It is important to emphasize that the metaverse is more than an isolated product, but the integration of several projects and tools aimed at the target audience, which requires the construction of a cohesive ecosystem.

The sentence by Ning et al (2021) can be related to the opinions presented by highlighting the three basic characteristics that define the Metaverse and that are relevant to the automotive sector.

Multitechnology is mentioned as fundamental to achieving an immersive and personalized experience for the user, which is highlighted by the interviewee when mentioning the importance of Metaverse in making the customer more comfortable and positively impacting sales.

Sociability is mentioned as a new form of social interaction that Metaverse makes possible, which is relevant for the automotive sector, where the opinion of friends and family can influence the purchase decision. This characteristic is also highlighted by the research that shows that the union of the Metaverse with the automotive sector arouses great interest in people.

Finally, hyperspace-time is mentioned as a feature that allows creating a virtual space that transcends the limitations of time and physical space. This is relevant for the automotive sector, where the possibility of taking the dealership to the customer through Metaverse can represent an innovation and allow companies to reach new audiences and expand their business more efficiently.

Thus, the opinions presented and the sentence by Ning et al (2021) converge when highlighting the fundamental characteristics of the Metaverse and its importance for the automotive sector, both to improve the user experience and to expand the reach of companies.

VIII.   Final considerations

By analyzing the entire process of research development, from bibliographic reviews to field research, it was possible to identify connection points both by researchers, specialists working in the area and by consumers of automobile services.

Therefore, the proposition of using Metaverse as a disruptive innovation tool to optimize the user experience in the automotive sector can be considered as a promising approach, since the curiosity and interest involving the use of virtual reality through integration was noticeable. of advanced virtual and augmented reality technologies, in which automotive companies can exponentially transform the way consumers experience and interact with their products.

Therefore, the Metaverse has a great power to significantly enhance and improve the user experience with technology. In this way, it can be concluded that the Metaverse proposition to optimize the user experience in the automotive sector is a promising strategy for companies that seek to stand out in an increasingly competitive market, finding that using the right technology and a focused approach on the user, it is possible to offer completely innovative shopping and interaction experiences.

From the studies, it is concluded that the application of the metaverse concept in the automotive sector is already a reality in some companies, mainly those that seek disruptive innovation to stand out in an increasingly competitive market, however it is essential that companies in the automotive sector to invest in research and development to improve metaverse technologies and make them increasingly accessible and intuitive for the user.

Thus, the metaverse concept can be increasingly applied and create incredible and personalized experiences in everyday life. Therefore, it is expected that this work will contribute to the understanding of the Metaverse and its impact on the world today, and also that it will serve as an incentive and inspiration for future studies.

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