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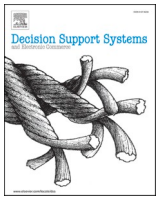

Looking forward through the rear-view mirror: A socio-technical imaginaries perspective for envisioning the Metaverse beyond the hype

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ABSTRACT

We build upon the theoretical underpinnings of federated networks and adopt a socio-technical imaginaries perspective to envision the future of the Metaverse, informed by an understanding of the past and an assessment of the present. In doing so, we employ a two-step methodological approach that includes interviews with experts on Metaverse development, complemented by a historical analysis of archival data on the development of existing federated networks. Our combined data analysis unearthed four characteristics essential for the development of the Metaverse, which often operate in conjunction. By analyzing the relationship among the identified core characteristics, we further unpack two key insights for the future development of the Metaverse. Our first insight is that the fundamental attribute of federated networks is dynamism. Our second insight is that by acknowledging this dynamism, we can better understand that the development of the Metaverse will not follow a linear progression, as the development of a core characteristic may affect the advancement of others. We discuss the implications of our work for theory as well as practice and delineate an agenda for future research on the topic.

1. Introduction

The Metaverse is in its infancy, and although it is widely discussed in the literature [17,21,38,79], it does not have a commonly accepted definition [47,55], since a comprehensive rendition has yet to be formed [17,79]. The absence of a widely accepted definition, however, creates a lack of consensus on what the Metaverse *is*, and what its future development *will be*. From a technological standpoint, the Metaverse revolves around a combination of digital technologies, associated with distributed ledger technology (DLT), artificial intelligence (AI), augmented reality (AR), and virtual reality (VR). From an architectural standpoint, however, it can be better understood as a *federated network*, which enables the creation of immersive virtual spaces that can simulate real-world experiences [23,75,80].

Federated networks can be viewed as a collection of components relating to a group of information needed by a specific application or a set of applications [48]. The Metaverse has many applications in sectors including healthcare, e-commerce, entertainment, and education [15,39,67,76,77]. Such an immersive virtual environment can capture the attention of both users and organizations and become an integral part of everyday life [8,80], representing a significant potential economic market that enables novel opportunities [16,36]. By understanding how it will evolve, thus, organizations can anticipate opportunities for innovation, investment, and growth. Concurrently, the Metaverse will likely reshape how people interact, communicate, and collaborate in immersive virtual environments [53,80]. Understanding its path forward, thus, allows us to anticipate and address social challenges related to identity, privacy, and digital inclusion [17,79]. Further to these, as the Metaverse grows, there will be a need for regulations to ensure safety, security, and fairness within immersive virtual environments. Understanding its future development, thus, can enable policymakers to anticipate regulatory needs and develop appropriate governance frameworks. It remains unclear, however, *how* the Metaverse will develop and *what* it will develop into. Such questions become increasingly timely for the broader decision support systems literature [3,6,27,28], as well as the extant information systems (IS) research agenda [30,38,66]. To address that lacuna, therefore, our research question is:

What are the key characteristics of the Metaverse architecture that relate to its future development?

Our study attempts to provide an answer to the research question on the future development of the Metaverse by trying to understand the

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past and taking stock of the present. Specifically, we conduct historical research on archival data of existing federated networks as well as interviews with experts involved in the current development of Metaverse projects. Such an approach enables us to unearth sorely needed insights into the future development of the Metaverse by creating an *analytical history of emergence* [51,65] of federated networks. By examining existing federated networks, we can learn from the past to develop a Metaverse in line with a shared goal, rather than working against one another to build dispersed spaces with different priorities. Our study provides insights into the core characteristics for the future development of the Metaverse and contributes to the extant IS literature through generalizable contributions that can be applied to wider research within and around federated networks in general, as well as spatial computing more specifically. By departing from a phenomenon-driven theorizing standpoint, the incorporated approach is in line with recent calls in the extant IS [26,50] and the broader management literature [24,72], while we further contribute to the line of research on phenomenon-focused problematization by incorporating a *Futures Research* lens [6,27,28,30].

Specifically, our approach enabled us to delve into the aspects shaping the future development of the Metaverse, uncovering four core characteristics: *interoperability*, *standardization*, *usability*, and *scalability*. By recognizing how such core characteristics interact, we further identified two pivotal insights: i) federated networks are characterized by dynamism, and ii) grasping such dynamism helps us realize that the future of the Metaverse will not follow a linear progression. Moreover, changes in one characteristic can significantly influence the progress of others, propelling the development of the Metaverse in unpredictable directions. By understanding the core characteristics associated with the future development of the Metaverse, and by mapping these against the evolution patterns of existing federated networks, theoretical insights can be formed that contradict conventional practices and current theoretical intuitions. Consequently, our study brings forward theoretical insights that are relevant to the topic beyond the buzzword [17,37,53,77] and provides policymakers, investors, developers, and commercial users with valuable practical insights to better use, design, and regulate the Metaverse [79].

The rest of our paper is structured as follows: In the next section, we outline the literature on the topic and introduce our socio-technical imaginaries perspective. We then outline our methodological approach, which is followed by our key findings. In the penultimate section, we discuss the implications of our work for theory and practice, while we conclude by delineating an agenda for future research.

2. Theoretical background

2.1. Defining the Metaverse

The Metaverse can be viewed as an immersive virtual space parallel to the physical one [56,79]. From a technological standpoint, its development can be attributed to digital technologies such as AI, VR, and AR, which enable the construction, mapping, and archival of virtual spaces and experiences [17,21] and allow such a space to be designed and experienced [67]. Many sectors make use of the Metaverse, including healthcare, education, retail, commercial entertainment, and social networking services [21,76,77]. Current popular examples of Metaverse spaces include the Horizon Worlds and Roblox, which enable users to socialize and host events and games. Current business applications include Microsoft Mesh, which enables the creation of professional VR spaces for business meetings and collaboration. As the development of the Metaverse is still in its early stages, however, the potential for such sectors and the applications and features of these have not been fully explored to date [17].

Whilst the Metaverse has received considerable attention in the broader management literature and the neighboring fields [21,53], there is not yet a consensus regarding its definition [55]. The various definitions of the Metaverse tend to involve descriptions of immersion and interconnected experiences through digital technologies and social interactions [60]. Further to this, the Metaverse is frequently described as a cyber-social system that connects the physical and virtual worlds [21,56]. Consequently, *immersion* is one of its defining characteristics [21,70]. Additionally, although 3D properties are not an essential aspect of the Metaverse, many definitions involve such aspects [21,53]. To better understand the potential of the space, as well as how it can be developed and towards what, the core characteristics of the Metaverse, thus, need to be further explored. Specifically, to achieve successful development and adoption of the Metaverse [69], the characteristics, rules, and strategies need to be understood for collective participation in its growth [43,79]. Such a perspective allows for the understanding of the key characteristics that make up the current and future architecture of the Metaverse and consequently enables us to further study how such a phenomenon could evolve.

2.2. Socio-technical imaginaries

The future has the potential to unfold in a multitude of ways, and, consequently, studying the future of a phenomenon involves observing, discussing, and envisioning something that *will become*, rather than something that *is*. Such studies can be described as envisioning the future by forming ideas of something unknown [6]. *Future Studies* examine what could and should happen in the future and have often discussed *probable* futures rather than *desirable* ones [27,28,30]. The future, however, is not set in stone and consists of various possibilities. Plausible futures are those that could realistically happen given current uncertainties, while probable ones are those that are likely to occur. Possible futures encompass all conceivable scenarios. *Desirable* futures, on the other hand, reflect the outcomes we desire, shaped by our values and proactive responses. Articulating a desirable future and how it can materialize is more achievable, and it is important to envision desirable futures [27,28]. By doing so, critical reflection allows greater societal relevance by leaning towards imaginaries of desirable futures.

The desirable future of an under-theorized phenomenon can be examined from a socio-technical imaginaries perspective, which can be defined as "*collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific and/or technological projects*" [35]. Socio-technical theories within the extant IS literature view organizations and organizational work as consisting of social and technical subsystems [30,57], which interact and influence one another [11,61]. In this sense, they shape how individuals view and interpret technological advances [59]. Consequently, socio-technical imaginaries are attainable futures cutting through the dualism of structure and agency, which combine subjective and psychological dimensions of agency with structured technological systems, and organizational behaviors [33]. Socio-technical imaginaries emphasize the performance element of technology and such phenomena can potentially progress from conception to realization, uncovering processes and narratives [34,63]. Woodall and Ringel [74], for instance, describe socio-technical imaginaries concerning DLT discourse as drawing on specific imaginaries to help shape the ways technology is introduced and understood through encoding shared meanings, values, and ideas into the discourse. The ways in which future technological development is imagined, coordinated, and accumulated into a concept of the world is an important element to examine [63]. By using such an 'imagined futures' lens, the unpredictability, and uncertainty of the future of strategic actions within fields concerning innovation can be controlled [9,25]. Such factors align with understanding the future of the Metaverse and, thus, we adopt a socio-technical imaginaries perspective.

3. Methodology

Our study stems from a phenomenon-driven theorizing standpoint [24,26] delving beyond mere gap spotting in an attempt to elucidate a phenomenon that is not explained by existing theoretical insights. Such

an approach is in line with recent calls in the IS [26,50] and the management literature [24,72]. Further to this, we take an interpretivistic approach [5] and use a *futures research* lens [2,27,28] to capture the core characteristics for the evolution of the Metaverse. Observing, discussing, and predicting something that *will become*, rather than something which *is*, however, poses a challenge. In doing so, therefore, our study is focused on articulating *desirable* futures rather than *probable* ones [27,28,30]. By doing this, critical reflection adds an element that allows greater societal relevance to our findings.

3.1. Data collection

Our methodological approach is bifold. First, we conducted a historical analysis of archival data related to the architectural evolution of successful federated networks that pre-existed the Metaverse to derive theoretical insights into their evolutionary patterns and characteristics. Second, using the insights from the analysis of the archival data, we formed a protocol for semi-structured interviews, which aimed to identify key structural characteristics of the Metaverse through interviews with experts on the topic.

3.1.1. Archival data

The archival data of our study was obtained from the *RFC Editor*, which is a repository responsible for the publication of technical documents known as Request for Comments (RFC). The RFC documents describe the protocols, standards, and procedures that led to the creation of the Internet and the Web. For the needs of our study, ten RFC were identified as relevant for each federated network architecture. All the RFC documents were chosen for their contribution to communication, ability to identify and locate resources, security, as well as architectural evolution of the network [4,23,73]. Specifically, the ten RFC documents that delineate the evolution of the Web are #2616, #3986, #6265, #6454, #6749, #7034, #7230, #7231, #7234, #7595, while the ten RFC documents that delineate the evolution of the Internet are #759, #1122, #1958, #2616, #2822, #6746, #6747, #6749, #6960, #5246; Further to these twenty RFC documents, #801 was also used as it delineates the transitioning from the Network Control Program (NCP) to the Transmission Control Protocol (TCP) in the ARPANET, which was the foundational step in the development of the modern Internet the way we know it [44,45,54]. When developing immersive spaces, understanding such aspects is needed to ensure integration, progression, and seamless operations [44,45]. Without such an understanding, there is a risk that immersive spaces will stagnate, become inefficient, and end up in fragmentation, hindering their ability to adapt to emerging needs and technologies and satisfy the purposes they were designed for. Archival analysis was first conducted to create a protocol for coherently understanding and analyzing the interview data.

3.1.2. Interviews

Our participants were recruited through a purposive sampling approach, specifically *expert sampling* [1]. Our participants demonstrated expertise through their involvement in Metaverse projects (i.e., developers, founders, investors); in total, 13 experts were recruited. A breakdown of the participants' roles—and, thus, type of expert—is shown in Table 1. By recruiting experts from multiple and diverse groups, an illustrative breadth of predictions is represented in our work [62]. It is important to note that 5 of our participants could be categorized under more than one type of expert group (i.e., founders can also be developers in their company). Such a perspective, however, enabled us to derive more accurately the potential key characteristics that make up the current state of the Metaverse and, therefore, enabled us to more accurately represent the characteristics that are important to its future development.

Our semi-structured interview protocol enabled deeper conversations and provided richer data, as the participants were enabled to discuss more freely and expand on topics they considered important, which also reduced potential biases as the participants were enabled to steer the conversation. The semi-structured interview protocol involved questions related to the i) experience and projects of participants, ii) their understanding of the Metaverse, iii) any planned future projects, and iv) characteristics that they deemed central to the current and future development of the Metaverse. The interviews lasted on average approximately 30 min; they were recorded after obtaining participants' permission and they were transcribed verbatim into pseudonymized transcripts for further semantic thematic analysis.

Table 1
Participants' characteristics.

Participant	Profession	Category of Expert
A	Marketing Agency	Developer
B	Financial Advisor	Investor
C	Marketing Coordinator	Investor
D	Company Founder	Founder
E	Marketing Team	Developer
F	Company Founder	Developer, Founder
G	Chief Marketing Officer	Developer, Investor
H	Lead of Web3.0 Studio	Developer
I	CEO	Developer, Founder
J	Marketing Director	Developer
K	CEO	Developer, Founder
L	CEO	Developer, Founder
M	Company Founder	Founder

Ethics approval was obtained by the relevant institutional review board before conducting the research, which considered the aims of the study, what the study entails, as well as that there is no deception to participants and no risk to them for taking part in the study. Before the interviews, all the participants were provided with an information sheet delineating the purpose and aims of the study, the topics that would be discussed during the interview, that there was no risk of taking part, how their data would be collected and stored, as well as their right to withdraw from the study at any point. The participants were also required to sign a consent form. Following the interviews, the participants were provided with communication details in case they had any concerns or questions or wished to withdraw. All the responses were pseudonymized, and all the data were stored on password-locked computers.

3.2. Data analysis

The RFC archival data was analyzed to create an analytical history of emergence [51,65] of existing federated networks by outlining their key characteristics (Fig. 1). Specifically, each one of the relevant RFC documents was analyzed in sequence and their key characteristics were identified. Data reduction was used to select, focus, simplify, abstract, and transform the data to identify patterns [49]. This process has also been described as data condensation [68], which entails reducing, condensing, or summarising large amounts of information to understand and observe patterns and meanings of information [22,71]. This is an important stage to reduce the high volume of information whilst also retaining the important and useful data from the RFC. The core aspects of each RFC were identified, and following this, the core components were characterized and collated into a timeline, which represents how each RFC is interlinked in the evolution of federated network architectures.

The semi-structured interviews were analyzed using the six phases of Braun and Clarke's [18] updated thematic analysis, which enabled us to identify, analyze, and report patterns [13]. These patterns were then collated into themes, which highlight higher-level patterns in responses between our participants and, thus, represent important aspects of the overall dataset [40,58]. The themes do not have to be the most prevalent parts of information in the interviews, but they can be the parts deemed to hold the highest importance in relation to our research question [13]. Thematic analysis can be conducted from two levels: semantic, and latent. The former follows an explicit analytic process, where

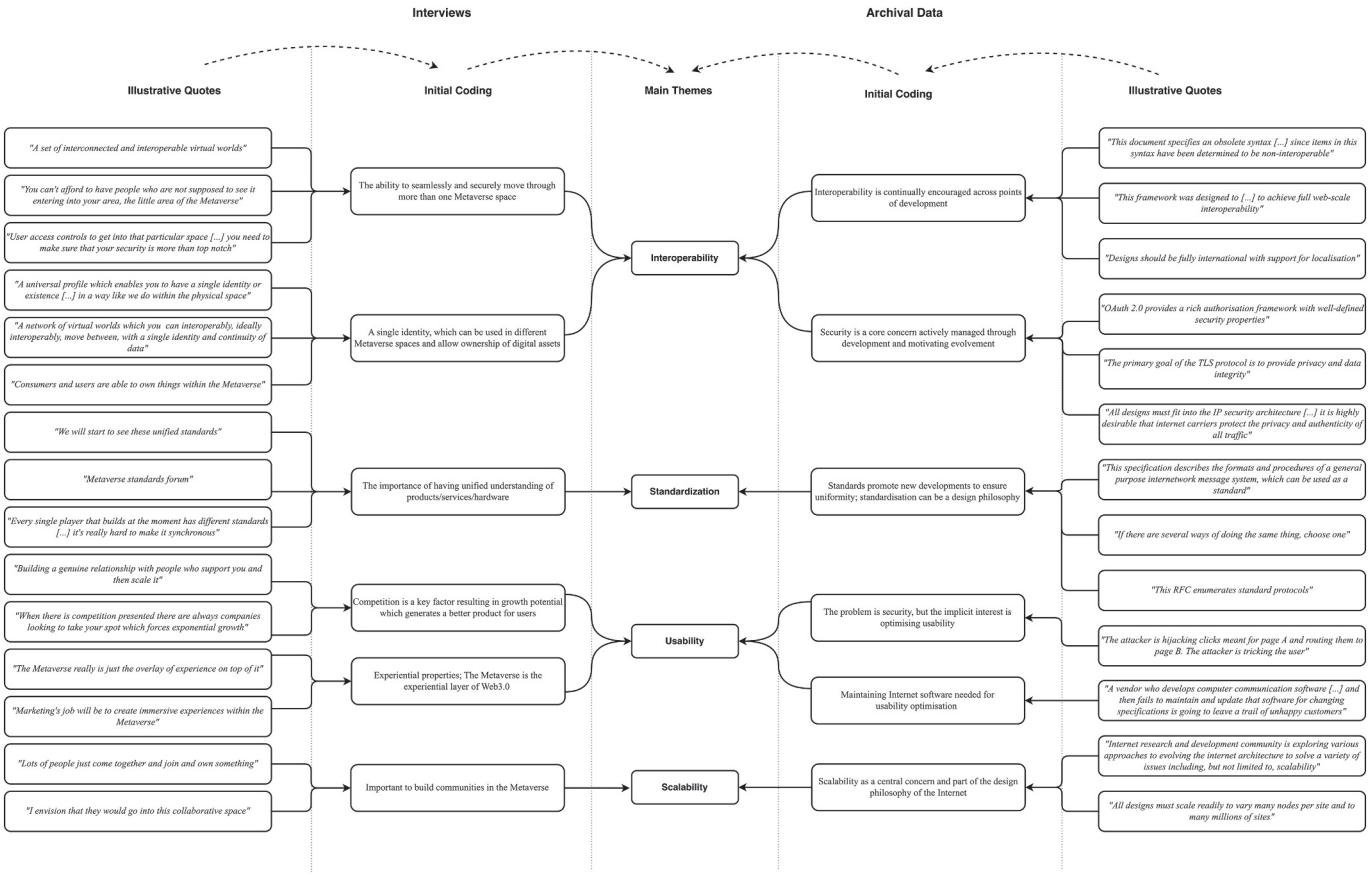

Fig. 1. Data structure of the thematic and archival analysis.

participants' descriptions are organized into key patterns, which are then interpreted to understand their significance and wider implications and meanings [1,12,52]. The latter, however, involves examining the underlying assumptions, ideas, and conceptualizations about the patterns, which are highlighted from the dataset [13]. In line with our research question, thus, we used *semantic thematic analysis*. To further enhance the validity of our findings as well as the rigor of our methodological approach, the interview transcripts were checked for consistency by our participants. After conducting the semantic thematic analysis, our findings were validated through a member-checking approach by a representative set of informants [14] that we measured through the Krippendorff's α calculated at $\alpha = 0.833$, which is above the universally accepted threshold of 0.8, providing further reliability to our findings [29,42].

We followed the traditional six-phase thematic analysis approach [18]. Phase one included data familiarisation; this is a common process of many qualitative analytical approaches and involves familiarising oneself with the dataset as a whole. The first phase provided us with an immersion in the dataset, and, thus, we were able to capture overarching ideas about the data, which were initially developed as a result of our familiarisation. The second phase involved initial coding; during this phase, the first set of codes was generated and these could overlap or have broader catchments. Phase three was where the initial themes were generated. Once initial codes were generated, overlapping codes were grouped to produce tentative themes. During phase four the final set of themes was developed and reviewed to identify the most important ones for answering our research question. The fifth phase involved refining, defining, and naming the themes, which involved refining the analysis and understanding its flow, and structure, which aided in the naming of the themes. The sixth phase involved writing and explaining our findings, which is an integral phase of the process for thematic analysis.

4. Findings

Our findings from the analysis of the archival data highlight the consistent evolution of the Internet as a federated network architecture. Such consistency is summarised in RFC #1958, which highlights that "*the principle of constant change is perhaps the only principle of the Internet that should survive indefinitely*". The data reduction analysis revealed that such constant change is driven by four factors: i) *interoperability*, ii) *standardization*, iii) *usability*, and iv) *scalability*. Further to the archival analysis, the analysis of the interviews unearthed the same four themes. The overview of the analysis and resulting themes is illustrated in Fig. 1, while we discuss the themes in detail in the following section.

An analytical history of emergence was created to show the evolution of the Internet and the Web as federated network architectures, as shown in Fig. 2. Links to the Metaverse and the wider Web 3.0 have also been added in the figure, while we further discuss the connections to the evolution of the Metaverse in detail in the following section. The timeline in Fig. 2 shows the evolution of the Internet and the Web, with each color depicting a link to each of the themes highlighted as a core characteristic in the data analysis of the RFC. Links have also been provided to showcase why each RFC was chosen for its usefulness to the future evolution and development of the Metaverse and wider Web 3.0. This shows how the RFC were useful in unearthing the development of the Internet and the Web, and, thus, how understanding and analyzing these stages can be useful in the future development of the Metaverse. By creating such a timeline, a reference point is being provided for deciding whether or not the Metaverse has come to fruition, providing baseline criteria and foundation for its usability.

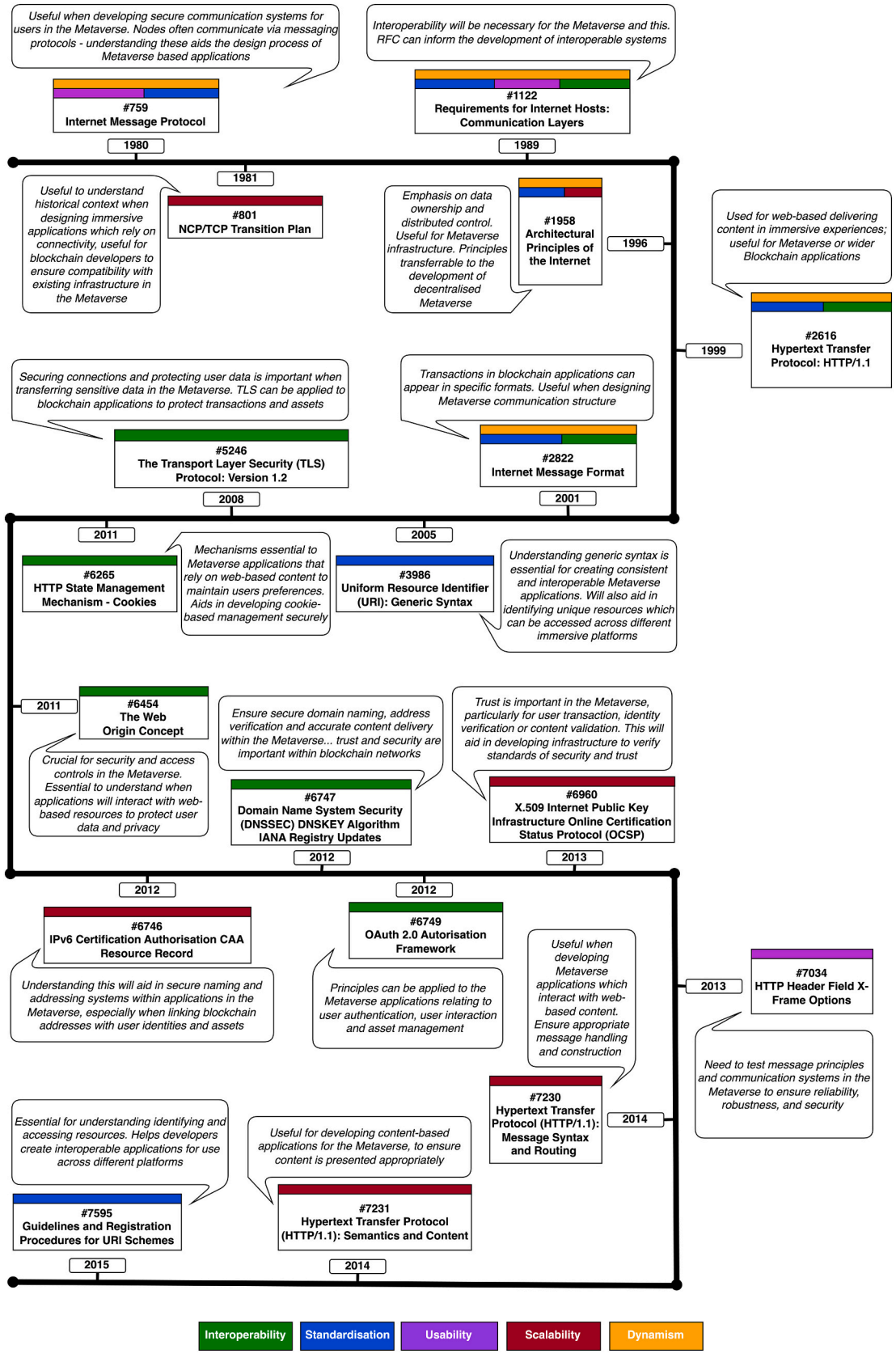

Fig. 2. Analytical history of emergence showing the development of the Internet and the Web based on the analysis of RFC in relation to the future development of the Metaverse.

4.1. Interoperability

Interoperability can be described as the ability to move between digital spaces seamlessly without having to exit and return to a new space. Many of the RFC explicitly mention the desire to achieve and enforce interoperability within federated networks. For example, RFC #1122 states as a core principle that "*the goal is full open system interconnection: an Internet host must be able to interoperate robustly and effectively with any other Internet host across diverse Internet paths*". There is a similar example in RFC #2822, which standardizes the syntax and format of emails. Here the principle of interoperability is protected by the document explicitly stating that the new standard overrides the earlier guidelines in RFC #822. The syntax guidelines of RFC #822 are described as "*obsolete*" because "*items in this syntax have been determined to be non-interoperable*". RFC #5246 discusses Transport Layer Security (TLS) 1.2, which improves communication security, highlighting that it was designed with interoperability in mind as it states that "*independent programmers should be able to develop applications utilizing TLS that can successfully exchange cryptographic parameters without knowledge of one another's code*". RFC #6749 discusses the OAuth 2.0 authorization framework, which was also developed with interoperability in mind as it was "*designed with the clear expectation that future work will define prescriptive profiles and extensions necessary to achieve full web-scale interoperability*".

Interoperability, however, also emerged from the analysis of the interviews, where participants described this as a key characteristic of the Metaverse. Participant H, for example, stated that interoperability will "*play a massive part because you need to be able to move between different virtual worlds within this space […] ideally interoperably*". Participant K stated that the Metaverse can be seen as a "*set of interconnected and interoperable virtual worlds"*. This view was echoed by participant I, who referred to the Metaverse interoperability as equally important to the one we have on the Internet: "*It's much like the initial days of the Internet unless you knew the URL before Google was invented you didn't know that website exists*". Similarly, participant I stated that in the early stages, the "*Internet looked very much like the Metaverse world at the moment […] there's no interoperability, it's not a Metaverse and there are no Metaverses, as much as there are no internets, you have one Internet*".

Further to being a key characteristic, our analysis revealed that interoperability had two prevailing sub-themes related to i) identity and ownership of digital assets, as well as ii) security and decentralization. Participants often mentioned identity during discussions around interoperability, and displayed diverse opinions on the nature and transferability of identity in the Metaverse; some highlighted the potential existence of one identity, whereas others discussed the potential for multiple ones. Many participants referred to a single identity, which can be brought along as users move through Metaverse spaces. Concerning a unified identity, participant H viewed Metaverse users as having "*one identity […] have an identity that you can control, but you move between different spaces […] kind of similar to the Internet and moving between different pages*". Similarly, this participant also stated that "*you should have […] an individual identity*". Participant E stated the "*Metaverse is the place where that person exists and you can travel between these different platforms*" and that the Metaverse should allow users to bring assets they have earned in one space into another and that therefore should be "*attached to a fraction of your digital identity*", thus also taking your identity with you between spaces.

While these views echo the idea of interoperability being a core characteristic for the future of the Metaverse, participant A stated that "*the idea of multiple interconnected spaces does not sound realistic*" and, thus, there would be several non-interoperable spaces, as "*competitive projects […] will be incentivized to keep users in their own ecosystems*". Both participants L and M believed different identities in different Metaverse spaces would be desirable. For instance, participant L said: "*I wouldn't want to restrict people to have multiple identities in multiple spaces if that's what they wanted*". Participant M, similarly, said: "*You're probably gonna want a different persona […] a user could create as many personas as they want*". Although there is a split in opinions on how identity will ultimately be constructed within the Metaverse, the prevalence of the issue among the experts who participated in our study indicates that identity is still a core characteristic within discussions around the Metaverse. Participant H stated that for interoperability to be brought about, standardization needs first to occur. These findings, however, further bring about similarities with the early stages of development of the Internet as well as the Web, highlighting the evolution of the Metaverse as a federated network.

Decentralization also emerged during the discussions on interoperability. Participant B, for instance, stated "*I am a strong believer of the Web 3.0 being a decentralized approach*". When referring to decentralization, many participants explicitly referred to ownership of assets and data. Participant L referred to Web 3.0 as "*the opportunity is both in, you know, decentralizing, allowing you to own your own data within the Metaverse*". Similarly, participant F stated that "*ownership is going to be the only thing that I can, I would, predict with 100% surety*", showcasing the importance of this as a core characteristic for the development of the Metaverse. Participant M was positive about the decentralized nature of the Metaverse, but expressed a belief in a "*decentralized nature*" that "*needs to have functionality […] you can't have someone who controls the server just to switch it off*". Participant C was positive about the Metaverse being decentralized and stated that "*as long as we stay away from centralization*". Participant J discussed the difficulties of a fully decentralized Metaverse, stating that "*it's difficult to find that middle ground […] full decentralization isn't always good but similarly centralized control isn't great either*", referring to the need for governance structure and standardization on the Metaverse; yet there are difficulties with how these can be created without allowing a centralized control. Regardless of these complications, most of our participants were positive about the aim of creating a decentralized space, with standardized rules, highlighting the prominence of this theme.

Security also emerged as an interoperability sub-topic. Security considerations as a driver for change of the Internet appear either explicitly or implicitly in the RFC. Explicit examples include RFC #5246, and #6749, which discuss TLS and OAuth respectively, and RFC #6454, which defines policies and security boundaries linked with the presentation of content in Web browsers. Such changes are fundamentally concerned with improving the security of the Internet, and they also appear implicitly. For instance, RFC #6265 discusses cookies, stating that "*cookies have a number of security pitfalls*", before highlighting potential design flaws in systems, where they are used for reducing risk. A similar type of security troubleshooting also appears in RFC #2822. Furthermore, RFC #1958 provides an overview of the importance of security stating that "*all designs must fit into the IP security architecture […] it is highly desirable that Internet carriers protect the privacy and authenticity of all traffic*".

The theme of security also emerged in the interviews, often overlapping with the themes of user privacy, particularly on personal information, identity, and transactions. Participant D highlighted that conversations "*about security*" are more readily occurring. Participant E stated that security is important for Metaverse development as users "*don't want to have to worry about different security threats that come with the blockchain and wallets*". Along the same lines, participant L said there "*needs to be the ability to have some sort of anonymity*" to protect users but that this may raise "*a whole bunch of ethical issues*". To mitigate this issue, participant M discussed the possibility of "*user access controls*" for a "*verification process*" to identify an "*actual person, that's verified*" behind anonymity and, thus, who is entering a space can be monitored to enable certain restrictions on privacy for who can access certain information. This can enable verified users to appear anonymously but be known by the platform so they can be monitored for safety. Participant D also suggested that ensuring "*security can also be one of the ways we can adopt more people*", therefore, attracting more people to use the Metaverse.

4.2. Standardization

Standardization can be seen as a teething issue of the Metaverse and can be described as implementing principles and criteria consensus. Standardization appears inherently across all RFC because—by their nature—they attempt to define and clarify aspects of the Internet, and the Web into coherent documents for the developers as well as the extant computer science community to follow. For instance, RFC #759 "*describes the formats and procedures of a general purpose internetwork message system, which can be used as a standard for the interconnection of individual message systems, or as a message delivery system in its own right*". Likewise, RFC #1122 "*enumerates standard protocols that a host connected to the Internet must use*". RFC #2822, #3986, and #7595 also explicitly mention standardization with regard to their given topics. RFC #1958, however, mentions standardization as a core design principle of the Internet, stating that "*if there are several ways of doing the same thing, choose one*".

Likewise, the analysis of the interviews reveals that the majority of our participants referred to the *"Metaverse Standards Forum*", which represents an attempt to discuss and create standardized governance across the Metaverse for aspects such as interoperability. Participant J, for instance, stated that "*without a unified vision, then you end up with the product that is not user friendly*". Notably, in such discussions, many of our participants were positive about a decentralized space with no centralized authority but standardized rules would then be needed to ensure safety and interoperability possibilities, similar to the way that existing federated network architectures have evolved in the past to reach their current forms. Participant F, controversially to the other experts of our study, stated an expectation that there will not be a persistent "*single standard*". Once again, these findings highlight similarities of the Metaverse with the early stages of the development of existing federated network architectures.

Standardization, therefore, is unearthed as a fundamental challenge for the development of the Metaverse, akin to the early stages of existing federated network architectures. Standardization in the Metaverse involves establishing consensus on principles and criteria to create coherent guidelines for developers. This process is evident across various RFC, which aim to define and clarify aspects of the Internet and the Web. For instance, RFC #759 outlines the formats and procedures for an internetwork message system, while RFC #1122 enumerates standard protocols for hosts connected to the Internet. Additionally, our participants recognized the necessity of standardized rules to ensure user-friendliness, safety, and interoperability, mirroring the development of existing federated network architectures. However, there are differing opinions among participants regarding the persistence of a single standard, with most foreseeing a decentralized space with evolving standards over time. Overall, these insights underscore the importance of standardization in shaping the usability and interoperability of the Metaverse, drawing parallels to the historical development of existing federated network architectures.

4.3. Usability

Usability can be understood as the process by which a service or product can attract and retain users. For example, this can be achieved by offering a unique service and improving overall efficiency as well as experience for the end user. Usability often appears as secondary to one of the other major themes but can still be seen as a driving motivator for change within the evolution of the Internet and the Web as federated network architectures. For example, although the fundamental concern in RFC #7034 is security by reducing the risk of clickjacking attacks, it states that "*the attacker is hijacking clicks meant for page A and routing them to page B. The attacker is tricking the user […] into clicking specific locations on the underlying page from server B*". Although security is the principal concern here, the adjustment recommended is indirectly motivated by a desire to optimize usability. Similarly, RFC #759 describes a new system for internetwork messaging, specifically noting greater functionality that allows messages to include "*data objects which could represent drawings, or facsimile images, or digitized speech*". The implication here is that the added functionality correlates to usability. Further, RFC #1122 provides an explicit example of ensuring usability through the following example: "*A vendor who develops computer communication software for the Internet protocol sweet and then fails to maintain and update that software for changing specifications is going to leave a trail of unhappy customers*". Usability considerations, thus, have played a significant role in the development of existing federated networks, by driving improvements in service offerings, efficiency, and overall user experience. Such improvements, motivated by factors like market competition and security concerns, have contributed to the development of existing federated networks. In the context of the Metaverse, where seamless interaction and immersive experiences are paramount, the influence of usability considerations becomes particularly prevalent. While the Metaverse continues to develop as a virtual experiential platform intertwined with Web3.0, the lessons learned from the usability-driven development of existing federated networks can inform the design and implementation of user-centric features and affordances of the Metaverse, ultimately enhancing its appeal and usability for a diverse range of users.

Within the interviews, two forms of usability were identified. First, the market competition can be seen as a driving factor in growth potential, which consequently generates a better offering for the end user. Participant C for example, stated that "*when there is competition presented there are always companies looking to take your spot which forces exponential growth and both technological development as well as user development";* thus, competition forces faster growth and better usability. Similarly, participant D stated that growing the Metaverse is about "*building a genuine relationship with people who support you and then scale it*". Second, the Metaverse is viewed as a virtual experiential platform, which is overlayed or intertwined with Web 3.0. Whilst this theme does not have much variation in definitions or discussions from the participants of our study, it was very prominent and, therefore, becomes a key characteristic of the Metaverse. Participant L was positive about Web 3.0 when stating that "*the Metaverse really is just the overlay of experience on top of it*", and that Web 3.0 and the Metaverse are "*slightly intertwined*". The experiential characteristic was central in many interviews. Participant B described the Metaverse as a "*virtual world that you are experiencing*". Similarly, participant H stated that the Metaverse was about "*creating experiences*", and that was an "*immersive virtual world experience*". Almost all the participants of our study suggested a reference to the experiential aspects of the Metaverse during their interviews, either explicitly or implicitly.

4.4. Scalability

Scalability appears as a core driver for change *across* many RFC. RFC #801, for instance, details that the "*base host-to-host protocol used in the ARPANET was inadequate for use in these networks*". Work then began on the development of the Internet Protocol (IP), and the transmission control protocol (TCP) as a means of scaling the capabilities of the Internet. Much later, within RFC #7230 it is summarised that "*HTTP was created for the World Wide Web (WWW) architecture and has evolved over time to support the scalability needs of a worldwide hypertext system*". RFC #7234 specifically details the development of HTTP/1.1. An essential feature of this update is to improve performance by using caches to streamline requests and message responses. The added performance helps the federated network architecture to become more scalable as traffic increases. Similarly, RFC #6960 details the development of a technical protocol that improves revocation and provides information more quickly along with additional status information. The result is increased efficiency and, consequently, scalability. RFC #1958 highlights that scalability concerns have been central to the development of the Internet as a federated network architecture: "*All designs must scale readily to very many nodes per site and to many millions of sites*". Finally,

RFC #6746 remarks on the continuing importance of scalability as a driver for change: "*Internet research and development community is exploring various approaches to evolving the Internet architecture to solve a variety of issues including, but not limited to, scalability*".

The interview transcripts also depicted many implicit references to scalability. Participant M, when referring to their own space in the Metaverse, stated "*Our users could come and collaborate within that space […] I envision they would go into this collaborative space*". Similarly, participant B stated: "*In Web 3.0 the importance for the community is significant, in order to have a Web 3.0 venture you need to have, at some point, you need to get a community*". Participant D also discussed the importance of "*building a genuine community*". Concerning the gaming side of the Metaverse, participant F said "*There may be a community of users or players*" also highlighting community and collaboration within other aspects of the Metaverse. The Metaverse was often referred to as a social media platform, highlighting the aspect of many more users and increased scalability without explicit mention. Participant I, for example, said "*I see Metaverses very much as social media platforms within this 3D environment*". Participant M also stated that one way to increase the user base of a Metaverse space is to "*build the community first*". There was a large consensus across all participant transcripts that community and increasing scalability, as a result, was a central characteristic of the Metaverse.

Scalability, therefore, is a crucial driver for the future development of the Metaverse, akin to its significance in the development of existing federated network architectures. The RFC demonstrate the continuous effort to enhance scalability, such as the development of protocols to accommodate the growing capabilities of the Internet and the Web. Similarly, advancements in protocols aimed to improve performance and efficiency, thereby increasing the scalability of existing federated network architectures. The interviews with experts further emphasized scalability, with implicit references to the importance of community building and collaboration within the Metaverse. Our participants envisioned the Metaverse akin to a social media platform, highlighting the necessity of accommodating a larger user base and increasing scalability. This parallels the historical emphasis on scalability in existing federated network architectures, highlighting its central role in shaping the evolution of the Metaverse.

5. Discussion

Our study represents an attempt to envision the potential future development of the Metaverse through its core characteristics. By conducting a historical analysis of archival data, we were able to identify factors that contributed to the development of the Internet and the Web, which are now unearthed also as key characteristics of the potential future development of the Metaverse. The broad implication, thus, is that the future development of the Metaverse, whilst not identical, is influenced by similar key factors that prompted the development of the Internet and Web. In turn, this suggests that the Metaverse might follow a corresponding development trajectory, allowing us to envision a potential path for its future.

5.1. Key findings

The principle of constant change is evidenced through the analysis of RFC. The development of existing successful federated network architectures appears to be largely driven by four distinct yet highly linked key characteristics: i) *interoperability*, ii) *standardization*, iii) *usability*, and iv) *scalability*. These key characteristics also emerged as core ones from our expert interviews, suggesting that both the development of existing federated networks and the one of the Metaverse are driven by similar factors.

Interoperability appears consistently across the archival analysis, and it is also the most heavily discussed characteristic within the expert interviews. Our findings show that interoperability on the Metaverse would essentially mirror the existing federated network architectures, where users will be able to easily move among the various Metaverse spaces. Overall, our findings demonstrate that interoperability would become a fundamental characteristic of the Metaverse. Recent studies also suggest—even from a hypothetical perspective—that interoperability will be a core feature of the Metaverse [46]. Interoperability is needed to support the seamless vision of the Metaverse and to promote the dissemination of the user-generated content that will popularise the platform [46], and it can be seen that a lack of uniformity is already causing issues with interoperability [20]. Interoperability is needed to ensure that users can access assets that are in different spaces, however as these spaces can be built in different environments, the interoperability among them might become limited [55].

The subthemes related to 'identity and ownership of digital assets', as well as 'security and decentralization' appeared in relation to the core theme of interoperability. Although not explicitly as a standalone theme, decentralization appears within most interviews and can be seen as a central aspect of the characteristics for the future of the Metaverse. The decentralized nature creates discussions around ownership, security, and identity. Without the existence of a central governing body, the cumulated body of knowledge on centralized platforms cannot be used to understand spaces such as the Metaverse, which is decentralized, as the insights on such platforms do not apply to decentralized ecosystems [31,41]. Concerning security, the Metaverse is built on DLT, and, as such, authentication access control and consensus mechanisms can allow users to have control over their data, thus ensuring a greater level of privacy for them [4,32]. However, it is worth noting that our participants expressed an urgency for better security and privacy in the Metaverse, particularly around the ownership of digital assets and identity, showcasing the importance of the subthemes for the development of the Metaverse.

Standardization is the most ubiquitous design philosophy, and our interviews also revealed that will become a core characteristic for the future development of the Metaverse. The frequency with which standardization was discussed among our participants echoes the focus that contemporary IS research has placed on the issue [21,38]. As it stands, however, the lack of a unified standardization process is giving rise to issues for interoperability and identity within the Metaverse [20,38,75].

Usability appears as a core characteristic for the development of federated networks, but often not explicitly. The challenge for the Metaverse is that real relationships have to be built between providers and users before being scaled up. This can be done by creating experiences that should be—crucially—immersive [70,75,80]. The Metaverse, however, will face challenges in this respect. If the Metaverse emerges primarily as a space in which activities are experienced, it stands to reason that its development will need to stress usability to a far greater degree than the development of the early Internet. Nevertheless, usability is a shared characteristic of the Internet, the Web, and Metaverse.

Scalability is also identified as a core characteristic of federated networks. Scalability is a measure of the quality of hardware and software that makes the Internet and the Web operate. Ensuring the scalability of the Metaverse infrastructure is essential for making it a viable ecosystem. Increasing the number of users in the Metaverse and, thus, its scale, is widely discussed in the literature, even if implicitly [21,43,79]. The Metaverse has also been defined as a *collective virtual shared space* [7], which highlights the importance of collaboration and a sense of community. The terms community and collaboration are prevalent in many of our interviews. It appears, thus, to be a noteworthy aspect of increasing scalability within the Metaverse. Facilitating a range of activities and functions can promote the opportunity to develop and grow based on community building and collaboration [19]. Regular interactions and collaboration within communities can enable high exposure to information and increase engagement [64]. As such, information sharing among users increases, creating greater influence, development, and collaboration [19]. This aspect can drive collaborative development, which in turn can influence the development of the

Metaverse with positive outcomes for the number of its users.

The implication, thus, is that the development patterns of federated networks might guide the one of the Metaverse. What the following demonstrates, however, is that the relationship among these shared motivating factors often appears as an implicit feedback loop, in which a development addresses another key concern, which addresses another, and so on. Our analysis reveals another underpinning characteristic of the early development of the Internet and the Web, and the early Metaverse: *dynamism*.

Our findings demonstrate that changes to the architecture of federated networks were catalyzed by the advancement of a single characteristic. Even when a change is directly aimed at a single core characteristic, however, it can also be seen to implicitly influence the other characteristics. RFC #6265, for example, addresses the technical specifications for cookies. The RFC calls for developers to follow its guidance to maximize interoperability. Such architectural instructions influence further factors that are motivators for change. Addressing cookie interoperability ensures that they behave consistently in different implementations. The consistency of behavior allows them to optimize their function, which is fundamentally related to aiding user functionality on the Internet and providing a personalized experience. The more seamlessly they can fulfill this function, the more likely they are to contribute to usability. The more optimized the usability, the more likely it is going to become used as standard. The more something is used as a standard, the more interoperable it becomes, and so a feedback loop develops. While addressing interoperability as a technical concern helps to drive change, it also influences other major characteristics. Such implicit interaction among the core characteristics of the Internet demonstrates the fundamental characteristic of dynamism. A similar conclusion can be gleaned from the expert interviews. Interoperability in the Metaverse, as discussed above, is seen as a foundational characteristic. Achieving the degree of interoperability discussed in our interviews naturally influences usability. As participant C hints, the easier it gets to use offerings across various spaces, the more optimal the user experience becomes, which in turn, would push interoperability as a standardized characteristic while the Metaverse develops. Just as with the RFC, promoting the technical characteristic of interoperability positively impacts usability and standardization, showcasing that there is a natural dynamism driving the development of the Internet and the Web, as well as the Metaverse.

Matching the characteristic of dynamism in the development of existing federated networks to the early stages of the Metaverse proves noteworthy. Our study suggests the finding of similar patterns between the development of the Internet and the Web, as well as the early Metaverse, enabling us to foreshadow a path for its future development. By matching the same inherent dynamism that promotes advances across each core characteristic, we may be able to better understand the *pace* of development and see when certain changes can catalyze rapid advancement. Understanding the shared characteristics as well as the dynamic relationship among them, can help us conceptualize the future development of the Metaverse not as a linear progression, but as a dynamic process with various ebbs and flows.

5.2. Theoretical implications

Our work brings forward sorely needed theoretical implications for the future development of the Metaverse specifically, and federated networks in general. The Metaverse can be conceptualized as a federated network, where diverse systems and components are interoperated within a unified immersive environment. Such a conceptualization aligns with the fundamental characteristics of existing federated networks as identified in our study. *Interoperability*, a cornerstone of federated networks, is critical for the Metaverse, enabling seamless interactions across disparate immersive spaces. Our findings affirm the importance of developing interoperability standards to facilitate such seamless interaction, thereby advancing theoretical understandings of how federated networks can evolve to support the Metaverse ecosystem. *Standardization* in federated networks ensures that diverse systems can operate cohesively. Our findings highlight the need for universal standards in the Metaverse to address issues related to security, privacy, and identity management. Such a need for standardization reinforces existing theories on federated networks, emphasizing the role of regulatory frameworks in maintaining system integrity and user trust. *Usability* in federated networks pertains to the ease with which users can navigate and interact with various spaces. The Metaverse, with its focus on immersive user experiences, pushes the boundaries of traditional usability concepts, necessitating new theoretical models that account for the heightened interactivity and expected engagement levels. *Scalability*, another critical aspect of federated networks, is essential for the Metaverse to support a growing user base and its increasingly complex set of applications. The findings of our study, therefore, contribute to the theoretical discourse by illustrating how scalability challenges in the Metaverse can inform broader federated network architecture theories, particularly regarding infrastructure development and resource allocation.

Research on the future of a phenomenon involves observing, discussing, and predicting something that *will become*, rather than something that *is*. *Futures studies* research has often discussed *probable* futures rather than *desirable* ones [27,28,30]. In contributing to this line of research, our study incorporates a socio-technical imaginaries perspective and envisions what the Metaverse can potentially become. The Metaverse can be seen as a social and technological system, and, therefore, the socio-technical imaginaries perspective provides us with the needed framework for studying the complex relationships between technology and society, highlighting the importance of understanding the technical aspects of technology, and its social dimensions. Both theoretical as well as technological developments on the Metaverse are increasingly expanding and, consequently, an attainable future is possible. This aligns with the definition of the socio-technical imaginaries perspective, whereby an attainable future emphasizing i) technological systems, ii) subjective and psychological dimensions, iii) performance, and iv) narratives as well as processes, is desirable [33–35,63]. Our study, thus, brings forward timely theoretical implications for the technological and social advancement of the Metaverse.

Specifically, we unearth the key characteristics for the future of the Metaverse and present an evolutionary comparison with existing federated networks, which can contribute to a better definition of the Metaverse. Our study, thus, is a timely attempt to develop a better understanding of the potential architecture of the Metaverse. Our study also has implications beyond the Metaverse, and our findings can be applied to wider research on federated network architectures, spatial computing, as well as digital platform ecosystems, which are topics that receive increasing attention in the extant literature [17,67,69,78]. Our study, thus, is timely beyond the Metaverse as a buzzword [37,53,77] and extends the theoretical underpinnings of federated networks by contextualizing their Metaverse principles. In doing so, our work makes the Metaverse accessible and relatable to legacy organizations [10]. By examining the interplay among interoperability, standardization, usability, and scalability, we provide a nuanced exposition of how the theoretical underpinnings of federated networks can guide the development of the Metaverse ecosystem. Such a theoretical advancement offers valuable insights for future research, bridging the gap between federated network principles and the emerging realities of the Metaverse.

5.3. Practical implications

Our findings also bring forward practical implications for multiple stakeholder groups, including developers, policymakers, investors, as well as commercial users involved in the burgeoning Metaverse ecosystem. By identifying the core characteristics essential for the future development of the Metaverse, we provide a roadmap for further

advancements in this domain. Specifically, for developers, the insights brought forward by our study underscore the necessity of focusing on interoperability to ensure seamless user experiences across Metaverse spaces. As the Metaverse aims to replicate and extend real-world interactions into immersive spaces, achieving a high level of interoperability will be crucial for fostering a cohesive user experience and enabling the movement of virtual assets and identities across Metaverse spaces. Policymakers can use the insights of our study to inform regulatory frameworks that promote standardization and ensure the safety and security of Metaverse users. Given the federated nature of the Metaverse, establishing universally accepted standards will be vital to mitigate risks related to privacy, security, and identity management. Policymakers should work collaboratively with industry stakeholders to develop and apply such standards, ensuring that the Metaverse evolves in a secure and user-friendly manner. For investors, our work highlights the financial opportunities of the Metaverse. By understanding the key characteristics driving its development, investors can make informed decisions for allocating resources and supporting technologies. The emphasis on usability and scalability in our study suggests that investments in user-centric designs and scalable infrastructure will likely yield significant returns as the Metaverse matures. Commercial users can leverage our insights to better integrate their offerings into the Metaverse. By aligning their offerings with the identified core characteristics—particularly usability—they can enhance user engagement and satisfaction. Businesses should focus on creating immersive, user-friendly experiences that take full advantage of the interactive capabilities of the Metaverse. As such, our study provides a comprehensive framework that various stakeholder groups can use to navigate the complexities of the evolving Metaverse. By prioritizing *interoperability*, *standardization*, *usability*, and *scalability*, we could collectively ensure that the Metaverse develops into a robust, secure, and engaging ecosystem. Such a proactive approach will address the current challenges and lay the groundwork for future innovations in the digital landscape.

5.4. Limitations and future research

Our work presents a novel approach for unearthing the core characteristics of the Metaverse architecture, and to form theoretical insights into its future development as compared to the one of existing federated networks. Such a novel approach, however, comes with limitations that need to be acknowledged. First, many of our participants were developers, and comparing the different types of experts was not possible. Future research endeavors can focus on single types of experts to provide more targeted insights, or incorporate a focus group discussion approach, to enable the various stakeholder groups to debate on the topic. Second, it would be ideal for the continuation of our study to recruit a larger number of participants. In selecting participants, however, we were particularly thorough and careful to look beyond the 'buzzword' and recruit experts involved in Metaverse projects. As the Metaverse is still in its infancy, we expect that future research endeavors will be able to see through the noise more easily in recruiting experts and be able to further validate and expand our findings.

Our study also opens many avenues for future research within the broader management and IS research agenda [3,66]. First, in further expanding this line of work, future research endeavors could attempt to recruit more expert participants. In doing so, such endeavors could further focus on the topics of anonymity, privacy, and security in the Metaverse, which merit further research and could provide vital insights for the development of the space. Such insights would enable future developments to increase security measures and anonymity and decrease privacy concerns related to the Metaverse. In line with this, future research into standardization and governance can also help to widen security measures to reduce anonymity and privacy concerns. Our work, thus, provides a bedrock for future research to further explore the characteristics that we unearth as key to the future development of the Metaverse. Beyond the architectural characteristics, future research should also examine how advancements in various digital technologies might shape the future development of the Metaverse. Such technologies can enable Metaverse users to interact with human-like AI-enabled agents, raising significant ethical concerns that require further investigation. Consequently, future research should also aim to better understand such interactions, ensure the safe conduct of Metaverse users engaging with human-like AI-enabled agents, and explore potential related governance mechanisms for the Metaverse.

6. Conclusion

Our study aimed to identify the core characteristics for the future development of the Metaverse through expert interviews, supplemented by archival data relating to the development of existing federated networks. Our combined analysis revealed four core characteristics: *Interoperability*, *Standardization*, *Usability*, and *Scalability*. The archival data placed particular attention on these characteristics often directly, through protocol and framework developments, or explicitly by discussing relevant considerations. Our interviews with experts, likewise, revealed a consistent focus on these characteristics. Interoperability was seen as the most fundamental characteristic for the future development of the Metaverse; although questions were raised about the extent to which a fully interoperable Metaverse is likely in the context of the contemporary economic landscape. Whilst standardization was also identified as essential, it faces challenges in being realized, though it remains to be seen whether the Metaverse Standards Forum can take enough hold to act as the equivalent to the RFC. Security was identified as a core characteristic, both for making the ecosystem safe as well as an onboarding mechanism. Usability was also seen as essential, with our interviewees placing great importance on this characteristic, likely due to the inherently more immersive nature of the Metaverse compared to the early development of the Internet and the Web. Scalability was a central characteristic across our data. During our interviews, the experts discussed the concept of scalability in relation to aspects such as community-building, as it is not known upon which set of technologies the Metaverse will be built, rendering discussions on the scalability of said technology moot. Such characteristics that are influencing development allow us to project onto the Metaverse a similar trajectory that the Internet and the Web experienced. By doing so, we can confidently assess the development of the Metaverse.

Our holistic approach to the core characteristics also revealed that they could often operate in conjunction. Developments in one of the core characteristics may drastically impact the advancement of another, driving development forward. Promoting security as a core characteristic, for instance, could improve usability, bringing with it the potential to further improve standardization. Taking note of this relationship among the core characteristics, enabled us to recognize two key insights: i) dynamism is the underpinning characteristic for the development of federated networks, and ii) it allows us to more readily understand that the future development of the Metaverse will not follow a linear progression. The socio-technical imaginaries perspective that we adopted in our study, therefore, has enabled us to see beyond the hype and unearth the core characteristics that will define the future of the Metaverse.

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Madaleine H.S. Hunt: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Visualization, Writing – review & editing. **Spyros Angelopoulos:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Funding acquisition,

Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

References

[1] H. Aguinis, A.M. Solarino, Transparency and replicability in qualitative research: The case of interviews with elite informants, Strateg. Manag. J. 40 (8) (2019) 1291–1315.
[2] D.G. Ancona, P.S. Goodman, B.S. Lawrence, M.L. Tushman, Time: a new research lens, Acad. Manag. Rev. 26 (4) (2001) 645–663.
[3] S. Angelopoulos, E. Bendoly, J.C. Fransoo, K. Hoberg, C.X. Ou, A. Tenhiälä, Digital transformation in operations management: fundamental change through agency reversal, J. Oper. Manag. 69 (6) (2023) 876–889.
[4] S. Angelopoulos, M. Brown, D. McAuley, Y. Merali, R. Mortier, D. Price, Stewardship of personal data on social networking sites, Int. J. Inf. Manag. 56 (2021) 102208.
[5] M.S. Archer, Realist Social Theory: The Morphogenetic Approach, Cambridge university press, 1995.
[6] G. Augustine, S. Soderstrom, D. Milner, K. Weber, Constructing a distant future: imaginaries in geoengineering, Acad. Manag. J. 62 (6) (2019) 1930–1960.
[7] R.C. Basole, H. Park, C.D. Seuss, Complex business ecosystem intelligence using AI-powered visual analytics, Decis. Support. Syst. 178 (2024) 114133.
[8] B. Basu, A.K. Kar, S. Sen, Antecedents of user experience in the immersive Metaverse ecosystem: insights from mining user reviews, Commun. Assoc. Inf. Syst. 55 (1) (2024) 13.
[9] J. Beckert, Imagined Futures: Fictional Expectations and Capitalist Dynamics, Harvard University Press, 2016.
[10] M. Benassi, R. Rialti, Exploring the Metaverse from a legacy company perspective: a capabilities-based view, Calif. Manag. Rev. 00081256241256997 (2024).
[11] R.P. Bostrom, S. Gupta, D. Thomas, A meta-theory for understanding information systems within sociotechnical systems, J. Manag. Inf. Syst. 26 (1) (2009) 17–48.
[12] R.E. Boyatzis, Transforming qualitative information: thematic analysis and code development, Sage Publications, Inc (1998).
[13] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual. Res. Psychol. 3 (2) (2006) 77–101.
[14] A.G. Candela, Exploring the function of member checking, Qual. Rep. 24 (3) (2019) 619–628.
[15] D. Chakraborty, A.K. Kar, D. Dennehy, Metaverse in e-commerce industry: current trends and future prospects, Electron. Commer. Res. (2023) 1–2.
[16] C. Chen, K.Z. Zhang, Z. Chu, M. Lee, Augmented reality in the metaverse market: the role of multimodal sensory interaction, Internet Res. 34 (1) (2024) 9–38.
[17] X. Cheng, J. Mou, X.-L. Shen, T. de Vreede, R. Alt, Guest editorial: exploring the research opportunities and challenges in the metaverse, Internet Res. 34 (1) (2024) 1–8.
[18] V. Clarke, V. Braun, Thematic analysis: a practical guide, Sage (2021).
[19] K. De Valck, G.H. Van Bruggen, B. Wierenga, Virtual communities: a marketing perspective, Decis. Support. Syst. 47 (3) (2009) 185–203.
[20] M. de Zwart, D. Lindsay, Governance and the global metaverse, in: Emerging Practices in Cyberculture and Social Networking, Brill, 2010, pp. 63–82.
[21] Y.K. Dwivedi, L. Hughes, A.M. Baabdullah, S. Ribeiro-Navarrete, M. Giannakis, M. M. Al-Debei, D. Dennehy, B. Metri, D. Buhalis, C.M. Cheung, Metaverse beyond the hype: multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy, Int. J. Inf. Manag. 66 (2022) 102542.
[22] J. Fan, F. Han, H. Liu, Challenges of big data analysis, Natl. Sci. Rev. 1 (2) (2014) 293–314.
[23] S.B. Far, A.I. Rad, Applying digital twins in Metaverse: user interface, security and privacy challenges, J. Metaverse 2 (1) (2022) 8–16.
[24] G. Fisher, K. Mayer, S. Morris, From the editors—phenomenon-based theorizing, Acad. Manag. Rev. 46 (4) (2021) 631–639.
[25] A. Giddens, The consequences of modernity, in: C.J. Calhoun (Ed.), Contemporary Sociological Theory, Blackwell, Malden, MA, 2007, pp. 2–243.
[26] R.W. Gregory, O. Henfridsson, Bridging art and science: phenomenon-driven theorizing, J. Assoc. Inf. Syst. 22 (6) (2021) 1509–1523.
[27] A.A. Gümüsay, J. Reinecke, Researching for desirable futures: from real utopias to imagining alternatives, J. Manag. Stud. 59 (1) (2022) 236–242.
[28] A.A. Gümüsay, J. Reinecke, Imagining desirable futures: a call for prospective theorizing with speculative rigour, Org. Theory 5 (1) (2024), 26317877241235939.
[29] A.F. Hayes, K. Krippendorff, Answering the call for a standard reliability measure for coding data, Commun. Methods Meas. 1 (1) (2007) 77–89.
[30] D. Hovorka, S. Peter, Research perspectives: from other worlds: speculative engagement through digital geographies, J. Assoc. Inf. Syst. 22 (6) (2021) 1736–1752.
[31] Y.Y. Hsieh, J.P. Vergne, The future of the web? The coordination and early-stage growth of decentralized platforms, Strateg. Manag. J. 44 (3) (2023) 829–857.
[32] T. Huynh-The, T.R. Gadekallu, W. Wang, G. Yenduri, P. Ranaweera, Q.-V. Pham, D. B. da Costa, M. Liyanage, Blockchain for the metaverse: a review, Futur. Gener. Comput. Syst. 143 (2023) 401–419.
[33] S. Jasanoff, Future imperfect: Science, technology, and the imaginations of modernity, in: S. Jasanoff, S.-H. Kim (Eds.), Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power, University of Chicago Press, 2015, pp. 1–33.
[34] S. Jasanoff, Imagined and invented worlds, in: S. Jasanoff, S.-H. Kim (Eds.), Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power, University of Chicago Press, 2015, pp. 321–342.
[35] S. Jasanoff, S.-H. Kim, Containing the atom: sociotechnical imaginaries and nuclear power in the United States and South Korea, Minerva 47 (2009) 119–146.
[36] T. Jung, J. Cho, D.-I.D. Han, S.J.G. Ahn, M. Gupta, D. Gopal, C.Y. Heo, S.M. C. Loureiro, M. Sigala, M. Trunfio, Metaverse for service industries: future applications, opportunities, challenges and research directions, Comput. Hum. Behav. 108039 (2023).
[37] A. Kaplan, M. Haenlein, To be or not to be: will virtual worlds and the Metaverse gain lasting traction? Calif. Manag. Rev. 00081256241259188 (2024).
[38] A.K. Kar, P. Varsha, Unravelling the techno-functional building blocks of metaverse ecosystems–a review and research agenda, Int. J. Inform. Manag. Data Insights 3 (2) (2023) 100176.
[39] H.M. Kim, S. Chakraborty, Exploring the diffusion of digital fashion and influencers' social roles in the Metaverse: an analysis of twitter hashtag networks, Internet Res. 34 (1) (2024) 107–128.
[40] H.K. Klein, M.D. Myers, A set of principles for conducting and evaluating interpretive field studies in information systems, MIS Q. 23 (1) (1999) 67–93.
[41] T. Kretschmer, A. Leiponen, M. Schilling, G. Vasudeva, Platform ecosystems as meta-organizations: implications for platform strategies, Strateg. Manag. J. 43 (3) (2022) 405–424.
[42] K. Krippendorff, Reliability in content analysis: some common misconceptions and recommendations, Hum. Commun. Res. 30 (3) (2004) 411–433.
[43] L.-H. Lee, T. Braud, P. Zhou, L. Wang, D. Xu, Z. Lin, A. Kumar, C. Bermejo, P. Hui, All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda, arXiv preprint. arXiv:2110.05352, 2021.
[44] B.M. Leiner, V.G. Cerf, D.D. Clark, R.E. Kahn, L. Kleinrock, D.C. Lynch, J. Postel, L. G. Roberts, S. Wolff, A brief history of the internet, ACM SIGCOMM Comp. Commun. Rev. 39 (5) (2009) 22–31.
[45] B.M. Leiner, V.G. Cerf, D.D. Clark, R.E. Kahn, L. Kleinrock, D.C. Lynch, J. Postel, L. G. Roberts, S.S. Wolff, The past and future history of the internet, Commun. ACM 40 (2) (1997) 102–108.
[46] W.Y.B. Lim, Z. Xiong, D. Niyato, X. Cao, C. Miao, S. Sun, Q. Yang, Realizing the metaverse with edge intelligence: A match made in heaven, arXiv preprint. arXiv:2201.01634, 2022.
[47] M.Á. López-Cabarcos, J. Piñeiro-Chousa, Illusion or reality? Building a metaverse community focused on value creation in the agricultural sector, Int. J. Inf. Manag. 77 (2024) 102782.
[48] D. McLeod, D. Heimbigner, A federated architecture for database systems, in: AFIPS National Computer Conference, ACM, Anaheim California, 1980, pp. 283–289.
[49] M.B. Miles, A.M. Huberman, J. Saldaña, Qualitative Data Analysis: A Methods Sourcebook, Sage, 2018.
[50] E. Monteiro, P. Constantinides, S. Scott, M. Shaikh, A. Burton-Jones, Editor's comments: qualitative methods in IS research: a call for phenomenon-focused Problematization, MIS Q. 46 (4) (2022) iii–xix.
[51] J.M. Njihia, Y. Merali, The broader context for ICT4D projects: a morphogenetic analysis, MIS Q. 37 (3) (2013) 881–905.
[52] M.Q. Patton, Qualitative Evaluation and Research Methods, 2nd ed, Sage, 1990.
[53] A. Polyviou, I.O. Pappas, Chasing Metaverses: reflecting on existing literature to understand the business value of Metaverses, Inf. Syst. Front. 25 (2023) 2417–2438.
[54] D. Price, D. McAuley, R. Mortier, C. Greenhalgh, M. Brown, S. Angelopoulos, Inter-social-networking: Accounting for multiple identities, in: International Conference on Social Computing and Social Media, Springer, Los Angeles, CA, USA, 2015, pp. 242–252.
[55] S. Richter, A. Richter, What is novel about the Metaverse? Int. J. Inf. Manag. 73 (2023) 102684.
[56] P. Ritala, M. Ruokonen, A. Kostis, The Metaverse flywheel: creating value across physical and virtual worlds, Calif. Manag. Rev. 00081256241252700 (2024).
[57] S. Sarker, S. Chatterjee, X. Xiao, A. Elbanna, The sociotechnical axis of cohesion for the IS discipline: its historical legacy and its continued relevance, MIS Q. 43 (3) (2019) 695–720.
[58] S. Sarker, X. Xiao, T. Beaulieu, Guest editorial: qualitative studies in information systems: a critical review and some guiding principles, MIS Q. 37 (4) (2013) iii–xviii.
[59] L. Sartori, G. Bocca, Minding the gap (s): public perceptions of AI and socio-technical imaginaries, AI & Soc. 38 (2) (2023) 443–458.
[60] S. Seidel, N. Berente, J. Nickerson, G. Yepes, Designing the metaverse, in: Hawaii International Conference on System Sciences, Maui, Hawaii, USA, 2022, pp. 6699–6708.
[61] S. Sismondo, Sociotechnical imaginaries: an accidental themed issue, Soc. Stud. Sci. 50 (4) (2020) 505–507.

[62] A.M. Solarino, H. Aguinis, Challenges and best-practice recommendations for designing and conducting interviews with elite informants, J. Manag. Stud. 58 (3) (2021) 649–672.
[63] B.K. Sovacool, D.J. Hess, Ordering theories: typologies and conceptual frameworks for sociotechnical change, Soc. Stud. Sci. 47 (5) (2017) 703–750.
[64] N.J. Stone, G. Yan, F.F.-H. Nah, C. Sabharwal, K. Angle, F.G.E. Hatch III, S. Runnels, V. Brown, G.M. Schoor, C. Engelbrecht, Virtual reality for hazard mitigation and community resilience: an interdisciplinary collaboration with community engagement to enhance risk awareness, AIS Trans. Human-Comp. Interact. 13 (2) (2021) 130–144.
[65] M. Struijk, S. Angelopoulos, C.X. Ou, Emergence and evolution of digital transformation: a morphogenetic approach, in: Academy of Management Proceedings 10510, Academy of Management Briarcliff Manor, NY, 2022, p. 11244.
[66] M. Struijk, C.X. Ou, R.M. Davison, S. Angelopoulos, Putting the IS back into IS research, Inf. Syst. J. 32 (3) (2022) 1–4.
[67] Y. Sun, Y. Zhong, Z. Zhang, Y. Wang, M. Zhu, How technical features of virtual live shopping platforms affect purchase intention: based on the theory of interactive media effects, Decis. Support. Syst. 114189 (2024).
[68] R. Tesch, Qualitative Research: Analysis Types and Software, Routledge, 2013.
[69] F. Tingelhoff, S. Klug, E. Elshan, The diffusion of the Metaverse: how YouTube influencers shape mass adoption, Calif. Manag. Rev. 00081256241246123 (2024).
[70] A.K. Upadhyay, K. Khandelwal, Metaverse: the future of immersive training, Strateg. HR Rev. 21 (3) (2022) 83–86.
[71] M.H. ur Rehman, C.S. Liew, A. Abbas, P.P. Jayaraman, T.Y. Wah, S.U. Khan, Big data reduction methods: a survey, Data Sci. Eng. 1 (2016) 265–284.
[72] G. Von Krogh, C. Rossi-Lamastra, S. Haefliger, Phenomenon-based research in management and organisation science: when is it rigorous and does it matter? Long Range Plan. 45 (4) (2012) 277–298.
[73] Y. Wang, Z. Su, N. Zhang, R. Xing, D. Liu, T.H. Luan, X. Shen, A survey on metaverse: fundamentals, security, and privacy, IEEE Commun. Surv. Tutor. 25 (1) (2022) 319–352.
[74] A. Woodall, S. Ringel, Blockchain archival discourse: trust and the imaginaries of digital preservation, New Media Soc. 22 (12) (2020) 2200–2217.
[75] N. Xi, J. Chen, F. Gama, M. Riar, J. Hamari, The challenges of entering the metaverse: an experiment on the effect of extended reality on workload, Inf. Syst. Front. 25 (2023) 659–680.
[76] W. Xu, N. Zhang, M. Wang, The impact of interaction on continuous use in online learning platforms: a metaverse perspective, Internet Res. 34 (1) (2024) 79–106.
[77] Y. Xu, W. Liu, T. He, S.-B. Tsai, Buzzword or fuzzword: an event study of the metaverse in the Chinese stock market, Internet Res. 34 (1) (2024) 174–194.
[78] Y. Xue, J. Sun, Y. Liu, X. Li, K. Yuan, Facial expression-enhanced recommendation for virtual fitting rooms, Decis. Support. Syst. 177 (2024) 114082.
[79] Z. Zhou, Z. Chen, X.-L. Jin, A review of the literature on the metaverse: definition, technologies, and user behaviors, Internet Res. 34 (1) (2023) 129–148.
[80] M. Zuo, Y. Shen, How features and affordances of a metaverse portal engage users? Evidence from exergames, Internet Res. 34 (1) (2024) 239–261.

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