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Review

Trends, Challenges, and Future Research Directions: Systematic Literature Review (SLR) on the Potential and Adaptation of Broadcast Radio in 3D Virtual Spaces (Metaverse)

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Abstract: By methodically mapping and synthesizing the existing literature, this study identifies new trends, multidimensional problems, and future research topics related to the adaptation and potential of Broadcast Radio within the metaverse ecosystem. In accordance with the PRISMA 2020 standards, a Systematic Literature Review (SLR) was carried out. Scopus, Web of Science, IEEE Xplore, and ScienceDirect were among the main academic databases searched, with an emphasis on the revolutionary years of 2020–2025. The theme synthesis included 37 peer-reviewed articles, all of which were selected using a rigorous method. In contrast to the old model of passive, linear listening, the results show that people are increasingly engaging with media in an inhabited, multisensory, and dynamic way. There are now three main areas of focus in the field of research: (1) the creation of more lifelike virtual studios and spatial interfaces; (2) the improvement of models for social interaction through the use of avatars; and (3) the new ways to make money on the Web 3.0. Using theories of presence and media richness, the results show how spatial auditory and visual social signals enable telepresence, which reframes audience motives within the U&G framework. Technical lag, expensive infrastructure, and complicated regulatory loopholes concerning copyright in 3D areas are some of the enormous obstacles highlighted by the study. To close the digital gap, this SLR gives a path forward for the media sector based on evidence, stressing the need of hybrid accessible approaches. It finds that radio can only survive if it becomes a community-driven platform where users can interact with one another, and it suggests that researchers should focus on studying the immersive age's sustainable business models and User Experience (UX) in order to make this shift.

Keywords: Virtual Reality (VR), Spatial Audio, User Experience (UX), Digital Transformation, Media Convergence, PRISMA, Web 3.0, Presence Theory.

1. Introduction

The media and communication industry has experienced several transitional phases, including digitization and convergence. It is therefore still a very dynamic sector, but because of immediacy, accessibility, and the personal nature of interaction that radio provides, broadcasting remains powerful [1]. Essential elements such as access to delivery involving humans in real time have proved difficult for digital-and-convergent platforms to emulate; hence, they remain key players within this rapidly evolving media-and-communication landscape.

Radio survived the assault of new media by transforming itself into an online and social medium. It has moved from unidirectional transmission to a very complex interactive communication system across various platforms. Being one of those

hybrid media that applies both tradition and innovation in today's digital practices, the implementation of internet streaming, podcasts, and social networking into radio has created different ways for audiences to engage with it [2].

Like other legacy media, radio has always been quick to keep itself relevant with new technology. Currently, a total game changer for the Metaverse in Media and real and virtual worlds combine experiences delivered to users; an immersive experience is a persistent 3D virtual environment based on Web 3.0 concepts of Augmented Reality (AR) and Virtual Reality (VR). In terms of radio broadcast delivery, this transformation permits movement beyond passive listening into active engagement with soundscapes within virtual worlds, allowing dynamism in storytelling as well as social interaction and customized content delivery based on contextual relevance [3,4].

The metaverse is not simply a new platform; it is an entirely fresh perspective on viewing, doing, and being engaged with content and communities. This tendency has the potential to reshape broadcasting as people comprehend listening to music. They will be able to do much more than just listen-they can interact with virtual artists' studios or as avatars basking in some 3D environment synchronized perfectly with music. How has broadcast radio taken its place in this virtual world? This remains one of the leading questions in media technology studies. Virtual reality (VR) and augmented reality (AR) are among the technologies that drive large parts of innovation within the metaverse by creating fully immersive sound experiences while perfectly mixing visual elements to enhance the user experience. Immersive media is about to break big as a leading platform once VR and AR technology develops further and becomes available to the larger public. This will bring fresh opportunities for radio broadcasters and new ways of sharing and delivering content that were previously considered forms of transmission [5].

The metaverse also opens up new avenues for monetization, content sharing, and content creation because blockchain technology enables digital assets to be created. Virtual events, interactive programs, and community content at digital venues can serve as means through which business innovation concepts are inspired and ways to engage with radio audiences [6]. Hence, several challenges abound in exploring the landscape of Metaverse technologies. In autonomous and mobile contexts that constantly evolve within the broader transformation of the digital world, where aspects such as trust-inequality bring long shadows on access to a faultless QoE, it becomes one among top priorities; there is an understanding set deep inside today's media professional about complex security frameworks together with regulations needed for success [7]. The traditional media and broadcasting industry is being washed over by a tidal wave from the metaverse, enabling previously impossible levels of engagement and interaction. To stay updated and provide new content in the era of Web 3.0, the industry must quickly adjust to the changing consumer preferences resulting from such innovative technologies. The leading media houses that wish to be at the forefront and thrive in future media have no option but to metamorphose into another set of houses [8].

There is abundant literature on the metaverse and its various aspects, demonstrating its overall impact on the ever-evolving world of visual media, gaming, and commerce. Not much literature appears to be available or published on the interaction between the metaverse and the broadcasting industry. Most contemporary research comprises theoretical discourse, industry reports, and case studies. However, we could not obtain a detailed summary of the findings. Before charting out a further course of action, there is a need to take stock of the work already done in this area,

identify hurdles, and evaluate results. A better demonstration of the current state of knowledge in this area can be provided by a Systematic Literature Review (SLR).

In response to this urgent requirement, this study conducts a Systematic Literature Review (SLR) with a comprehensive scope. This review aims to achieve the following specific goals.

▪ This study examines how broadcast radio and the metaverse intersect, unveiling a realm of endless opportunities and transformative potential.

▪ Exploring the key technical, economic, and regulatory challenges that broadcast radio encounters as it transitions into 3D virtual spaces.

▪ This study provides a reference for subsequent research in the field of immersive communication and proposes unexplored future research directions.

Those working in academics and business will both profit from this SLR. Its stated goal is to lay out the present status of metaverse radio fusion research in an experimentally grounded context.

Our study approach is outlined in the Literature Review (SLR) portion of this work. The rest of the paper is organized as follows. In Section 3, we highlight the trends and issues that were found through our data analysis. The implications of these results for both theory and practice are discussed in Part 4. Section 5 wraps up the study and offers some suggestions for where the field might go from here.

2. Materials and methods

2.1 Study Design

The research methodology applied in this study is an SLR method. The SLR method was chosen because of its systematic, transparent, and replicable manner of identifying, appraising, and synthesizing findings from all research relevant to the study objectives. To minimize possible bias, two researchers independently screened and extracted themes and later negotiated their differences to reach an agreement on any conflicting issues. The approach adopted in this review adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 recommendations [9]. However, despite following the PRISMA framework, the protocol for this study was not officially registered in PROSPERO because the research involves media and communication technologies that are not normally associated with clinical and health-related topics.[10]

2.2 Research Questions

The review process was guided by three primary research questions (RQs):

• **RQ1:** What are the main trends in research connecting the Metaverse with radio broadcasting?

• **RQ2:** In what ways do technical, economic, and regulatory challenges influence the adaptation of radio broadcasting within the metaverse?

• **RQ3:** The existing literature on this topic suggests potential avenues for future research.

2.3 Search Strategy

On November 11, 2025, four main academic databases—Scopus, WoS, IEEE Xplore, and ScienceDirect–were searched. We chose these databases because they have every peer-reviewed journal in the field of communication science and IT covered.

The search strategy utilized Boolean operators (AND, OR) with keywords in the titles, abstracts, and keywords.

("metaverse" OR "virtual reality" OR "Web 3.0" OR "virtual world*") AND ("broadcast*" OR "radio station*" OR "audio media") AND ("adaptation" OR "engagement" OR "interaction" OR "business model*").

2.4 Inclusion and Exclusion Criteria

We established transparent eligibility criteria to ensure the selection of high-quality, relevant content. The years 2020–2025 were selected with the intention of capturing the most crucial period of the Metaverse's evolution. Late in 2021, Facebook changed its name to Meta, marking the transition of the metaverse from an obscure game concept to a paradigm in mainstream media. This change takes place all through this time. Following this change in the market, academic interest in 3D virtual worlds surged.

The selection of high-quality and relevant material was ensured by establishing precise qualifying criteria. **Table 1** summarizes the inclusion and exclusion criteria utilized in this investigation. For this analysis, the years 2020–2025 were chosen on purpose.

Table 1. Eligibility Criteria for Article Selection

Criterion	Inclusion Criteria (IC)	Exclusion Criteria (EC)
Time Period	Published between 2020 and 2025.	Published before 2020.
Document Type	Peer-reviewed journal articles and conference proceedings were included.	The collection includes grey literature, such as blogs, editorials, news, book reviews, and reports.
Language	English and Indonesian.	Other than English and Indonesian, there are other languages.
Core Subject	Must integrate "Radio Broadcasting" (or audio media) with "Metaverse" (or VR/AR/3D spaces).	General metaverse studies without media context; studies focusing solely on gaming.
Content Focus	Some articles addressed trends, technical/economic hurdles, or engagement models (RQ1-RQ3).	Narrative reviews lack a systematic methodology, and the articles solely discuss music streaming/podcasts without a broadcast context.

2.5 Selection Process and Data Extraction

Below, we outline the steps that comprise the selection process. Reference management software was used to first eliminate duplicates. The second step was to check the abstracts and titles using the Inclusion Criteria (IC). Third, to ensure relevance, the articles that passed the first screening were downloaded and read in full.

For data synthesis, 37 articles were included in the final analysis. The author and year, journal/conference, research objective, methods used, principal findings, and relevance to research questions were the columns from which data were collected for each publication. Figure 1 shows the PRISMA Flow Diagram, which details the systematic flow of the selection process and the number of data rejected at each stage.

3. Results and Discussion

3.1 Overview of Selected Literature

An extensive body of material was culled from the articles that passed muster through a stringent screening procedure. Scopus, Web of Science, IEEE Xplore, and ScienceDirect were the early search engines that yielded 358 articles in total. The final data synthesis contained 37 papers after deleting duplicates and applying

the inclusion/exclusion criteria during title, abstract, and full-text screening. The PRISMA flowchart (**Figure 1**) shows the methodical selection process.

This process is illustrated in **Figure 1** (PRISMA Flow Diagram).

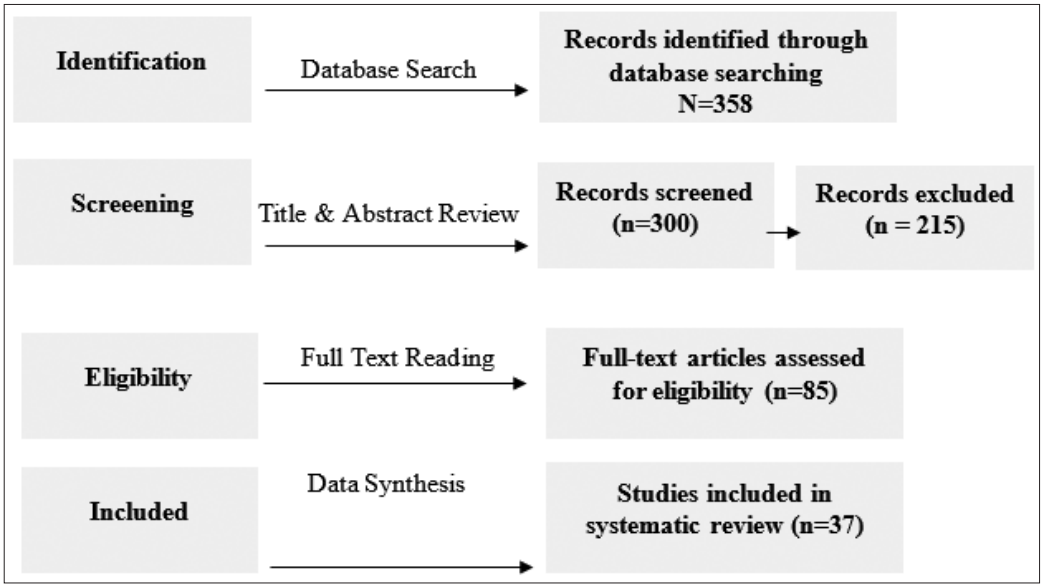

Figure 1. Visualization of the PRISMA Flow Diagram

Research activity clearly took off after 2022, according to the 37 publications we included. With interest in the metaverse rising worldwide, this spike makes sense. The fact that 75% of these articles were published between 2023 and 2025 is quite intriguing, as it shows that this issue is becoming a new and rapidly changing field of study. The multidisciplinary character of the subject is demonstrated by the large number of articles that have originated from journals that concentrate on communication and technology, such as Telematics and Informatics.

3.2 Identification of Research Trends (RQ1)

The thematic analysis of the 37 articles identified three primary trends characterizing the adaptation of radio broadcasting in 3D virtual spaces.

• Trend A: Spatial Interfaces and Immersive Studios (35% of publications). This paper discusses the priorities set for research on the design of User Experience (UX) in virtual environments. The results show that a "presence" can be felt or established by broadcasters using avatars and visual stimuli within 3D studios. The important basics found in several studies for immersion is spatial audio; therefore, sound gives directionality to make virtual listening appear more realistic [11].

• Trend B: Evolution of Interaction and Engagement Models (45% of papers). This is articulated as a shift from passive consumption to more intensive involvement, hence articulating humans as being engaged with processes rather than merely end consumers. Metaverse implementation places the audience not as faceless bystanders but avatars who can participate in numerous ways, such as live collaboration and visual feedback, besides virtual events participation, making radio a community-driven social medium rather than simply a one-way broadcast [12].

• Trend C: Novel Methods of Revenue (20% of articles). This is a trend that explores the possibility of long-tail revenues in Web 3.0, although it is currently in its infancy. Some of the strategies identified include virtual advertising, sale to listeners' avatars' virtual goods, and issuing Non-Fungible Tokens (NFTs) for exclusive

broadcast content.VIRTUAL ADVERTISING,Issuing NON FUNGIBLE TOKENS (NFTS)for EXCLUSIVE BROADCAST CONTENT&SELLING VIRTUAL ITEMS FOR LISTENERS AVATARS are some among identified techniques.iHeartLand on Roblox is one example that demonstrates how radio stations can earn from virtual environments outside spot ads through features such as access to play mini games inside the environment&nft gated accesses [13].

3.3 Multidimensional Challenges (RQ2)

Three main types of obstacles that prevent seamless integration of radio into the metaverse have been identified in the literature.

• Obstacles in Technology and Architecture: One major issue is the persistently high latency, which is especially problematic when attempting to synchronize immersive 3D graphics with real-time audio. There is a lot of resistance to universal access because there are no standardized spatial audio formats and problems with interoperability between various VR/AR gear systems [14].

• Financial and Manpower Limitations: Building and maintaining a metaverse server and virtual infrastructure can be out of reach for small and medium radio stations. The sector is also short-handed when it comes to broadcasters who possess the multidisciplinary abilities necessary for virtual community management and 3D interface design [15].

• Ethical and Regulatory Considerations: One example of the complicated jurisdictional difficulty that copyright management in 3D spaces poses is international virtual worlds and music licensing. The ethical considerations include data privacy, avatar safety, and the possibility of AI-powered personalized content displaying bias–issues that the current legal framework does not adequately address [16].

3.4 Future Research Directions (RQ3)

Three areas have been recognized as priority areas for future studies based on the gaps that have been identified:

▪ Empirically putting the theory into practice through quality of experience (QoE) assessments on how effective immersive broadcasts are in communication and user happiness.

▪ Frameworks aimed at developing strong business models take advantage of digital assets and the creative economy for the sustainable monetization of radio.

▪ Unified Global Governance: Addressing copyright and ethical concerns through the development of worldwide regulatory standards for 3D broadcasting.

4. Discussion

This Systematic Literature Review (SLR) shows that there is a major paradigm change when broadcast radio is adapted for the Metaverse. This development goes beyond simple technological improvements; it transforms the medium into an immersive, multi-sensory, interactive, and inhabited experience rather than just an aural one.

4.1 Presence and Media Richness: The Psychological Shift

Theoretically, Presence Theory and Media Richness Theory would deliver on the Trend A concept of ‘immersion.’ Radio is no longer just an audio accompaniment; it has become experiential within the Metaverse.

• Technologies such as MPEG-H 3D audio provide “telepresence”the subjective feeling of actual existence within a virtual environment, in addition to an enhancement in sound quality. It allows radio broadcasters to bring a spatial immersive reality close

to physical meetings by allowing listeners to perceive both the direction and distance of sounds [17,18].

• Avatars increase the media richness of radio, which then acts as a social cue. Metaverse-linked radio provides visible social cues such as facial expressions and emotive gestures, moving from a lean medium to a rich medium [19]. This leaves little room for misinterpretation and creates an equally strong contextual relationship between the broadcasters and listeners.

4.2 Redefining Audience Motivations: Beyond Passive Consumption

Trend B, the growth of interaction models, poses a serious threat to the long-standing U&G paradigm. In the past, people passively listened to the radio to gain knowledge or amusement. However, our research shows that there is a new set of social and agentic gratifications driving people to listen to radio in the Metaverse.

The fundamental shifts in audience motivations and gratifications are summarized in **Table 2**.

Table 2. Comparison of Uses and Gratifications (U&G) in Traditional Radio vs. Metaverse Radio.

Dimension	Traditional Radio	Metaverse Radio
Interaction Type	Parasocial (One-way)	Social Presence (Multi-way/Real-time)
User Identity	Anonymous Listener	Avatar-based Self-Presentation
Engagement Mode	Auditory (Passive)	Multisensory (Active Participation)
Community Goal	Information/Entertainment	Co-creation and Shared Experiences

This shift implies that providing "experiential value" is crucial to the future of radio Virtual studios allow users to do more than just listen; they also allow them to experience the content, create their own digital identities, and engage with others through a shared set of icons and symbols [20].

There are several problems with using the traditional Uses and Gratifications paradigm in the metaverse. This is due to the fact that the Metaverse provides a wider range of interactions, encourages people to engage with groups and avatars, lets them express themselves through characters, and boosts social interaction. The complex, interactive, and fully immersive nature of user experiences in the Metaverse is a new element that the U&G framework needs to include if it is to remain relevant [21].

Research has claimed that delivering a broadcast in the metaverse is difficult. However, technology is only one aspect of this issue. Delays in systems, integration, and the usage of immersive devices are technical issues that need to be resolved. This includes user experience and ethical and social issues. The metaverse has redefined social interactions, and users are now reconsidering their identity, empathy, and relationships within virtual spaces [22]. Broadcasting relies heavily on audio communication; hence, this change is very important for broadcasting, which means applying interactive elements from the Metaverse while maintaining trust and social bonds. Radio exists due to these factors, and concerns about digital inequalities, privacy, and trusted interactions may affect emerging(impact)radio stations that have to deal with both social and physical realities [23].

Ethical questions emerge when considering the automation and personalization of the metaverse with artificial intelligence. Consider AI as an example of this. To make broadcast content more entertaining, it can be tailored to match individual

interests. Privacy, data security, and the possibility of content manipulation are among the serious concerns that arise. Broadcast media in an AI-driven Metaverse faces significant obstacles related to bias, discrimination, and the assurance of factual information. [24]. Cybersecurity, data protection, social standards, and digital literacy are critical in metaverse-enhanced broadcasting. We need to reconsider how people use these systems because multimedia tools are becoming increasingly important for sharing audio information with others. It is critical to ensure that they can reach a large audience without causing consumers to become dependent on AI or being overwhelmed by information. [25]. In addition, there are certain peculiarities with consumer devices that are pivotal for accessing the Metaverse. These include guaranteeing that various devices can work together, limiting the fields of view, and preserving synchronization. These factors have the potential to influence how listeners engage with and understand radio broadcasts in this new digital realm. [26].

4.3 The Convergence of Technology and Human Experience

There is a need to recognize the conflict between innovation and accessibility, despite the many opportunities. One of the biggest problems is the "digital divide" that was mentioned earlier. Broadcasters must use Hybrid Accessibility Models to integrate AI, blockchain, and VR/AR to create a "Humane Metaverse" [27].

Radio stations can play the role of digital literacy agents to connect traditional FM/AM accessibility with the hardware-intensive requirements of Web 3.0. The objective is not to do away with radio altogether but to provide a better experience for listeners by making it more engaging and responsive to the needs of the digitally native generation.

Concerns regarding ethics, privacy, and security can be effectively addressed by incorporating the metaverse into the broadcasting sector, which presents a great opportunity to merge state-of-the-art technology with human experience. The manner in which people engage with these innovations should also be carefully considered [28]. If we want the metaverse to enhance the radio experience, we need to use good tactics from various fields [29]. In this article, we examine the pros and cons of the metaverse, focusing on radio stations. Some worry that the metaverse may further exacerbate the economic and talent divide between bigger, better-funded radio stations and smaller, more locally focused stations. To ensure that all students are on an equal footing, it is crucial to consider realistic solutions and invest strategically in technology. Problems with regulations exist (Challenge C), most notably with respect to the copyright of three-dimensional music. To tackle this enormous problem, media regulators and tech platforms worldwide need to cooperate to create a cooperative framework [30].

Trends A and B show that research is on the rise, yet there are still significant gaps. Most current studies do not conduct a thorough empirical evaluation but instead concentrate on potential, as mentioned in Recommendation P3.1: Quality of Experience (QoE). It is critical to conduct additional quantitative studies that contrast the metaverse's advertising and monetization strategies with conventional digital broadcasting (P3.2). The main goal of this literature review is to bring together the results of these different studies and lay a structured empirical groundwork for future studies, especially those that will focus on creating virtual broadcasting ethics norms.

The conflict between the hardware-intensive metaverse and the inherently accessible traditional radio is one of the most notable contradictions found in this SLR. For a long time, radio has been an affordable medium that even those in rural areas can use, since it does not require a high-speed Internet connection [31]. The

"digital divide" is already wide, and the shift to 3D virtual spaces could widen it due to the prohibitive expense of VR/AR gear and the requirement for extremely fast networks [32].

A solution proposed in the literature to this problem is the use of "Hybrid Accessibility Models." Listeners can still enjoy spatial audio aspects through low-bandwidth web browsers or mobile devices, thanks to radio stations' implementation of cross-platform interoperability [33], eliminating the need for expensive headphones for complete immersion. Moreover, radio stations should continue to provide 'single-stream' standard audio services for all listeners while implementing the Metaverse as an additional, supplementary option. Broadcasters can play a role in helping to cover the digital literacy gap to ensure that no one is left behind in this transition to Web 3.0.

However, there are flaws in this SLR. The first limitation is that it is only available in English and Indonesian; thus, it may miss out on relevant research in other languages or gray literature, such as company reports that are not publicly available. Furthermore, the review is highly susceptible to rapid technological development due to its 2020–2025 timeframe, suggesting that the results may require an update in the near future.

4.4. Social Responsibility and the Digital Divide

The introduction of radio into the Metaverse raises serious moral questions. Owing to its low technical requirements and independence from the Internet, radio has long been hailed as the most accessible and democratic form of mass communication [34]. The results of this SLR show, however, that for the moment, the Metaverse is hardware-intensive, necessitating things like pricey virtual reality and high-speed broadband. Consequently, a "digital divide" emerges, which may cause listeners from less privileged backgrounds or geographically isolated areas to be left out [35].

The study indicates that radio stations should implement hybrid accessibility methods to tackle this issue. Thus, the metaverse should amplify existing broadcasting forms rather than supplant them. To fulfill their social obligation, broadcasters must guarantee that all platforms are compatible with one another, allowing users to enjoy rich 3D experiences on mobile apps or low-bandwidth web browsers [36]. Radio may continue to be an inclusive medium by sticking to a "dual-stream" strategy that offers the Metaverse for greater participation and traditional audio for universal access. In addition, radio stations should ensure that everyone enjoys the "symphony of the digital age" by serving as advocates for digital literacy and leading their conventional listeners into Web 3.0 settings with simplified interfaces. [37].

5. Conclusion

The potential of broadcast radio and its adaptation within the metaverse ecosystem are mapped out in detail in this Systematic Literature Review (SLR). Radio is not only surviving the digital shift but is growing into an immersive, multi-way communication platform, according to this study that synthesizes evidence from 37 peer-reviewed studies published between 2020 and 2025.

According to the results, the listener's function was radically transformed from that of a passive receiver to that of an active participant when spatial audio and avatar-based interaction were combined (Trends A and B). Since reasons for participating in virtual environments now include social presence, self-presentation, and co-creation, this change theoretically requires an enlargement of the Uses and Gratifications (U&G) model. However, there are significant challenges ahead of us in this regard. The main

reasons why 3D spaces are not more widely used are technical delays, expensive development costs, and the lack of a consistent worldwide copyright system.

If radio stations want to keep up with the times in the Web 3.0 age, this study lays out a plan for them to do so by examining sustainable revenue strategies such as NFTs and virtual products, with an emphasis on experiential value. Policymakers must quickly establish adaptable media legislation to safeguard content producers and consumers in global online communities.

Future studies should shift from theoretical and exploratory investigations to empirical assessments of UX and QoE in various virtual radio environments. This study provides the data needed to create a future for the broadcasting profession that is more inclusive, engaging, and sustainable in the immersive age.

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Data Availability Statement: All data underpinning the findings of this systematic literature review, including a comprehensive list of the 37 incorporated articles, are fully accessible in the References section of this manuscript. Additional data supporting this study can be obtained from the corresponding author upon reasonable requests.

Ethics Approval: This study comprised a systematic literature review utilizing publicly accessible secondary data and did not involve human participants, human data, or animal trials. Therefore, we did not need to obtain formal ethical approval for this study.

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