

Beyond the Stage: Accessibility in Virtual Reality Music Events



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Abstract

Virtual reality (VR) concerts are an example of how technological advances are transforming the music industry. These immersive events can connect audiences around the world through interactive experiences, but they also raise significant accessibility challenges, particularly for people with disabilities. This paper examines the potential integration of accessibility services in VR music events. Drawing on existing literature in VR accessibility, it proposes an analytical matrix that connects key design dimensions of these events with potential access barriers, affected user groups, available strategies, and their limitations. Challenges include spatial navigation, sensory intensity, controller-based interaction, and multimodal communication, among others, while potential opportunities lie in multimodal feedback, adaptable interfaces, and personalised interaction settings that can support more flexible and inclusive participation. While the analytical matrix presented here is informed primarily by broader VR accessibility research, empirical testing in real-world VR music events will be necessary to validate and refine these approaches. Ultimately, VR represents both an opportunity and a challenge: it can either reinforce existing accessibility barriers or establish new standards of inclusivity in the music industry. If VR concerts aim to broaden cultural participation, a collaborative effort between developers, artists, and accessibility experts is essential to ensure that these immersive experiences are engaging, inclusive, and accessible to all.

Keywords: virtual reality, accessibility, music, universal design, disability

Más allá del escenario: la accesibilidad en los conciertos en entornos de realidad virtual

Resumen

Los conciertos en realidad virtual (RV) son un ejemplo de cómo los avances tecnológicos están transformando la industria musical. Estos eventos inmersivos pueden conectar al público de todo el mundo a través de experiencias interactivas, pero también plantean importantes desafíos relacionados con



la accesibilidad, especialmente para las personas con discapacidad. Este artículo analiza la posible integración de los servicios de accesibilidad en conciertos en RV. A partir de la investigación existente sobre accesibilidad en RV, se propone una matriz analítica que conecta las dimensiones clave del diseño de estos eventos con las posibles barreras de acceso, los grupos de usuarios afectados, las estrategias disponibles y sus limitaciones. Entre los desafíos se encuentran la navegación espacial, la intensidad sensorial, la interacción basada en controladores y la comunicación multimodal, mientras que las oportunidades potenciales incluyen la retroalimentación multimodal, las interfaces adaptables y la personalización de la interacción, que pueden favorecer una participación más flexible e inclusiva. La matriz de análisis se nutre principalmente de estudios generales sobre accesibilidad en RV, por lo que para validarla y perfeccionarla será necesario llevar a cabo estudios empíricos enfocados específicamente en conciertos en dichos entornos. En este contexto, la RV es tanto una oportunidad como un desafío: o bien replica las barreras de accesibilidad existentes en los conciertos tradicionales o establece nuevos estándares de inclusión en la industria musical. Si los conciertos en RV aspiran a ampliar la participación cultural, será esencial que desarrolladores, artistas y expertos en accesibilidad colaboren a fin de garantizar que estas experiencias inmersivas sean atractivas, inclusivas y accesibles para todas las personas.

Palabras clave: realidad virtual, accesibilidad, música, diseño universal, discapacidad

Au-delà de la scène : accessibilité dans les concerts en réalité virtuelle

Résumé

Les concerts en réalité virtuelle (RV) illustrent comment les avancées technologiques transforment l'industrie musicale. Ces événements immersifs peuvent connecter des publics du monde entier grâce à des expériences interactives. Cependant, ils soulèvent également d'importants défis en matière d'accessibilité, en particulier pour les personnes en situation de handicap. Cet article analyse l'intégration potentielle des services d'accessibilité dans les concerts en RV. Sur la base d'études précédentes, nous proposons une matrice d'analyse qui met en relation les aspects clés de la conception des concerts dans ce format avec les obstacles potentiels qu'ils posent, les groupes d'utilisateurs concernés, les stratégies d'accessibilité existantes et leurs limites. Parmi ceux-ci, on peut citer notamment les défis liés à l'orientation dans l'espace, à la surcharge sensorielle, à l'interaction avec les commandes et à la communication multimodale. L'étude met également en évidence les solutions offertes par les technologies immersives, telles que les stimuli multimodaux, les interfaces adaptatives répondant aux besoins d'accessibilité des utilisateurs et la possibilité de personnaliser les modes d'interaction, contribuant ainsi à une participation plus flexible et inclusive. La matrice d'analyse s'appuie principalement sur des études générales portant sur l'accessibilité en réalité virtuelle. Par conséquent, la validation et son perfectionnement nécessiteront donc la réalisation d'études empiriques spécifiquement centrées sur les concerts en RV. Dans ce contexte, la RV constitue à la fois une opportunité et un défi : soit elle reproduit les barrières d'accessibilité existantes dans les concerts traditionnels, soit elle établit de nouvelles normes d'inclusion dans l'industrie musicale. Si les concerts en RV ont vocation à élargir la participation culturelle, la collaboration entre développeurs, artistes et spécialistes de l'accessibilité est essentielle afin de garantir que ces expériences immersives soient attractives, inclusives et accessibles à toutes les personnes.

Mots-clés : réalité virtuelle, accessibilité, musique, design universel, personnes en situation de handicap

Além do Palco: Acessibilidade em Eventos Musicais de Realidade Virtual

Resumo

Os shows em realidade virtual (RV) são um exemplo de como os avanços tecnológicos estão transformando a indústria musical. Esses eventos imersivos podem conectar públicos de todo o mundo por meio de experiências interativas, mas também levantam desafios significativos de acessibilidade, especialmente para pessoas com deficiência. Este artigo examina a integração potencial de serviços de acessibilidade em eventos musicais de RV. Com base na literatura existente sobre acessibilidade em RV, propõe uma matriz analítica que relaciona as principais dimensões de design desses eventos com possíveis barreiras de acesso, grupos de usuários afetados, estratégias disponíveis e suas limitações. Os desafios incluem navegação espacial, intensidade sensorial, interação baseada em controladores e comunicação multimodal, entre outros, enquanto as oportunidades potenciais residem no feedback multimodal, interfaces adaptáveis e configurações de interação personalizadas que podem apoiar uma participação mais flexível e inclusiva. Embora a matriz analítica aqui apresentada seja fundamentada principalmente em pesquisas mais amplas sobre acessibilidade em RV, testes empíricos em eventos musicais de RV no mundo real serão necessários para validar e refinar essas abordagens. Em última análise, a RV representa tanto uma oportunidade quanto um desafio: ela pode reforçar as barreiras de acessibilidade existentes ou estabelecer novos padrões de inclusão na indústria musical. Se os shows em RV têm como objetivo ampliar a participação cultural, é essencial que haja um esforço colaborativo entre desenvolvedores, artistas e especialistas em acessibilidade para garantir que essas experiências imersivas sejam envolventes, inclusivas e acessíveis a todos.

Palavras-chave: realidade virtual, acessibilidade, indústria musical, desenho universal, pessoas com deficiência

Introduction

Virtual Reality (VR) can be defined as “a medium composed of interactive computer simulations” that aims to immerse users through visuals, sounds, and haptic vibrations, typically using head-mounted displays (HMDs) and motion-tracking controllers (Sherman & Craig, 2019, p. 16). While early prototypes of VR date back to the 1960s (Harley, 2022) the technology has become commercially available to wider audiences in the past few decades, particularly since the release of the now discontinued Oculus Rift headset in 2016. Today, VR applications span a wide range of domains, including healthcare, education, and entertainment (Peed & Lee, 2024).

VR concerts are part of this expansion. In recent years, they have been promoted as alternatives to traditional live events, reducing many of the physical, geographical, and economic constraints associated with in-person performances (Park et al., 2024). One of the earliest and most influential examples of a VR concert is *Alone Together*, a performance by electronic music producer Jean-Michel Jarre that took place in June 2020 on VRROOM, a social VR platform (Jarre, 2020). The music was performed live from Jarre’s studio and attendees were able to join as avatars in a 3D virtual space, where they could move around and interact with other users. The concert was attended by 2,500 people, demonstrating the potential of the platform to host large music events (Vitillio, 2020).

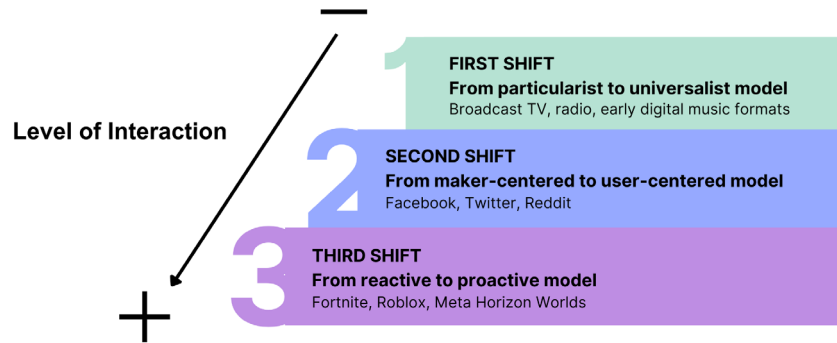
Following Jarre’s concert, other artists have created large-scale VR experiences hosted on popular gaming platforms. For example, rapper Travis Scott’s *Astronomical* concert in Fortnite in April 2020 drew nearly 28 million users worldwide (Gensler, 2020). *Astronomical* was entirely pre-recorded and staged in Fortnite’s existing game engine, allowing for visually striking sequences such as a giant avatar of Scott towering over the audience, and changes of environment like an underwater stage or an outer space

scene (Scott, 2020). The success of *Astronomical* set a precedent for subsequent music events in VR, including Ariana Grande’s *Rift Tour*, hosted on Fortnite in 2020, and Blackpink’s *The Virtual* concert, hosted on PUBG Mobile in 2022.

VR music events are distinct musical experiences shaped by immersion and interactivity, and some studies suggest that they strengthen the perceived connection between audience members and performers (Jung et al., 2024; Onderdijk et al., 2023). However, they also introduce new layers of complexity for users with diverse access needs. Spatial navigation may create barriers for blind and low-vision (BLV) users who rely on auditory orientation cues, while dense and visually complex environments can cause overstimulation for neurodivergent or cognitively diverse participants. Musical content and voice-driven interaction may pose barriers for D/deaf and hard-of-hearing (DHH) audiences if subtitles or sign language options are absent, and gesture-based controls and controller-dependent movement can restrict participation for users with motor disabilities.

This paper examines how accessibility can be integrated into the design of VR music events. Specifically, it proposes an analytical matrix that links VR concert design dimensions to associated barriers, affected user groups, and available technological and design solutions drawing on existing research in VR accessibility. In doing so, it aims to provide a conceptual foundation for more inclusive music experiences and to support interdisciplinary collaboration between users, designers, developers, artists, and accessibility professionals.

The article is organised as follows: Section 2 defines accessibility in the context of digital entertainment and characterises VR concerts. Section 3 describes the methodology developed to create an analytical matrix for accessibility in VR concerts, which is presented in Section 4. Then, the study’s findings are discussed in Section 5, along with a reflection

Figure 1. The Evolution of Digital Entertainment and Accessibility (based on Greco, 2018)

on the importance of integrating accessibility into development workflows. This discussion is followed by the conclusion of the paper, which summarises the main findings and outlines directions for future research.

1. Background

The present study draws from two intersecting topics: digital entertainment and accessibility. This section outlines how digital entertainment has shifted from passive consumption to immersive and participatory environments, and the impact this evolution has had on accessibility. Then, it situates VR concerts within this trajectory, highlighting the lack of specific research on accessibility in immersive music experiences.

1.1 The Evolution of Digital Entertainment and Accessibility

Digital entertainment refers to entertainment content that is consumed through digital technologies. It includes passive forms (e.g., streaming movies, music) and interactive forms (e.g., online gaming, social VR). Digital entertainment has evolved through structural shifts that have transformed how content is produced, distributed, and consumed. These transformations can be explained in parallel with what Greco (2018) defines as the three shifts of accessibility: (1) from particularist to universalist approaches to access, (2) from maker-centred to

user-centred design, and (3) from reactive to proactive models of inclusion (Figure 1).

From the 1950s until the late 1990s, digital entertainment was characterised by passive forms of entertainment. Examples include broadcast television, radio, early digital music formats, and early web-based streaming services. In this context, the user was mainly a receiver, and the information was consumed in a linear and unidirectional manner, with scarce interaction or intervention in the content. During this phase, accessibility followed a particularist model: solutions were developed for specific groups and often added as an afterthought. Accessibility services such as subtitling and audio description were conceived as compensatory services, rather than as elements embedded within the production process.

The early 2000s were the start of a change of paradigm due to the emergence of Web 2.0 and social media interactive platforms such as Facebook (2004), Reddit (2005), and Twitter (2006), which allowed users the possibility of becoming content creators. This phase aligns with the consolidation of “participative culture,” defined by Jenkins (2006) as a model where digital content is not only consumed passively, but in a collaborative way that allows audiences to reinterpret and expand this content. Pérez-Rodríguez et al. (2022) describe this phase as characterised by new models of creativity, self-representation, and

participation embedded in social media cultures. This participatory transformation mirrors Greco's second accessibility shift: the movement from maker-centred to user-centred approaches. At this point, design started embracing usability studies, user interfaces, and user experiences (UX).

From the mid-2010s onwards, digital entertainment entered a new phase characterised by real-time immersive and embodied environments. Platforms such as Fortnite, Roblox, VRChat, and Meta Horizon Worlds offer experiences that go beyond gaming, as they are social and collaborative spaces. UX in these environments is shaped by the feeling of immersion, the sense of presence and the possibility of interacting with other users. Some studies on UX in VR highlight the need to integrate concepts such as interactivity and "create-ability"¹ in the immersive environment to ensure that the resulting experience is significant and sustainable (Gandhi et al., 2024).

This transformation aligns with Greco's third shift: the move from reactive to proactive accessibility. In immersive environments, accessibility must be embedded at the architectural level of the software and should not be limited to isolated services such as subtitles or audio description. Instead, it must address features inherent to VR, namely multimodal sensory integration, embodied interaction, spatial navigation, social participation, and hardware compatibility (Creed et al., 2024; Dudley et al., 2023; Mott et al., 2019). A single event (e.g., a virtual concert in Fortnite) can generate activity across streaming platforms, Discord communities, and fan-driven content ecosystems, exemplifying digital convergence (Jenkins, 2006). Within this participatory ecosystem, accessibility becomes a cross-layer concern that spans platforms, interaction modalities, and social practices, reinforcing the need to examine

immersive entertainment experiences through an accessibility-oriented lens.

1.2 Concerts in VR

VR concerts are a prime example of the third shift in digital entertainment. Chen et al. (2025) identify five main design choices that impact a VR concert experience, drawing from the results of a set of interviews and surveys conducted with concert goers:

1. Technology design, which refers to the design of the hardware, such as the headset, and to the multisensory experience of the concert enabled by technology, namely the visual, auditory, tactile, and kinesthetics stimuli.
2. Content design, which refers to the conceptual and artistic composition of the music experience, including aspects such as artist selection, musical repertoire, concert-related information, and the format of the performance (e.g., live or pre-recorded).
3. Interactive experience design, which refers to the way audiences interact among themselves and with the musical experience, including their emotional response and engagement.
4. Immersive experience design, which refers to the behavioural logic and interactive dynamics of the VR environment and its avatars, both performers and audience members. They may be designed to simulate realism or to create deliberately surreal or enhanced experiences.
5. Autonomy experience design, which refers to users' capacity to personalise and control their experience, including modes of interaction with other participants, avatar embodiment and behaviour, environmental settings, and viewing perspective within the virtual space.

VR concerts are both comparable and distinct from other VR experiences. On the one hand, they share core technological and experiential

¹ The term "create-ability" refers to the ability of users to create a virtual environment and simulate real life (Dincelli & Yayla, 2022).

characteristics with immersive VR environments, such as reliance on headsets, multisensory stimuli, and avatar-based interaction. On the other hand, they are distinguished by their performative and event-based nature, their focus on musical and artistic content, and the social dynamics of a shared experience among audience members.

This combination creates a complex design ecosystem that is specific to immersive music events and has direct implications for accessibility. Features such as spatial navigation, multisensory stimulation and real-time interaction may generate accessibility barriers that differ in configuration or intensity from those found in other VR contexts. However, they may simultaneously offer new opportunities for inclusive design, particularly through customisation, alternative sensory channels, and adaptive environments.

To examine how accessibility has been addressed specifically in VR concerts, we conducted a focused search aimed at identifying peer-reviewed academic literature addressing accessibility in VR concerts². However, this search yielded only four results:

1. A study by Dang et al. (2023), where a survey with 102 BLV persons and interviews with 25 BLV participants showed that there is a demand for accessible music experiences in VR, particularly if they combine auditory and haptic feedback.
2. A survey by Onderdijk et al. (2023) about the motivations, experiences and expectations of 74 VR concert attendees which—despite not collecting demographic data on

disability, explicitly—mentions accessibility for persons with disabilities as an incentive for VR concert attendance;

3. A conceptual framework for audio description (AD) in VR concerts by Dang et al. (2024), based on interviews with BLV AD users and BLV AD professionals and encompassing three modalities: spatial AD, view-dependent AD, and explorative AD; and
4. A study about a wearable haptic device by Hewitt et al. (2025) that converts audio into synchronised haptic feedback in a pre-recorded VR concert for DHH users, with the potential of also functioning in live performances through pre-defined haptic patterns.

The limited number of studies may reflect the relative novelty of VR concerts as a research domain, as well as the methodological challenges associated with studying this type of events. Dudley et al. (2023) note that empirical research in VR is affected by technical limitations, small sample sizes, and rapid technological developments. In the case of VR concerts, these challenges are even more evident: they are often one-off events, and replication (or the creation of an immersive music experience for research purposes) requires significant resources. Moreover, technological and musical variables are hard to isolate, and gathering reliable data inside immersive environments presents methodological and technological constraints, particularly when users are asked to both enjoy and report the experience.

2. Methodology

This study adopts a qualitative, analytical approach aimed at linking defining characteristics of VR concerts with accessibility challenges and existing strategies. To operationalise this approach and given the limited number of studies addressing this topic, the present study analytically links the five design dimensions identified in VR concerts by Chen et al. (2025) to accessibility challenges and solutions identified in

2 The search string used was: (“virtual reality concert” OR “VR concert” OR “immersive concert” OR “virtual reality music event” OR “VR music event”) AND (accessib*) OR (disab*). This string was applied across five major academic databases (Scopus, Web of Science, ProQuest, SAGE Journals, and Google Scholar) to identify peer-reviewed studies that addressed accessibility or disability in VR music events.

the broader literature on VR accessibility. By mapping general VR accessibility strategies onto the specific design features of immersive music events, we assess their applicability and limitations for accessible VR concert design.

We selected relevant research on accessibility in VR based on the following criteria: (1) explicit focus on accessibility in VR or immersive contexts; (2) clear identification of specific user groups; and (3) discussion of technological, design-based, or interaction-based strategies aimed at reducing barriers or supporting inclusive participation. This ensured that the selected studies provided concrete, transferable insights applicable to immersive music settings.

From each study, key information was extracted and organised according to a set of analytical categories designed to support the development of the conceptual framework presented in Section 4. These categories were: VR feature, associated accessibility barrier, potentially affected user group, strategies, and limitations. Then, categories were organised following Chen et al.'s (2025) taxonomy on VR concert experience design, introduced in Section 1.2. Their framework identifies five

core dimensions that influence the design of VR concert experiences: technology, content, interactive experience, immersive experience, and autonomy experience.

This mapping process allowed for the identification of patterns, overlaps, and tensions between experience design and inclusive design. In particular, it enabled the analysis of how specific characteristics (such as multisensory feedback, avatar embodiment or spatial audio) may simultaneously enhance immersion while generating accessibility barriers for certain user groups. It also allowed us to situate accessibility within the structure of VR concert environments, rather than treating accessibility as an external add-on.

3. Analytical Matrix

The analytical matrix in Table 1 links the five design dimensions of VR concerts proposed by Chen et al. (2025) with specific VR features and their accessibility barriers (and the affected user group), strategies, and limitations. Rather than examining accessibility solutions as isolated technical features, the matrix situates them within the structure of VR concerts.

Table 1. Analytical matrix for accessibility in VR concerts

Dimension	VR Feature	Associated Accessibility Barriers	Potentially Affected User Groups	Strategies	Limitations
Technology	Head-mounted displays, controllers	Setup complexity, tracking errors, incompatibility with assistive devices, motion sickness	Users with motor disabilities, cochlear implant users, mobility aid users, older adults	Alternative controllers, simplified onboarding, seated modes, hardware compatibility adjustments	Platform dependency, limited standardisation
	Platform-dependent concert environments	Uneven accessibility implementation across platforms	All users	Cross-platform accessibility frameworks, accessibility-by-design guidelines	Commercial priorities, non-standardised practices, limited interoperability

Table 1. Analytical matrix for accessibility in VR concerts (continued)

Dimension	VR Feature	Associated Accessibility Barriers	Potentially Affected User Groups	Strategies	Limitations
Content	Spatialised visual scenography	Visual complexity, information overload	BLV and neurodivergent users	Audio description, magnification, high-contrast overlays, adaptive visual layers	Audio description timing challenges, visual clutter trade-offs, performance constraints
	Embedded subtitles, captions	Visibility issues, readability challenges, placement conflicts in 3D space	DHH users	Customisable appearance (size, colour, font), adaptive positioning in 3D space	Occlusion risks, user preference variability, increased visual load
	Sound-driven musical content	Limited perception of musical structure, rhythm and dynamics	DHH users	Sound visualisation, synesthetic representations, haptic feedback	Cognitive overload, artistic interpretation constraints, hardware requirements
Interactive Experience	Avatar-based interaction, real-time communication	Communication barriers, limited non-verbal cues	DHH, neurodivergent and non-native language users	Text chat, gesture libraries, visual feedback cues, customisable social interaction settings, real-time translation, sign language avatar integration	Reduced spontaneity, fragmented communication modes, processing delays
	Multisensory immersion (audio, visual, haptic feedback)	Sensory overload, desynchronisation between modalities	Neurodivergent, DHH and BLV users	Adjustable sensory intensity, modality toggling, personalised feedback calibration	Increased system complexity, design trade-offs between immersion and comfort

Table 1. Analytical matrix for accessibility in VR concerts (continued)

Dimension	VR Feature	Associated Accessibility Barriers	Potentially Affected User Groups	Strategies	Limitations
Immersive Experience	Environmental realism or surrealism	Orientation difficulties, difficulty distinguishing relevant cues	BLV and neurodivergent users, older adults	Spatial audio cues, guided navigation modes, simplified environments	Reduced aesthetic richness, tension between artistic freedom and clarity
	Crowd simulation, avatar density	Overstimulation, navigation barriers	Neurodivergent users	Adjustable crowd density, private viewing modes, controlled interaction zones	Reduced sense of collective presence, altered social dynamics
Autonomy experience	Avatar embodiment, customisation	Limited accessible customisation options	All	Preset accessibility profiles, simplified configuration menus, voice-controlled customisation	Restricted personal expression, platform constraints
	Control over perspective, interaction modes	Restricted camera angles, forced standing perspective	Users with motor disabilities, users prone to motion sickness	Adjustable viewpoints (first/third person), interaction remapping	Technical limitations, potential imbalance in shared experience

3.1 Technology

Accessibility challenges at the technological level are linked to head-mounted displays (HMDs), controllers, and platform infrastructure. Hardware configuration and setup complexity may generate barriers related to calibration, controller tracking and navigation, particularly for users with motor disabilities (Mott et al., 2020). In addition, incompatibilities between standard HMDs and assistive devices, such as cochlear implants, have been documented (Gluck et al., 2024), while conflicts with mobility aids and problems such as motion

sickness may limit participation for certain users (Kempa et al., 2025).

Proposed strategies include alternative or adaptive controllers, simplified onboarding processes, seated interaction models, hardware compatibility adjustments, and accessible tutorials (Steffens et al., 2025). Nevertheless, these solutions are still dependent on the platform, meaning that their implementation is voluntary and, therefore, varies across proprietary ecosystems and may be discontinued, modified, or restricted according to commercial priorities rather than accessibility standards (Aich et al., 2025).

3.2 Content

Content design features introduce barriers related to perception, information presentation, and multimodal translation of artistic content. Spatialised visual scenography may generate visual complexity and information overload, particularly affecting BLV and neurodivergent users. In conventional concert settings, surtitles and subtitles for the deaf and hard-of-hearing are typically projected onto peripheral screens, forcing audience members to shift their gaze between the main performance and the textual information (Desblache, 2021). In VR, subtitles can instead be embedded spatially within the environment. Head-locked subtitles, which follow the user's gaze, provide continuous visibility without breaking immersion, and allow users to engage with both the performance and textual content simultaneously (Agulló et al., 2019; Brescia-Zapata et al., 2025; Brown et al., 2018; Rothe et al., 2018). Customisation is also crucial in this context: users can benefit from controlling the size, colour, opacity, and positioning of subtitles, ensuring that textual information remains readable against diverse visual backgrounds (Shidende et al., 2024). Similarly, for users with residual vision, tools such as magnification, high-contrast text, and visual augmentation can enhance access to lyrics, visual stage cues, and interactive elements (Jiang et al., 2023).

Sound-driven musical content poses particular barriers for DHH audiences, as music relies heavily on auditory perception to convey rhythm, intensity, and structure. VR environments offer expanded possibilities for translating musical information into alternative modalities. Sound visualisation systems can represent loudness, duration, spatial location, and timbre visually, as demonstrated by EarVR+ (Mirzaei et al., 2021) and SoundVizVR (Li et al., 2022). Artistic and synesthetic approaches further extend these possibilities. For example, Tepljakov et al. (2016) represent music through coloured,

moving shapes whose size and hue reflect volume and frequency.

In parallel, haptic feedback can communicate rhythm, emotional intensity, and spatial information (Turchet et al., 2021). Dang et al. (2023) report strong engagement among BLV users when haptic interaction is meaningful, while Venkatesan and Wang (2023) show that haptics can simulate vibrations, emotional touch, and collective audience sensations felt in in-person music events. Haptic devices, including directional pressure arrays (Chen et al., 2019), interactive gloves (Villar et al., 2025), and wearable systems translating movement into localised vibrations (Jung et al., 2024) may expand embodied musical perception, also for DHH users (Cavdir, 2024; Hewitt et al., 2025).

In addition, VR environments allow sound customisation tools that enable users to prioritise instruments, adjust volume parameters, or apply spatial assistance for improved localisation (Cao & Jain, 2024). For BLV audiences, spatial audio and audio description (AD) provide additional access layers. Spatialised narration can preserve immersion in 360° environments (Jiang et al., 2023), and Dang et al. (2024) propose spatial, view-dependent, and explorative AD models tailored to VR concerts. These approaches facilitate understanding of performer gestures and stage dynamics and support independent navigation within virtual venues. Research on spatial audio for orientation further demonstrates its value for wayfinding and cognitive mapping in immersive spaces (Guerreiro et al., 2023; Fialho et al., 2021; May et al., 2020).

Despite these advances, limitations remain. Visualisations and haptic systems may increase cognitive load, require additional hardware, or constrain artistic interpretation. AD must be carefully timed to avoid masking musical elements, and sound customisation may introduce trade-offs between user control and

intended sound design. Consequently, accessibility in VR concert content design requires a careful balance among perceptual clarity, multisensory translation, and artistic integrity.

3.3 Interactive Experience

Interactive features shape how users communicate, collaborate, and interpret social cues within VR concerts. Communication encompasses accessibility services like sign language interpretation (SLI), live subtitles, text-to-speech (TTS) technology for translation, and voice control. Anderton (2022) demonstrates that SLI can be rendered effectively in 360° VR, with fixed-position interpreters enhancing presence and arrow-based guidance outperforming radar for directing attention. Wen et al. (2021) further this by developing an AI-enabled glove system that recognises words and sentences and translates them into text and audio for non-signers. Real-time captioning has also been integrated into VR, ranging from speech-to-text systems with emotional labelling (Tharun et al., 2023) to accurate spatialised speech bubbles in avatar-based environments (Waldow & Fuhrmann, 2020). These tools highlight the potential for VR concerts to provide contextually aware and immersive communication solutions. Subtitles or SLI could be dynamically linked to performers, instruments, or audience interactions, while TTS and translation services could enable cross-lingual participation.

Social interaction accessibility also depends on avatar representation and multimodal cues. McVeigh-Schultz et al. (2019) explore avatar design and social mechanics to encourage pro-social behaviour, while Segal et al. (2024) show that haptic feedback can complement visual and auditory cues in social interactions in VR. In VR concerts, these strategies could allow users to perceive attention, rhythm, or emotional engagement from others, enriching both performance enjoyment and social inclusion.

The importance of disability signifiers in avatars should not be overlooked, as they can support identity expression and visibility for people with disabilities, who may prefer avatars that reflect their lived experience (Zhang et al., 2023). At the same time, such disclosure can increase the risk of targeted harassment (Blackwell et al., 2019), underscoring the need for protective design measures and moderation mechanisms to ensure safe and inclusive participation.

Moreover, ensuring accessibility in the interactive aspect of VR includes meeting cognitive demands associated with real-time multi-user environments. VR concerts often involve real-time communication, environmental exploration, and interpretation of dynamic social and musical events, which may increase cognitive load for some users. In this context, optional virtual assistants or AI-guided prompts could explain social cues, highlight musical motifs, or suggest interaction strategies. Such interventions could support neurodivergent users who experience difficulty processing multiple simultaneous inputs, facilitating participation without compromising immersion (Collins et al., 2024).

3.4 Immersive experience

The immersive experience in VR environments stems from the integration of different sensory channels, which gives the user the impression of “being there” (Slater & Wilbur, 1997). However, the same feature that immerses an individual in the VR world may create barriers for another. For example, spatialised sound can enhance orientation and environmental awareness for some users (Fialho et al., 2021; May et al., 2020), but it may also disadvantage DHH users. Complementary approaches such as auditory object mapping (Guerreiro et al., 2023) and spatialised AD (Dang et al., 2024; Jiang et al., 2023) demonstrate how auditory and narrative layers can support navigation and scene comprehension.

Similarly, haptic feedback can expand and limit immersive accessibility possibilities. Studies show that vibrotactile systems can convey rhythm, emotional content, and environmental dynamics (Turchet et al., 2021; Venkatesan & Wang, 2023), all particularly important in concerts, while wearable technologies enable embodied interaction and collective sensation experiences (Chen et al., 2019; Villar et al., 2025; Jung et al., 2024). However, hardware limitations and integration challenges may persist in VR (Ciccone et al., 2021; Teófilo et al., 2016).

3.5 Autonomy Experience

Autonomy refers to users' capacity to navigate, personalise, and control their experience in a VR environment. From a movement perspective, locomotion accessibility research demonstrates the benefits of alternative interaction techniques such as teleportation, gaze navigation, and voice control for users with motor disabilities (Mott et al., 2020). These strategies enable independent exploration of virtual venues while mitigating physical fatigue.

Autonomy also encompasses personalisation of sensory and informational content. In VR concerts, users may need to adjust the complexity of visual, auditory, or haptic stimuli to match their perceptual and attentional capacities. For example, AD and sound visualisation systems can be designed to provide variable levels of detail, enabling users to focus on core musical elements or explore more nuanced environmental cues (Dang et al., 2024). Adaptive systems such as configurable sound visualisation and AI prompts can support comprehension and reduce cognitive overload, particularly for neurodivergent users (Collins et al., 2024). Finally, multimodal distribution (such as combining spatialised audio with visual or haptic representations) can facilitate user engagement with musical content through channels that best suit their cognitive profiles (Caravella & Shivenner, 2026; Hewitt et al., 2025).

4. Discussion

The analytical matrix for accessibility in VR concerts developed in this paper reinforces a broader observation emerging in immersive technology research: accessibility in VR is shaped by a persistent tension between rapid technological innovation and the diverse, evolving needs of users. Multidisciplinary workshops conducted by Creed et al. (2024) highlight ongoing difficulties in aligning VR design practices and inclusive principles among researchers, practitioners, and users; on their part, Dudley et al. (2023) identify three structural barriers in VR environments: diversity in user needs, lack of guidance and tools for developers, and difficulty in conducting empirical research. These challenges are directly applicable to VR concerts, where accessibility remains underexplored.

Inclusivity in VR concerts extends beyond disability, involving factors such as age, income, culture and geographical context. For example, older adults or those with limited digital skills might find immersive concerts either inaccessible or too overwhelming, especially compared to younger generations who may be more comfortable with technology (Gluck et al., 2024). Additionally, immersive technologies sometimes require expensive equipment (i.e., headsets, high-speed internet connection, and haptic devices), which can leave out potential users from lower-income backgrounds.

Another key issue is the absence of consolidated guidelines and standardised tools for accessible immersive entertainment. While there are standards and best practices that apply to physical concert venues (Bossey, 2020), VR platforms still need to be regulated. This gap in guidance, together with the relative novelty of immersive technologies, makes it hard to create inclusive experiences from the onset, leading to late-applied solutions and only when possible (Brescia-Zapata, 2025). Moreover, most of the music events organised

in immersive platforms depend on proprietary software such as Fortnite, Roblox, and Horizon Worlds, which were not originally designed with accessibility as a core principle (Dwivedi et al., 2022). This absence of frameworks and tools that allow for accessibility services results in fragmented or inconsistent practices, as users, developers, artists, and accessibility experts remain disconnected from each other (Ander-ton et al., 2025; Gerling & Spiel, 2021).

The analytical framework proposed in this study responds to this gap by linking the defining dimensions of VR concert design to user-centred accessibility barriers and strategies. By situating accessibility within these structural dimensions, the framework shifts the discourse from compensatory add-ons to integrated design logic. Specific VR features carry accessibility implications that must be addressed during the conceptualisation phase rather than retrospectively.

Translating this conceptual integration into practice requires clearly defined professional roles and interdisciplinary collaboration. Ensuring equitable access to immersive entertainment depends on coordinated expertise across design, engineering, content production, and policy domains. In this context, accessibility and universal design offer complementary foundations. Accessibility focuses on removing barriers to ensure equal participation for persons with disabilities (Broderick, 2020; United Nations, 2007), while universal design promotes the creation of products and environments usable by the widest possible range of people without the need for specialised adaptation (Connell et al., 1997). These principles underpin regulatory initiatives such as the Web Accessibility Directive, the European Accessibility Act, and the Audiovisual Media Services Directive, as well as standards including EN 301549, EN 17210, and EN 17161.

Therefore, accessibility professionals play a pivotal mediating role in VR concert production.

This group includes accessibility consultants, specialised translators, UX/UI designers, developers, researchers, and creative practitioners. Accessibility consultants conduct audits and ensure compliance with relevant standards, identifying barriers and advising production teams throughout the development cycle. Specialised translators implement linguistic and multimodal access services, including subtitles, audio description, sign language, and easy-to-understand adaptations, which are particularly relevant in cultural and educational contexts (Orero et al., 2018). UX/UI designers integrate inclusive principles at the interface design stage, ensuring that menus, navigation systems, and interaction flows are perceivable and operable. Developers implement technical compatibility with assistive technologies such as screen readers, alternative input devices, and speech-to-text systems. Researchers contribute empirical evidence through user testing and evaluation, helping refine solutions and inform evolving standards.

One of the biggest challenges faced by accessibility professionals is the disconnect between the development of standards and guidelines and their implementation in the real world. Often, abstract principles need time to be transformed into tangible technical solutions that can be implemented in an effective way. This situation creates a gap between the proposals at the theoretical level and what is offered to final users (Kuppelwieser, 2025). To turn these standards and norms into practical and accessible solutions, there is a need for collaboration among all parties in the process: from regulatory bodies and the technological sector to the final users, whose experiences and needs must be the basis of the developments in the field (Vinadé & Marczak, 2024). Without this cooperation, there is a risk that accessibility will only be treated as a formality, limiting its real impact on the final product.

Despite the structured approach adopted in this study, the methodology has several

limitations. First, the framework relies on insights from broader VR accessibility literature rather than being grounded exclusively in VR music events, which may limit the direct applicability of some findings. Second, the selection of papers was guided by relevance and transferability rather than a fully systematic search, meaning that some relevant studies could have been overlooked. Third, the analysis is based on the information reported in the selected studies, which varies in detail, scope, and methodological rigor, potentially affecting the comprehensiveness of the extracted categories. Finally, while the framework provides a structured lens for connecting VR features, accessibility challenges, and design strategies, empirical validation in real-world VR music events is necessary to confirm its practical utility.

5. Conclusion

VR concerts are becoming a significant component of contemporary digital culture, expanding how musical performances are produced, experienced, and shared. By combining immersive environments, embodied participation, and real-time interaction, they reshape audience engagement while also raising pressing questions about access for diverse audiences. If this format aims to broaden participation beyond physical, geographical, and economic constraints, accessibility must be considered an integral part of its development, not an afterthought.

This paper has contributed to this discussion by connecting the defining design dimensions of VR concerts with the accessibility needs of diverse user groups. Drawing on existing research on VR accessibility, it has outlined an analytical matrix that maps concert features to potential barriers, affected users, available strategies and their limitations. In doing so, it offers a conceptual tool to support more systematic reflection on how immersive music experiences can be designed with inclusion in mind, and it highlights the interdependence

between technological infrastructures, artistic choices, interaction models, and user autonomy.

For professionals working in immersive entertainment (i.e., designers, developers, producers, artists, and accessibility specialists) this paper underscores the importance of interdisciplinary collaboration and early-stage planning. Accessibility considerations must be embedded within creative and technical workflows, supported by platform-level commitments and informed by the lived experiences of users with disabilities. Without such integration, inclusive features risk remaining fragmented, inconsistent, or optional.

At the same time, this research presents several limitations. The analysis is grounded primarily in broader VR accessibility literature rather than in empirical studies focused exclusively on VR concerts. The selection of research was guided by relevance and transferability, and the reviewed studies vary in scope and methodologies. Moreover, the proposed framework has not yet been tested in applied concert settings.

Future research should therefore investigate how specific accessibility measures influence engagement, immersion, and social presence in VR music events. Studies on hardware ergonomics, compatibility with assistive technologies, and cross-platform implementation are also needed. Comparative analyses across immersive formats, including augmented and mixed reality, may additionally clarify how inclusive strategies can be adapted to different technological environments.

Ensuring accessibility in VR concerts ultimately concerns fair participation in evolving forms of cultural expression. As immersive music experiences continue to develop, aligning technological innovation with inclusive design will be essential to shaping a more inclusive digital entertainment landscape.

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