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Where Are We Now?—Exploring the Metaverse Representations to Find Digital Twins

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Abstract: The Metaverse promises to change our lives and how we usually interact with the world. However, it can only evolve with technological development and entertainment engagement advances. To investigate more leads regarding this concept, we have a main search question: How are the Metaverse, gaming, and digital twins represented in Academia? To answer it, we need to verify and determine how the Metaverse is defined, how gaming, as an entertainment industry, is represented, and how Digital Twins are defined by scientific knowledge. It will also be important to analyze how these concepts are intercorrelated. Here, we present a documental study—meta-analysis—of the most relevant indexed scientific papers published in the last ten years, according to predefined inclusion and exclusion criteria. Leximancer software will help us determine the main concepts and themes extracted from these articles—namely from the Keywords, Abstracts, Methodologies, and Conclusions sections. This study allows us to understand how these concepts are perceived, contribute to a scientific discussion, and give suggestions for future research and new leads on approaching these concepts.

Keywords: metaverse; gaming; adults; virtual worlds; virtual reality; digital twins

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1. Introduction

The significance of technology in our daily lives is undeniable, acting as a pervasive force that shapes our interactions, work dynamics, and learning experiences. The intricacies of modern existence underscore technology's essential role in personal, societal, and economic advancement. This all-encompassing influence is not merely a convenience but a transformative factor that has redefined the very fabric of human civilization, affecting communication, work methodologies, learning approaches, and entertainment modalities.

Since it appeared in gaming, the Metaverse concept has rapidly gained prominence, introducing immersive experiences facilitated by virtual reality technology [1]. These experiences not only serve as vital means of communication but also act as promoters of well-being [1]. The development of the Metaverse opens up new frontiers for innovation, prompting a continuous need for technological enhancement to redefine our digital existence further.

Digital Twins, a relatively recent concept, can enhance decision-making, optimize performance, and streamline processes across diverse industries. As a bridge between the physical and digital realms, Digital Twins emerge as potent tools for facilitating a deeper understanding of complex systems. But how can the Digital Twins help develop the Metaverse concept? Can they guide the technology needs for this concept?

And so we ask: How are the Metaverse, gaming, and Digital Twins represented in Academia? In this context, we also aim to understand (1) how the Metaverse is defined; (2) how gaming, as an entertainment industry, is represented; (3) how Digital Twins are represented by scientific knowledge; and (4) how these concepts are intercorrelated.

This research constitutes a segment of a doctoral investigation that conducted a comprehensive documentary analysis—meta-analysis—of the most pertinent scientific papers indexed within the last five years across prominent scientific databases, namely B-On, Scopus, and Google Scholar. The study meticulously utilized each paper's Titles, Keywords, Abstracts, Introductions, and Conclusions sections. Employing qualitative data from these sections, we applied the Leximancer software to conduct a textual or content analysis on the document texts, identifying high-level concepts. This process yielded vital ideas and actionable insights through models, enabling the creation and examination of a map highlighting emerging concepts and dimensions related to the Metaverse, gaming, and Digital Twins.

As a qualitative research tool under CAQDA (Computer-aided Qualitative Data Analysis Software), Leximancer facilitates observing relationships between the primary ideas within these concepts. Additionally, it serves as a valuable resource for exploring and deriving potential future studies, delving deeper into these emerging concepts and uncovering their interconnections.

The current study has been structured according to the PRISMA 2020 guidelines [2,3], starting with a general introduction and a concise literature review. Following these sections, we comprehensively explain the methodology, focusing on the themes and key concepts derived from the analyzed articles. Subsequently, we present the study's findings, followed by a discussion that considers the implications of the results. The study concludes with recommendations and suggestions for future research endeavors.

2. Background

2.1. Metaverse

Neal Stephenson's groundbreaking 1992 science fiction novel "Snow Crash" marked the inception of the Metaverse concept, envisioning a collective virtual shared space formed by the convergence of physical and virtual reality [4]. This expansive digital realm incorporates augmented reality, virtual reality, and the internet, offering users a continuous and immersive experience. As technological progress continues, the Metaverse has become a focal point for innovation, as evidenced by the ambitious vision proposed by companies like Facebook (now Meta), striving to create an immersive space surpassing current online interactions [5]. Mark Zuckerberg, Meta's CEO, envisions the Metaverse as the next evolutionary step for the internet, providing a three-dimensional digital environment for people to interact, work, and socialize [5].

The fusion of "meta" and "universe" in the term itself conveys a sense of transcendence and an encompassing digital world where daily life and economic endeavors can unfold [6]. This dynamic environment constitutes a three-dimensional virtual realm grounded in the physical world but liberated from physical constraints, facilitating interpersonal interactions through customizable avatars [7]. Participants engage in diverse social, economic, and cultural activities within this space [8].

The term "Metaverse" is an intermediary layer between our reality and the digital realm [9], denoting an expansive 3D virtual shared space. This conceptual space enables various activities facilitated by augmented and virtual reality technologies [10]. Some perspectives emphasize the Metaverse as a massively scaled and interoperable realm of real-time virtual worlds, experienced simultaneously and continuously by unlimited users through virtual and augmented reality technology [11,12]. Additionally, the Metaverse is conceptualized as an extension of the internet, with a consensus that it will possess interoperability and interconnectedness [13].

Despite being nascent, the Metaverse concept promises a transformative impact on how we connect, collaborate, and engage with digital content. Advancements in technology suggest that the Metaverse may become integral to daily life, unlocking new possibilities for creativity, communication, and commerce in an increasingly interconnected world.

Functioning as a post-reality universe and a collaborative, multiuser environment, the Metaverse seamlessly integrates physical and digital virtuality. This integration results in multisensory interactions and networked environments akin to the immersive experiences of massive multiplayer online video games [14]. The Metaverse converges various elements, embodying facets of online gaming, social networking, augmented reality, and virtual reality, providing a platform for extensive digital engagement [15]. The synergy between these elements highlights the Metaverse's potential to reshape the landscape of digital experiences and interactions in the foreseeable future.

2.2. Digital Twins

The Digital Twins concept, established in 1991 [16], was initially designed for NASA's Apollo program to enhance their spacecraft simulation models [17,18]. It was later introduced by Michael Grieves in 2002 at a conference at Michigan University [19,20]. Since then, it has become a significant technology trend, particularly gaining prominence in 2017, and is now widely used in various fields such as technology, academies [21], and engineering [22].

Digital Twins are essentially digital copies of physical objects [23,24], like a building or facility [25], that can mirror the real-world entity in real time [23]. They facilitate two-way communication between digital and physical objects [26], thereby helping organizations monitor, analyze, and optimize product lifecycle performance [23]. They are used to stimulate the components involved in the system [27] and find applicability in various industries, such as healthcare [28], urban planning [29], education [17], and design [30].

Data from sensors and other sources, such as BIM models [31], are collected to create Digital Twins. These represent the current state of the physical object or system [26,31]. They can be integrated with other emerging technologies [32,33], ensuring confidence, traceability, compliance, authenticity, quality, and security [34]. They have been implemented in academic spheres for diverse applications, ranging from diagnosing power electronic converters [35] to exploring parallel societies and social interactions [36,37]. They also have utility in the dynamic capture of robotic information [38], the development of digital double-edge networks [39], and various other innovative cross-disciplinary fields [31].

Digital Twins, defined as the collection of digital artefacts from components and a system, can evolve with real systems [40]. They connect to IT systems to use available digital information [40], serving as an evolution of monitoring, diagnostics, and optimization tools [30]. A digital twin is a comprehensive simulation that integrates multiphysics, multiscale, and probabilistic elements to replicate a real-world vehicle or system as initially built [41]. This simulation uses advanced physical models, sensor updates, fleet history, and other relevant data to accurately mirror the life and behavior of its corresponding physical counterpart [41].

A digital twin is a real-time virtual representation of a tangible, real-world physical system, acting as an indistinguishable digital counterpart for practical applications [42]. It is used for the analysis and prediction of the system's behavior, the optimization of its performance, and the ability to control it remotely [42]. The integration of the Internet of Things (IoT), artificial intelligence (AI), and software analytics into Digital Twins creates simulations that forecast the performance of a product or process [42].

The use of Digital Twins offers diverse advantages, including improved efficiency [43], reduced operational costs [44], promoting more sustainable processes, and facilitating predictive maintenance [45]. Digital Twins technology leverages real-time data to generate simulations that accurately forecast the performance of processes or projects. It integrates seamlessly with the Internet of Things, software analytics, and artificial intelligence, enhancing overall productivity [17]. While the predictions for the Digital Twins market are favorable, its full potential requires addressing significant limitations and challenges, as this technology depends on societal readiness and the maturity of technology [46]. Despite most applications still being in the early stages, the potential for transformation in various domains is significant [46].

2.3. Digital Twins vs. Metaverse

Digital Twins play an essential role in constructing the Metaverse, transforming the real world into a virtual space through comprehensive twinning [47]. This process involves continuous real-time communication between Digital Twins and their real-world counterparts, allowing the Metaverse to mirror the current state of reality [48,49]. Digital Twins are digital representations of physical entities or processes created based on data connections, serving as virtual "clones" aligned with real-world counterparts [50]. This enables the exploration of the entire life cycle of physical substances and processes, seamless data transmission between the virtual and real realms, and the realization of real-time, bidirectional information feedback [20,47].

The adaptability of Digital Twins extends across various fields, showcasing their flexibility [51,52]. In relation to the Metaverse, they manifest in diverse forms [47]. The connection between Digital Twins and the Metaverse finds resonance in quantum mechanics, particularly in the phenomenon of quantum entanglement [53]. Much like the instantaneous communication observed between entangled quantum particles, the interaction between reality and the virtual world in the Metaverse reflects a state of immediate sensing and communication [54]. This connection draws parallels between quantum entanglement and the realization of Digital Twins, manifesting the Metaverse where the real and virtual worlds achieve complete consistency [47].

Taking a broader perspective, the Metaverse is an expansive, enduring, and cohesive realm comprising diverse virtual environments, including Digital Twins networks, social networks, digital publishing networks, virtual 3D networks, cyber-physical infrastructures, cloud infrastructures, and blockchains [55]. Lee et al. [56] introduced the term digital twin-native continuum, outlining three developmental stages of the Metaverse. The initial stage primarily involves Digital Twins and digitizing the real world. In the subsequent stage, Digital Twins and other virtual entities come together to create isolated cyber-physical environments called many virtual worlds. Ultimately, these numerous virtual worlds become interconnected, forming the complete Metaverse. This focuses on envisioning the Metaverse as a space where large-scale simulations can be collaboratively conducted through extensive networks of interconnected Digital Twins [55].

As the Metaverse evolves, incorporating Digital Twins can enhance the realism and functionality of the virtual environments, providing a more accurate representation of physical objects and systems within the Metaverse. In this way, it contributes to a more immersive and potential reshaping of how we interact and perceive both virtual and physical spaces, unlocking new possibilities for collaboration, exploration, and problem-solving across different industries.

2.4. Gaming

The gaming world has undergone a remarkable transformation in recent years, evolving into a multi-billion-dollar industry that transcends traditional boundaries [55–58]. Video games have risen to the status of global entertainment, captivating a diverse worldwide audience. The immersive nature of modern gaming experiences, facilitated by advanced graphics, realistic simulations, and compelling narratives, has elevated the medium to new heights. As a result, gaming is not just a pastime but a cultural phenomenon that shapes social interactions and influences popular culture [57–60].

Online gaming has played a pivotal role in revolutionizing the industry, fostering a dynamic ecosystem where players can connect and compete in real time, irrespective of geographical distances [61]. Massive multiplayer online games (MMOs) have gained prominence, providing expansive virtual worlds for players to explore and collaborate. World of Warcraft and Fortnite have become virtual spaces where millions of users engage in cooperative and competitive gameplay, forming intricate online communities [61].

As technology advances, emerging trends such as virtual reality (VR) and augmented reality (AR) are poised to redefine the gaming experience [62]. Virtual reality headsets provide an immersive, 360-degree environment, while augmented reality overlays digital elements in the real world. These technologies can create even more engaging and interactive gaming environments, pushing the boundaries of what is possible in the gaming world [62].

The integration of virtual reality and augmented reality into gaming represents a transformative shift, offering players an unprecedented level of immersion and interaction. This evolution aligns with the industry's commitment to delivering cutting-edge experiences beyond traditional gaming norms. As virtual and augmented reality technologies continue to advance, the gaming world is poised for further innovation, promising thrilling and captivating experiences for players worldwide. The convergence of these technologies holds the potential to shape the future of gaming, pushing the boundaries of creativity and player engagement to new frontiers.

2.5. Metaverse, Digital Twins, and Gaming

The connection of the Metaverse, Digital Twins, and the gaming world forms a captivating nexus that shapes the landscape of digital experiences. The concept of the Metaverse, as initially envisioned in 1997 [63] and explored in 2005 [64], represents a virtual shared space where users engage in immersive experiences surpassing traditional online interactions. This evolving digital realm goes beyond being a mere extension of the internet, fostering interconnection and providing a platform for varied activities. Digital Twins bring a layer of realism to this virtual space by serving as replicas of physical entities [41,65]. In the gaming world, incorporating Digital Twins enhances the authenticity of virtual environments, contributing to a more immersive and engaging player experience.

Having the potential to replicate real-world entities in virtual spaces, Digital Twins find a significant application in the gaming world. As discussed, Digital Twins create lifelike characters, environments, and objects, enhancing the overall realism of virtual worlds [65]. This integration becomes evident in the Metaverse, where players can interact with and manipulate digital counterparts, closely mirroring real-world physics and dynamics. The result is a dynamic and responsive gaming environment beyond traditional boundaries.

Furthermore, the Metaverse is more than just a gaming platform. It is a dynamic social space where users interact. This combination of Metaverse and Digital Twins thus enhances social interactions within the digital realm, fostering a more immersive and authentic experience. As these technologies continue to advance and converge, the boundaries between the real and virtual worlds blur, opening up unprecedented possibilities for interconnected and lifelike digital environments [66,67].

2.6. Leximancer Software and Qualitative Research

We opted to utilize the CAQDA software Leximancer for our research, placing it in the category of typical data mining [68]. Leximancer is an efficient tool for conducting textual analyses on documents and extracting high-level concepts, key ideas, and actionable insights by applying models, interactive visualizations, and data exports. Utilizing machine learning, Leximancer identifies critical concepts based on their similarity and association with other words, subsequently generating and classifying a glossary for each dataset.

Leximancer, functioning as a text mining tool, can automatically generate merging concepts from text without requiring specific inputs [69]. This feature enables it to extract key concepts using concept maps, shedding light on trends, providing a swift understanding of new domains, and offering global scopes. The reliability and stability of Leximancer's analysis have been demonstrated, showing comparability to intercoder reliability [70]. It consistently produces stable maps for studies [69], facilitating in-depth data analysis and result gathering. This contribution is vital to qualitative research theoretical analysis, substantial context, and overall research confidence and sureness [6], which are imperative for any researcher. Leximancer has become widely utilized across various academic research domains, including business, the public sector, social sciences, cultural studies, education, leisure, and tourism [71], solidifying its status as a valuable asset for diverse research endeavors [68].

In our exploration, we identified qualitative research as the most suitable approach for comprehending various concepts, ideas, and dimensions related to our primary themes [68]. This method provided the flexibility to delve into the relationships between categories, allowing us to recognize their potential and transformations throughout the research process [72]. Consequently, we could concentrate on observing these aspects without needing extensive measurement, aligning with the qualitative nature of our study [73].

Qualitative research, whether adopting a more naturalist model observing voice and subjectivity or a constructionist approach examining emerging natural features in the social world, hinges on transforming life into extraordinary features [74]. This approach allows for uncovering significant aspects of the individual [13], granting access to subjective meanings beyond the scope of other methods. This phenomenon is recognized as the pluralization of life worlds [75]. It is crucial to note that qualitative research has evolved in tandem with technological advancements, influencing its trajectory [75].

In the realm of qualitative research, the role of technology is increasingly prominent. Qualitative Data Analysis (QDA) and Computer-aided Qualitative Data Analysis (CAQDAS) now play pivotal roles in data analysis, supporting the entire qualitative data analysis process [76]. QDA software significantly contributes to the validity of the analysis [77,78], enables research consolidation [76,79], and streamlines sample decisions [80]. And facilitating data management through various techniques such as retrieving indexed text segments, constructing electronic cross-references, and defining linkages between index worlds, variables, and filters [68].

Despite concerns voiced by some authors about potential distractions, technology, particularly QDA software, has demonstrated a substantially positive impact on the research process. It simplifies data management, enhances analysis, and opens up new possibilities beyond initial expectations [81,82]. Integrating technology into qualitative research has become instrumental in navigating the complexities of data analysis and fostering a more efficient and insightful research journey.

3. Methods

This section will detail our methodology. It is divided into the Data Gathering section, where we explain how we made the selection, describing the exclusion and inclusion criteria and sample characteristics. The Preparing and Analyzing Data section will describe the data analysis process using the Leximancer software. Finally, we will discuss the Concept Data Results, where we analyze the results of the Leximancer analysis.

3.1. Data Gathering—Articles

To conduct our study, we extensively explored major scientific database platforms, specifically B-On, Scopus, and Google Scholar. Our focus was on searching for indexed scientific articles, commencing with the initial consideration of four primary keywords: Metaverse, Gaming, Virtual Reality, and Digital Twins. In the initial phase of our research, it became apparent that employing these four keywords did not yield satisfactory results. Consequently, we reevaluated our approach and split them into two pairs.

The initial pair, comprised of Metaverse and Digital Twins, was chosen to delve into the intricate relationship between these two concepts. This exploration aims to enhance our understanding of how Metaverse and Digital Twins intersect and complement each other. The second pair consisted of Digital Twins and Gaming, providing a focal point to unravel the connections and synergies existing between Digital Twins and the gaming world. The rationale behind selecting these pairs stems from prior research insights that highlighted the Metaverse's foundational role in the gaming world [1,11,83,84], emphasizing the pivotal role of the gaming realm in shaping and advancing the Metaverse concept [15].

Our decision to exclude the virtual reality concept from the initial keyword search was guided by its inherent presence in a computer-generated environment [12]. Virtual reality naturally integrates into this setting, forming a seamless connection between the Metaverse and users [85]. By omitting virtual reality as a distinct keyword, we aim to focus explicitly on the organic and inherent integration of virtual reality within the broader Metaverse context. This strategic exclusion aims to streamline our exploration and analysis, concentrating on the core dynamics between Metaverse, Digital Twins, and Gaming.

For selecting the 24 articles/scientific papers (Table 1), we considered inclusion and exclusion criteria. For the inclusion criteria: having at least two keywords mentioned from the main four used; having at least one of these keywords mentioned in the title; mentioning at least three key concepts mentioned in the text; the concept of the article is aligned with the goal of our study. As for the exclusion criteria, they should not be included in any inclusion points. We have not made a publication year limitation; however, since Digital Twins has been a recent concept since 2017 [42], it is justified that the relation between this concept only started appearing around 2019. Please see Figure 1 that shows the PRISMA 2020 flow diagram for systematic reviews.

Table 1. The selected articles.

Articles	Published By	Year
[46]	MDPI	2023
[86]	MDPI	2023
[24]	IEEE	2023
[87]	IAARC	2021
[56]	ARXIV	2021
[31]	MDPI	2023
[88]	CellPress	2022
[47]	Elsevier	2022
[27]	Taylor and Francis	2019
[26]	MDPI	2020
[89]	IEEE	2022
[42]	ASME	2023
[17]	Elsevier	2022
[20]	IEEE	2023
[90]	IEEE	2022
[91]	ACM	2023
[92]	Elsevier	2023
[93]	MDPI	2023
[55]	JMIRx Med	2022
[94]	MDPI	2023
[95]	IEEE	2023
[96]	IEEE	2023
[97]	IEEE	2022
[98]	Springer	2023

The majority of the articles were from 2023 (54.1%), and the remaining were from 2022 (29.2%), 2021 (8.3%), 2020 (4.2%), and 2019 (4.2%) (Table 2). Looking at the article types, we can observe that the majority are Journal Papers (83.3%), and the remaining are Conference Papers (12.5%) and pre-print (4.1%) (Table 3).

Table 2. Type Articles Years Information.

Type Articles	Count	%
2023	13	54.1
2022	7	29.2
2021	2	8.3
2020	1	4.2
2019	1	4.2

Table 3. Type Articles Information.

Type Articles	Count	%
Journal Paper	20	83.3
Conference Paper	3	12.5
Pre Print	1	4.2

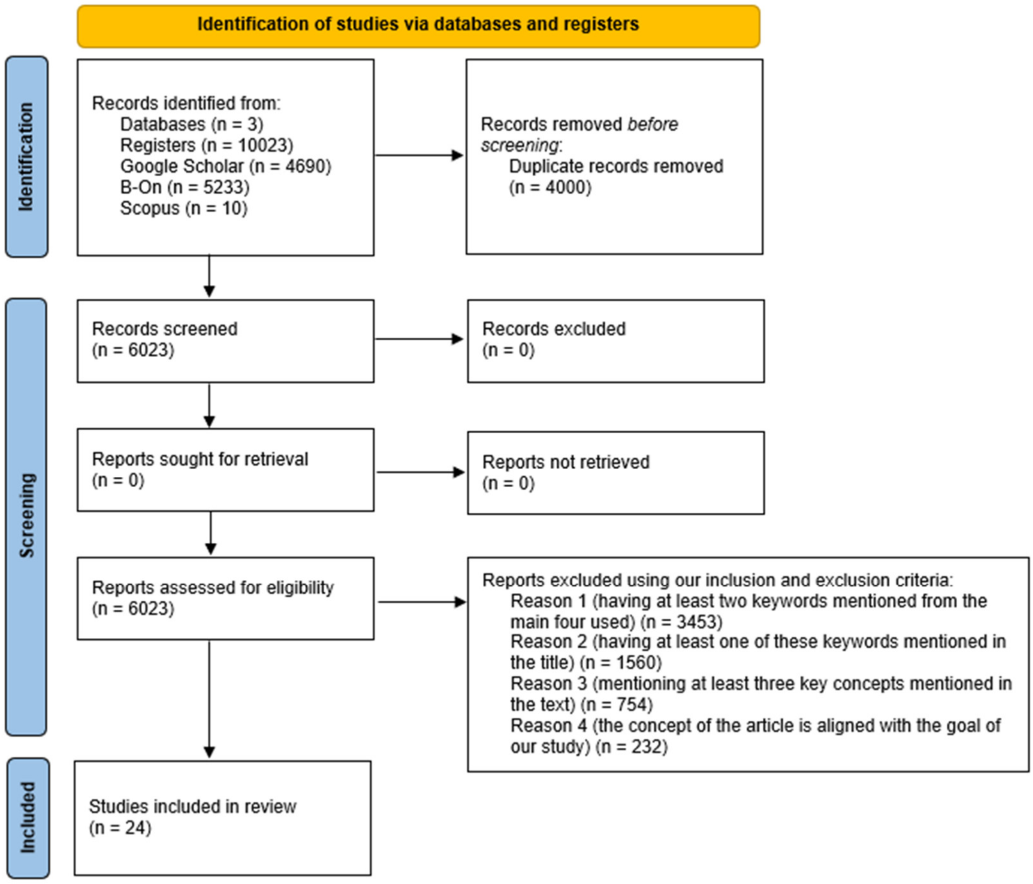

Figure 1. PRISMA 2020 flow diagram for systematic reviews.

It is possible to observe the diversity of publishers, perhaps because of the novelty of the theme, but the most recurrent are IEEE (29.2%), MDPI (25%), and Elsevier (12.5%) (Table 4).

Table 4. Published By Information.

Published By	Count	%
Taylor and Francis	1	4.2
IEEE	7	29.2
MDPI	6	25
Elsevier	3	12.5
ACM	1	4.2
ARXIV	1	4.2
ASME	1	4.2
CellPress	1	4.2
IAARC	1	4.2
JMIRx Med	1	4.2
Springer	1	4.2

3.2. Preparing and Analysing Data—Procedure

After meticulous selection based on predefined inclusion and exclusion criteria, 24 articles were carefully chosen for our study. All freely available PDFs were systematically arranged into a dedicated folder to streamline our organization process. Subsequently, we extracted comprehensive data from each article, covering essential elements such as titles, abstracts, keywords, introductions, conclusions, year of publication, published as, and published by. This information was then consolidated into a structured Excel spreadsheet, representing each category in distinct columns. The rationale behind incorporating elements such as titles, abstracts, keywords, introductions, and conclusions was strategic, each contributing unique value to our research [99–102].

Following the meticulous data collection, we systematically generated five distinct text files: titles, abstracts, keywords, introductions, and conclusions. Each file was methodically populated with data extracted from the corresponding articles, ensuring a coherent alignment with the designated file titles. For instance, the titles file contained all article titles, and this consistent pattern persisted across the other files. These text files, repositories of extracted information, were then meticulously uploaded and analyzed one by one using Leximancer. Special attention was given to language standardization, including merging similar words, addressing singular and plural forms, and eliminating insignificant words such as definite and indefinite articles (e.g., a, an, or the). Subsequently, concept maps were constructed through Leximancer, offering a nuanced analysis aligned with our research question, objectives, and theoretical–conceptual literature reviews. We used the following configurations for all the concept maps created: visible concepts—100%; theme size—50%. These concept maps, visually depicting primary concepts distilled from the articles, are crucial in representing thematic groupings with shared textual elements [103].

It is essential to note that these concept maps, generated through Leximancer, provide visual clarity to the primary concepts extracted from the articles (Figures 1–5). Each cluster of concepts represents a thematic grouping that shares common textual elements [103]. Importantly, these concept maps can be replicated as necessary, offering a dynamic and adaptable tool for ongoing analysis [103].

3.3. Concept Data Results

According to the titles extracted (Figure 2), we can observe that the Leximancer software has produced three main themes: two have similar relevance, Digital and Twin (Table 5), and the other, Digital Twin, has a 100% relevance (Table 5). These were the main concepts expressed in all the titles of the 24 articles. This result highlights the importance of the Digital Twins concept as a creator and builder of the dynamic digital complement of physical objects reflecting real-world entities in real time [23–25] and showing the readers the most central concept they aim to develop in their research.

Table 5. Titles relevance table.

Concepts	Count	Relevance (%)
Digital Twins	4	100
Digital	3	75
Twin	3	75

We can observe the keywords extracted from the articles (Figure 3), which have four main themes: COVID, Digital, Reality, and Twins (Digital Twins). We can see in Table 6 the relevance percentage of the main concepts. We can observe the connection and relationship that the Digital Twins have with the Metaverse through the concept and transformation of the Reality concept and the technological accent from the Digital and Virtual worlds. This allows us to understand that concepts, such as Digital Twins, Reality, and Virtual, are almost lifecycle main components for the existence of the Metaverse. As for the COVID theme, mention is natural since some of the articles mention using these concepts to overcome COVID-19 pandemic difficulties.

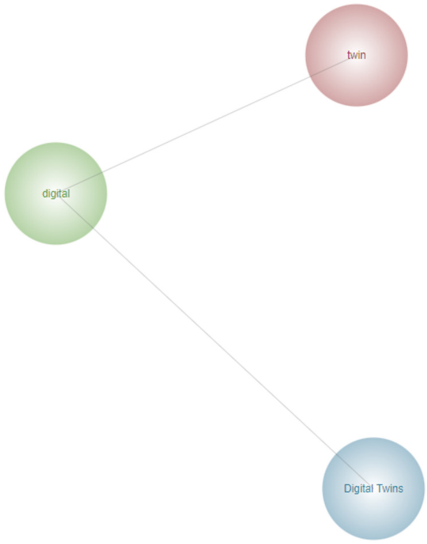

Figure 2. Titles concept map.

Table 6. Keywords relevance table.

Concepts	Count	Relevance (%)
COVID	5	100
Digital	5	100
Reality	5	100
Twin (Digital Twins)	5	100
Twins (Digital Twins)	5	100
Virtual	5	100
Digital	4	80
Metaverse	4	80

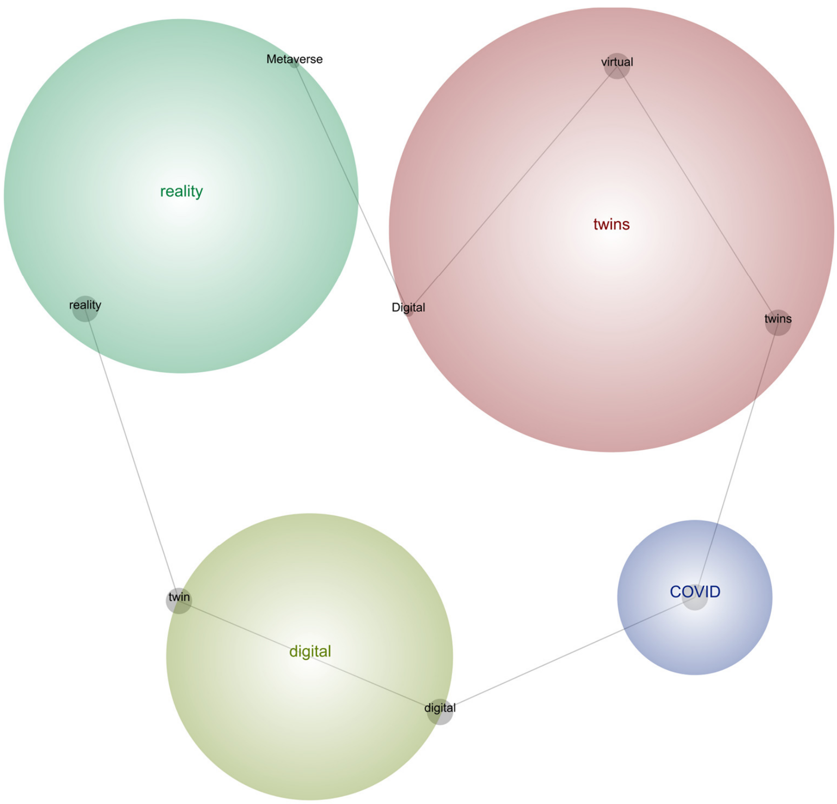

Figure 3. Keywords concept map.

According to the abstracts analysis, we can observe six main themes: Digital Twins, Technologies, Worlds, Use, Future, and 3D (Figure 4). Table 7 represents the percentage of relevance of the main concepts, with Digital Twins (100% relevance) and Technologies (60%) being the most relevant main themes.

The results confirm what we previously found, with the keywords analysis, that the Digital Twins concept is connected with the Metaverse and that these two concepts are connected to the virtual worlds. Technologies are the base connection of the Digital Twins and should be seen as a development for the future. Digital Twins or the Technologies depend on their use by users through their needs, mainly for game or gaming actions. The 3D concept appears connected to the virtual environment because it is essential to create the most engaging virtual worlds possible for the user.

Table 7. Abstracts relevance table.

Concepts	Count	Relevance (%)
Digital Twins	48	100
Digital	45	94
Virtual	41	85
Metaverse	39	81
Technologies	29	60
Worlds	21	44
Use	19	40
Paper	14	29
Immersive	14	29
Construction	13	27
Users	11	23
Development	11	23
3D	10	21
Physical	10	21
Study	10	21
Industry	10	21
Presents	9	19
Various	9	19
Research	8	17
Urban	8	17
Data	8	17
Social	8	17
Intelligence	8	17
Propose	8	17
Need	7	15
Game	7	15
Vsps (Virtual Service Providers)	6	12
Future	6	12
Process	5	10

Observing the results of the introduction, Figure 5 shows six main themes: Technology, Virtual, Potential, Industry, Used, and Paper. As for the concept with the higher percentages of relevance, we have the Virtual (100%) and the Metaverse (87%); see Table 8.

Once again, we can observe the importance of the virtual concept for creating the potential for the Metaverse concept. Without this technology, we could not see the connection between the Metaverse and Digital Twins concepts because the Digital Twins concept is considered something that will help the learning process so they can be integrated with its technology in future industries. The concept paper emerges naturally since technology plays an essential role in the online environment.

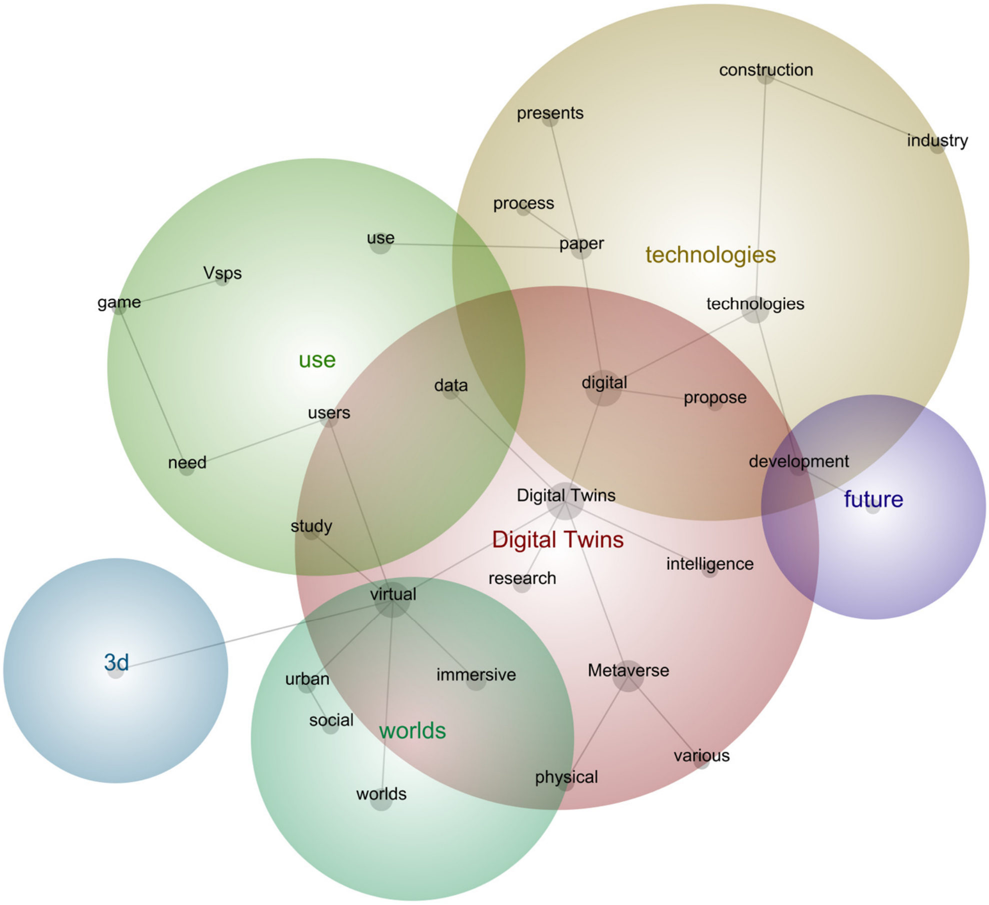

Figure 4. Abstracts concept map.

Table 8. Introductions relevance table.

Concepts	Count	Relevance (%)
Virtual	186	100
Metaverse	162	87
Digital	110	59
Technology	106	57
DTS (Digital Twins)	101	54
World	92	49
Physical	82	44
Users	53	28
Used	52	28
Data	44	24
System	43	23
AR (Augmented Reality)	41	22
Reality	41	22
Real	39	21
Social	39	21
Development	39	21
VR (Virtual Reality)	33	18
Construction	33	18
3D	32	17

Table 8. *Cont.*

Concepts	Count	Relevance (%)
Environment	32	17
Various	31	17
Potential	31	17
Immersive	29	16
Research	28	15
Applications	27	15
Paper	27	15
Experience	26	14
Industry	26	14
Concept	25	13
Information	25	13
Urban	25	13
Future	25	13
Learning	25	13
Create	24	13
Models	23	12
Interaction	19	10
Time	19	10
Online	17	9
Model	17	9
Service	15	8
Work	14	8

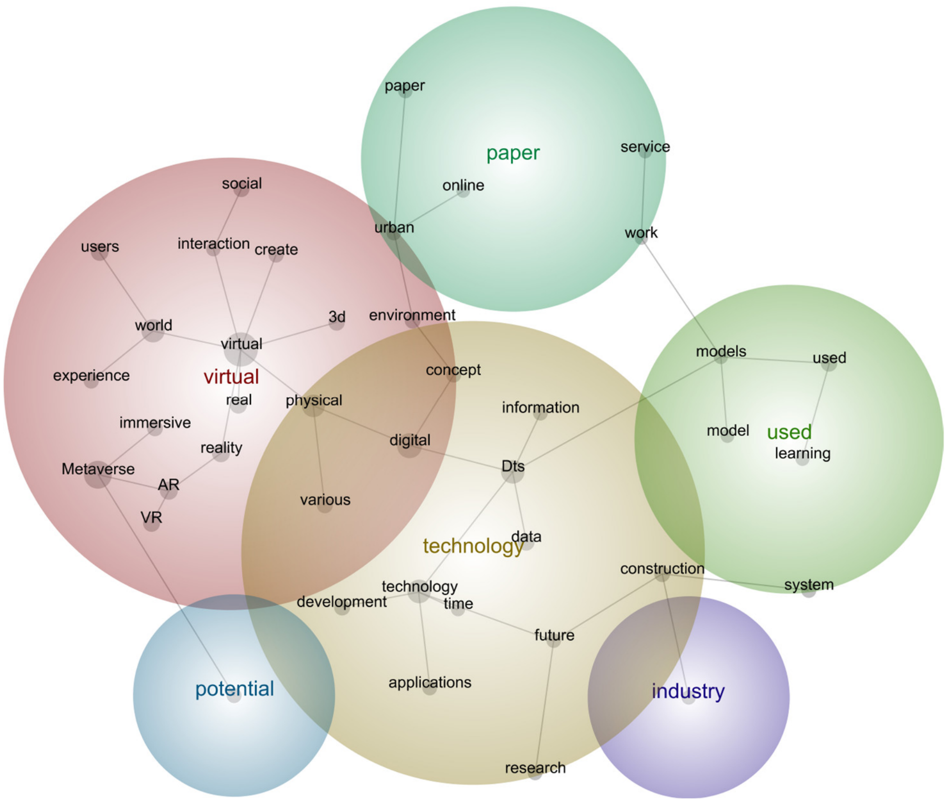

Figure 5. Introductions concept map.

As for the conclusions analysis (Figure 6), we can see five main themes: Virtual, Technology, Data, Virtual Reality, and Model. In Table 9, we can see that the most relevant concepts are Technology (100%), Digital Twins (89%), Virtual (68%), and the Metaverse (58%).

As the other analysis shows, the main focus is on technology and technological development. Digital Twins technology has demonstrated its potential when approaching digital virtual reality and worlds, showing the potential it can bring to the Metaverse concept. It is also important to understand that the models created by the data given to the technology have a significant role in developing technology or more technological contributions to train and gain more virtual reality insights.

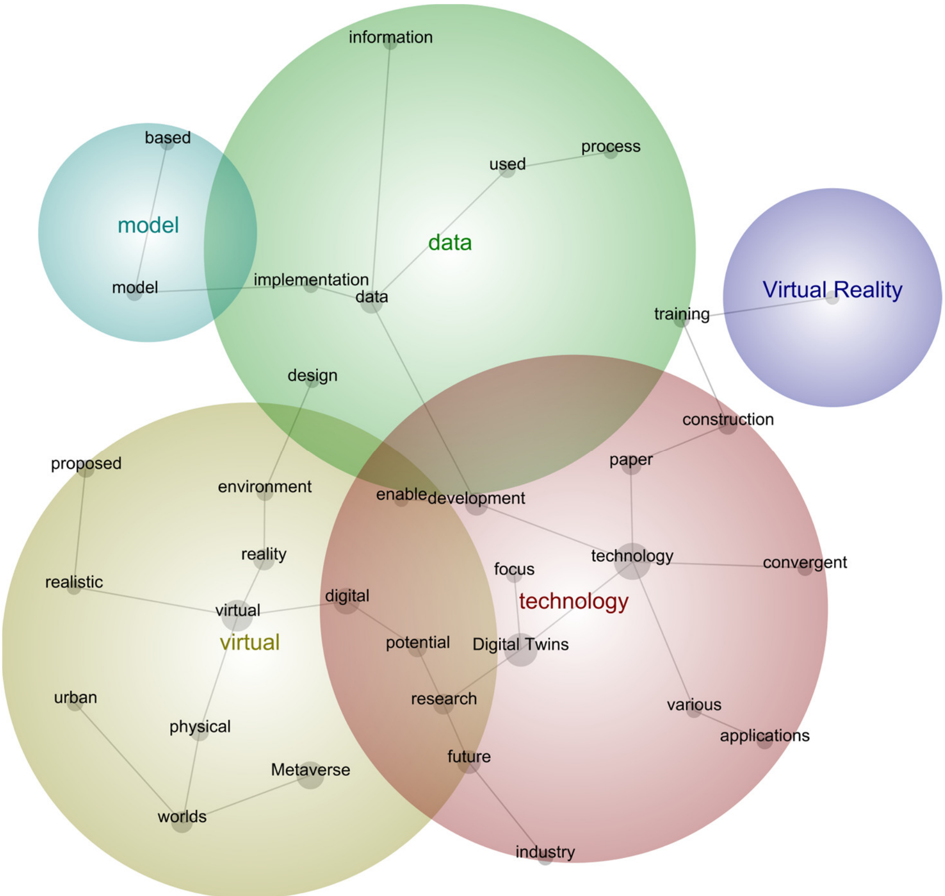

Figure 6. Conclusions concept map.

Table 9. Conclusions relevance table.

Concepts	Count	Relevance (%)
Technology	79	100
Digital Twins	70	89
Virtual	54	68
Metaverse	46	58
Digital	43	54
Future	35	44
Data	34	43
Development	33	42
Worlds	31	39
Reality	29	37
Paper	26	33
Construction	25	32
Research	23	29
Physical	22	28
Used	22	28
Proposed	21	27
Potential	19	24
Applications	18	23
Urban	17	22

Table 9. *Cont.*

Concepts	Count	Relevance (%)
Training	16	20
Model	16	20
Industry	16	20
Environment	14	18
Various	14	18
Process	14	18
Convergent	13	16
Implementation	13	16
Information	13	16
VR (Virtual Reality)	12	15
Focus	12	15
Based	12	15
Realistic	11	14
Enable	10	13
Design	10	13

4. Discussion

Our findings gave us essential findings regarding the Metaverse, Gaming, and Digital Twins representations, contributing to understanding a more profound knowledge of these individually and their relation.

As for our first objective, how the Metaverse is represented, we can observe the relationship between the Digital Twins and virtual reality. The virtual reality concept appears naturally since the Metaverse can be defined as a computer-generated environment [12] that connects users through avatars [85], creating an immersive virtual environment [68] centralizing platforms in different activities [104] through this technology. As for the Digital Twins concept relation, we could understand that they are a part of the technology use or can be used by the Metaverse since they are connected with digital and virtual reality. In this way, we understand that the Digital Twins concept allows the Metaverse to achieve complete consistency between the real and virtual worlds [47]. Some authors also claim that the Digital Twins are part of the three development stages of the Metaverse [55], showing the potential significant transformation with incorporated technology [104].

Regarding the gaming industries being represented, our second objective, we can understand that it is clearly stated as a means by which users allow themselves to be immersive and engage with the Digital Twins and the Metaverse technologies, showing its potential as an entertainment media art promoter of these technologies. The gaming industry has potentialized technology, becoming a lived experience [6], using technology to create engaging and immersive experiences that can evolve with technology development [83]. We cannot forget the importance of the gaming world because it is the founder of the Metaverse [1,11,84]. This media art entertainment is the focal point where the animation will combine virtual reality [84] and join the technology evolution to generate new user experiences by creating new realities, languages, and types of communication to a single or global scope and, therefore, transform the society [105].

Regarding our third objective, how the Digital Twins are represented, we could see that they are considered the core means to connect the technology to the Metaverse concept. It shows that the future is promising since it can and is evolving and has numerous applications. They are changing how virtual and digital worlds build physical objects essential to online communication. These results are precise and show us the Digital Twins' purpose, which is to develop or facilitate [25] digital replicas of physical objects [23,24], allowing the creation of a dynamic digital counterpart that mirrors the new real-world entity in real time [23]. It also brings the ability to monitor, analyze, and optimize performance in industries [19], enabling two-way communications between digital and physical objects [24] and linking between worlds [24]. The Digital Twins, in this way, show us their importance as a technology and in Academia [21], being able to extend their applicability through diverse industries such as healthcare [28], urban planning [29], education [17], design [30], and entertainment, through the gaming world.

As for our last objective, how these concepts are intercorrelated, we were able to see a clear path in their relation. The Metaverse will continue to use technology evolution to engage users in virtual and immersive experiences, using the gaming industry to reach users. The Digital Twins will be used as a technological set to optimize and enhance the Metaverse concept, aiming for an even deeper immersive experience through the Metaverse user's interactions, allowing the Metaverse to become closer to its complete version [55]. In this way, the connection to these concepts (Metaverse, Digital Twins, and Gaming) will become a nexus that will shape the landscape of digital experiences, surpassing traditional online interactions. Digital Twins bring a layer of realism to the virtual space [41,65], which, incorporated with the gaming world, will enhance the authenticity of the virtual environments, creating a more immersive and engaging player experience. The integration of these combinations becomes evident in the Metaverse because players will interact and manipulate digital counterparts, closely mirroring real-world physics and dynamics, resulting in a dynamic and responsive gaming environment beyond traditional boundaries.

5. Research Limitations and Future Work

The number of papers selected can be considered limited. A more comprehensive sample could reinforce our results or lead us in new directions, exploring broader concepts. Nevertheless, for a meta-analysis, 24 is considered a good sample. Another limitation could be our choice of keywords, and other decisions could allow more or fewer articles. However, these decisions were made with the validation of previous studies.

In future studies, we will continue to analyze these concepts through their evolution and continuously understand how far or close their relationship may be in the future.

6. Conclusions

The surprising developments technology can bring to the Metaverse concept are impressive. The future continuously guides us through different experiences and allows us to learn from the past. Our minds will enable us to keep progressing through the future. Modern society has created awareness of technological needs, not only on a personal level. Technology has come to influence our lives in every aspect. One of the most essential aspects is in the entertainment area, looking up to our need to play. Games have shown us this importance since primitive cavemen. Today, technology enhances our playing, creating different ways of relating and communicating with others and virtual worlds.

Although on a media art level, through films, mankind showed us their fears and challenges dealing with technology evolution, the idea of technology helping humans (WALL-E, Disney movies) may be closer to our reality.

Looking at the relationship between the three concepts (Metaverse, Digital Twins, and Gaming), we see almost an expected life cycle of mutual help since they create a better experience and overcome new obstacles, creating new possibilities for the future. Looking at our results, it seems like a bright future. We cannot forget that life is made up of personal achievements. However, when we join forces with others, the capacity that leads us to discovery is more incredible and, therefore, brighter. The same applies to technological development when the gaming world enters virtual digital achievements through Digital Twins, which can overcome obstacles and help us reach closer to a complete Metaverse concept.

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