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ORIGINAL

Digital Art as a Tool for Social Influence in the Modern Media Space and Metaverse

El arte digital como herramienta de influencia social en el espacio mediático moderno y el metaverso

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ABSTRACT

Introduction: the current research examines the evolving nature of digital art, specifically virtual galleries, NFTs, and AR/VR installations. The primary emphasis is on the metaverse and its impact on society within the Ukrainian context. In Ukraine, digital art has been steadily developing irrespective of significant economic and infrastructural constraints. Several local artists are attempting to become influential in the NFT space. However, metaverse technologies often remain limited. Hence, the study identifies gaps in comprehending the expanded potential of digital art and its capability to enhance major social changes in such countries as Ukraine.
Method: this qualitative research presupposes the use of case studies, online interviews, and a content analysis of social media (Twitter and Instagram) posts. Thematic analysis has resulted in the organization of findings into the following categories:
forms of digital art, social impact of digital art, challenges associated with digital art use in Ukraine, and metaverse engagement.
Results: the results received indicate that digital art in the metaverse can increase public awareness and has significant fundraising opportunities. However, broader participation in this country is limited.
Conclusions: digital art is applied in Ukraine to attract global attention to the war. This indicates the multifaceted capabilities of art and a tool for impacting society.

Keywords: Artificial Intelligence; Art; Digital Art; Metaverse; Ukraine; NFT; Social Change.

RESUMEN

Introducción: la presente investigación examina la naturaleza en evolución del arte digital, en particular las galerías virtuales, los NFT y las instalaciones de AR/VR. El énfasis principal recae en el metaverso y su impacto en la sociedad en el contexto ucraniano. En Ucrania, el arte digital se ha desarrollado de forma sostenida pese a importantes limitaciones económicas e infraestructurales. Varios artistas locales intentan posicionarse como influyentes en el ámbito de los NFT. Sin embargo, las tecnologías del metaverso suelen seguir siendo limitadas. Por ello, el estudio identifica lagunas en la comprensión del potencial ampliado del arte digital y de su capacidad para impulsar cambios sociales significativos en países como Ucrania.

Método: esta investigación cualitativa supuso el uso de estudios de caso, entrevistas en línea y un análisis de contenido de publicaciones en redes sociales (Twitter e Instagram). El análisis temático permitió organizar los hallazgos en las siguientes categorías: formas de arte digital, impacto social del arte digital, desafíos asociados al uso del arte digital en Ucrania y participación en el metaverso.

Resultados: los resultados obtenidos indican que el arte digital en el metaverso puede aumentar la sensibilización pública y ofrece oportunidades significativas de recaudación de fondos. No obstante, la participación amplia en el país es limitada.

Conclusiones: en Ucrania se recurre al arte digital para atraer la atención global hacia la guerra. Ello pone de relieve las capacidades multifacéticas del arte como herramienta de impacto social.

Palabras clave: Inteligencia Artificial; Arte; Arte Digital; Metaverso; Ucrania; NFT; Cambio Social.

INTRODUCTION

Topic Contextualization

Art is a social phenomenon of significant importance, which acts as a mirror of the social and cultural dynamics of a community.[1] Skills and creativity help artists reflect public interests, attitudes, mood, and interactions, creating a common language that overcomes cultural and linguistic barriers. Hence, art emerges as a powerful driver for social union, communication, dialogue promotion, and mutual understanding.[2] Artworks contain messages that highlight multiple issues that are critical to society, making a negative impact on different aspects of life. It assists artists in expressing criticism of political and social challenges.[3] Hence, art has a power that not only reports the current state of action but also inspires future changes, motivating people to act and engage in social issues. Visitors of galleries, workshops, and cultural initiatives, as well as individuals interested in art, are capable of making changes in life by offering spaces for socialization and reflection.[4] Thus, art is a critical constituent of the social landscape that impacts culture and politics.

Technology development has made a significant impact on different spheres, including art. In the 21st century, humans experienced the emergence of digital art that has become a part of communication and contemporary art.[5] Technology has enhanced the appearance of new forms of artistic expression, including virtual galleries, non-fungible tokens (NFTs), and AR/VR installations.[6] These forms have gone beyond creative boundaries, enabling people to view themselves in art and reflect their concerns. Artists rely on metaverse platforms, such as Spatial, The Sandbox, and Decentraland, to convey their messages and make them known among different population groups.[7] These platforms enhance social interaction and encourage active participation in cultural life. This attracts public interest in virtual spaces that facilitate digital art. Hence, the combination of art and virtual spaces has given rise to a powerful new medium that welcomes interaction, political commentary, self-expression, and activism.

The Ukrainian Context

While this phenomenon is global, its manifestation in contexts of crisis and conflict, such as in Ukraine, reveals its deeper potential. There are many globally recognized artists in Ukraine. Technology impact on digital art development in the country is worth attention.[7] Dmytro Kolyander, Stepan Ryabchenko, and Oleksii Sai use digital practices in their creative approaches. Ukrainian artists skillfully produce NFT collections, showing their works in international exhibitions and collaborating in international projects. These days, when the country faces a Russian invasion, digital art has become a powerful tool for resistance.[8] Moreover, it is used for charity, and NFT auction initiatives are central in supporting the Armed Forces of Ukraine, highlighting the war-related horror, and documenting essential events. However, irrespective significant digital art development in Ukraine, there are several challenges that pose development barriers, including poor digital infrastructure, limited high-tech equipment and insufficient access to it, decreased digital literacy, and governmental support.

Research Problem

The rapid adoption of metaverse technologies to exert social influence in situations of acute conflict and nation building remains a largely unexplored area, especially in resource-constrained environments such as Ukraine. Although digital art has gained popularity and metaverse technologies have rapidly evolved, their potential as social impact tools remains insufficiently examined in countries with limited resources, including Ukraine. Therefore, this can create a favorable basis for the creation of new identity forms, cultural resistance, and civic engagement.[9] This makes a need for examining how Ukrainian artists use metaverse platforms and digital tools to advocate, express, and communicate in virtual environments that provide extended opportunities.

Research Aims and Questions

The main purpose of this research is to examine the role of digital art in shaping social impact within the metaverse with a focus on the Ukrainian context. Hence, the study is conducted to answer the following questions:

1. How are metaverse platforms used by digital artists in Ukraine for engagement and interaction?
2. What messages do Ukrainian digital artists communicate in the metaverse?
3. What barriers affect digital art development in Ukraine?
4. What are the ways of addressing the digital art development barriers?

METHOD

Research Design

The current research used a qualitative research design to examine the social influence of digital art in the metaverse with a focus on Ukraine. The choice of that approach related to the benefits it provided in addressing research questions. Hence, it provided a deep insight into practices, meanings, and narratives that help define how Ukrainian digital artists apply emerging technologies to express identity, activity, engagement, and resistance. That approach was flexible, enabled collecting public opinions and attitudes, as well as was cost-effective and efficient for the topic under investigation. Finally, it assisted in analyzing cultural phenomena and allows for capturing individual experiences of digital artists in a dynamic digital environment.

Data Collection

Case Study

Case study analysis helped examine real-life examples of Ukrainian digital artists who represent urgent topics and themes, including political, cultural, and social ones. To choose the appropriate case studies, the researcher used inclusion criteria, including social impact, digital platform use, or cultural relevance. The analysis of Ukrainian contemporary digital artists has helped identify three prominent personalities (figure 1). One of them is Dmytro Kolyander (also known as Kolya Korobka), based in Kyiv, and famous for his NFT collections and digital zines, which represent the aesthetics of war and underground culture. 'WTF is Metaverse' is Koyander's project that offers a critique of techno-utopianism while using engaging spaces and augmented layers of meaning. Another Ukrainian artist discussed in the paper is Stepan Ryabchenko. He is a leading figure in the digital art sphere. Ryabchenko's series titled 'Virtual Mythology' represents post-humanity, national trauma, and futurism through imaginary creatures and 3D features. This artist has received global fame and his works are available on NFT platforms. Furthermore, Ryabchenko's VR-based projects are displayed in digital biennales and virtual galleries in different parts of the world. Finally, the current study examines Zinaida (Zinaida Likhachova), whose digital works and installations include the use of VR and digital performance. 'Transformation Rituals' and other works of the artist seek to explore Ukrainian heritage, focus on national identity, and represent femininity. Zinaida interacts with tech developers and actively curates international exhibitions. Hence, these case studies were central in the current research, and their combination with artwork analysis, digital ethnography, and online interviews with the artists assisted in answering the research questions. Hence, the choice of the case study related to the capability of this research design to contextualize understanding, exploring practices and meanings, and examining opportunities. Case study is particularly suitable for the current study as it enables getting an in-depth exploration of digital artists' practices and challenges in the Ukrainian context. Furthermore, it helps examine the use of metaverse platforms for engagement, investigate barriers to digital art development, integrate diverse data sources, and indicates ways to strengthen digital art in Ukraine.
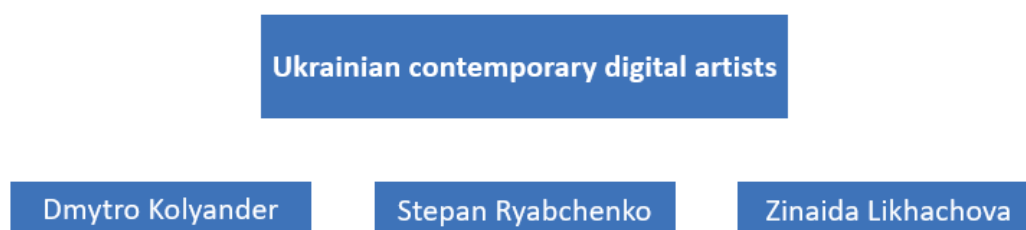

Figure 1. Contemporary digital artists

Interviews

The researcher conducted online interviews with the participants from the Ukrainian digital art ecosystem. Those participants included five digital artists, including Dmytro Kolyander and Stepan Ryabchenko, two gallery organizers from NFT Culture Ukraine or other galleries, and one or two metaverse users. The choice of the artists directly related to their role in the Ukrainian digital art scene, direct engagement with NFT and metaverse

platforms, as well as their social impact. These figures provide valuable insights into challenges of creating with limited infrastructure and help learn about digital exhibition visibility. Hence, every participant was contacted using social media sites to explain the aim of the story and its impact on the digital art development in Ukraine. The online interview consisted of ten questions. The researcher asked the participants to answer them. The interviews were conducted to learn about artistic preferences, digital art development and its impact, social attitudes, as well as platform accessibility and usage.

Sampling Strategy

The use of the purposive sampling enabled identifying participants engaged with digital art in Ukraine and capable of providing deep insights into this theme, uncovering digital art as a social impact tool. Digital artists were chosen based on their visibility in the Ukrainian digital art, their active engagement with NFT platforms, as well as their contributions to addressing political and social problems. They offered perspectives in digital work. Moreover, gallery organizers were selected because of their endeavors to promote artists internationally, curate digital art, and manage visibility in metaverse and virtual environments. Additionally, metaverse users were encouraged to participate in the study to reflect the audience perspective and inform how Ukrainian digital art is experienced and perceived in immersive platforms. Social media platforms (Instagram and Twitter) were used to identify participants.

The researcher contacted each participant directly via social media messaging. They sent a brief explanation of the aim, nature, and impact of the study on the development of digital art in Ukraine. Thus, the sampling strategy ensured that all participants engaged with the digital art.

Content Analysis (Social Media)

Information collected through social media sites was analyzed. The researcher analyzed posts collected from social media platforms such as Twitter and Instagram. The period of posts was from 2022 to 2025. The posts showed public engagement with the digital works of Ukrainian artists. The research focused on the following hashtags: #NFTUkraine, #DigitalResistance, #MetaverseArt, #UkrainianArtists. Their choice related to the fact that they represent the key research themes, including the NFT's role, engagement with immersive platforms, contributions of Ukrainian artists, and activism. They assist in tracing cultural narratives of war, resistance, and identity as they are generated on global platforms. The primary emphasis was on war, related events, identity, resistance, and digital citizenship (figure 2). It enabled tracing the cultural narratives generated by digital artists and amplified in real-time.
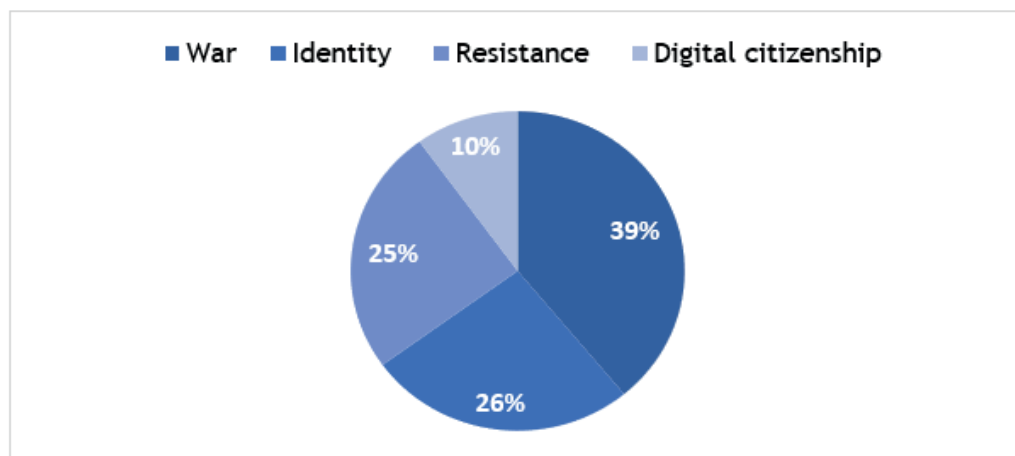

Figure 2. Topics of focus

Participants

The research participants were chosen based on purposive sampling to ensure expertise and relevance. Hence, the respondents were five Ukrainian digital artists, two gallery organizers, and two platform users as they directly deal with digital art and understand its impact and use. They were males and females aged from 25 to 45 and have experience in creating or promoting digital artworks through either social media or metaverse platforms.

Data Analysis

Thematic analysis helped examine the primary data, case documentation, secondary data, and social media context (figure 3). The key themes were grouped into the following categories: social platform engagement,

social messaging, access barriers, and aesthetic strategies. The researcher focused on recurring patterns that reveal the functioning of digital art in Ukraine as an influence mechanism in various environments. The thematic analysis was conducted using the six-step framework by Braun and Clarke due to its suitability for exploring practices, experiences, practices, and social meanings. First, the researcher examined the interview transcripts, social media content, and case documentation. Then, they generated initial codes capturing meaningful data units. Third, the researcher organized codes into broader categories and divided them into the following themes: social platform engagement, social messaging, access barriers, and aesthetic strategies.
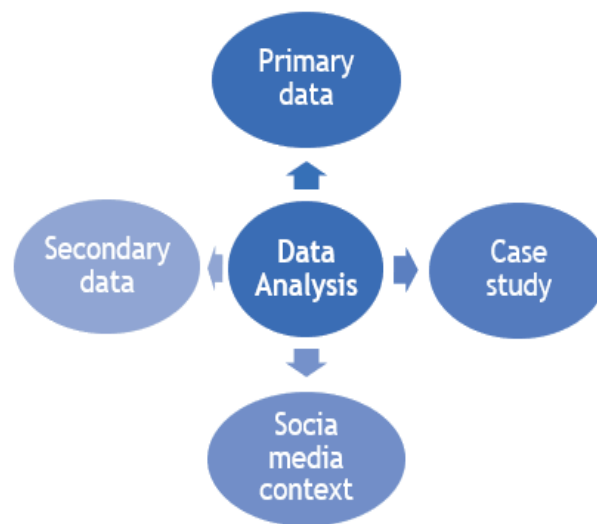
Figure 3. Data analysis

Ethical Considerations

The study will strictly align with ethical academic integrity standards. Hence, before the online interview, the researcher will get informed consent from the interviewees. Moreover, research participants will be given an option to remain anonymous. It will increase the chance of getting reliable information and the desire to provide extended answers. Furthermore, the collected data will be properly stored and applied only for the research purpose. Finally, the researcher will handle sensitive issues such as trauma, war, violence, and political identity with increased care and confidentiality. Thus, the research acknowledges that the digital artist may work under pressure, considering the political and social situation in Ukraine. Also, artists may experience stress and outside impacts on their professional lives. However, respect, flexibility, and empathy will guide all data collection stages.

RESULTS

Metaverse Platform Use

Traditional art forms presuppose the use of multiple materials and methods, and digital art mimics them. Technology advancement has penetrated art, providing lifelike canvases, digital brushes, and digital tool copies, for instance, scissors and knives. Hence, digital lenses enable the creation of almost any art form.[10] Digital illustration apps help explore art with only scrolls, clicks, and taps.[11] Digital art includes various creative expressions made with the help of digital technology, including pixel art, 3D modelling, digital painting, vector art, and others [12]. Hence, digital art comprises any art created through digital tools or platforms.[13,14] Digital art possibilities constantly increase due to technological advancements.[15] These days, AR, AI, and VR enable artists to create unique experiences that surpass traditional boundaries. Digital artists in Ukraine work using various technologies, combining them with innovation and creativity to provide meaning and depth. Hence, NFTs are frequently applied to make a symbolic and economic impact. These are not only referred to as a financial tool, but also a symbolic act of visibility, transparency, and ownership.[16,17] Dmytro Kolvander is one of the artists who, collectively with NFT Culture Ukraine, implemented blockchain to tokenize visual commentary on corruption and war.[18] For instance, the limited-edition NFTs of Kolyander, that saw the world during the 2022 invasion, assisted the artist in raising funds for volunteers. The online interview indicated that it was a valuable experience for the artist, enabling him to reach a global audience and draw public attention to war, violence, and related issues. The artist claimed that his messages were supported by people from different parts of the world.[7] Another form of digital art includes engaging exhibitions in the metaverse.[19,20] Ukrainian artists used multiple platforms, including VRChat, Decentraland, and others, to host exhibitions.[7] For instance, Stepan

Ryabchenko was among the artists who created explorable 3D environments. These environments were based on the artist's digital mythology, which enables users to experience sculptures, sounds, and avatars related to Ukraine, Ukrainian art, scenes, and motives.[21] Furthermore, augmented reality (AR) was applied as public art that assisted in reclaiming public space during crisis and war. For instance, Zinaida Likhachova, together with the project digital monument development and collaborated via smartphone in locations which are significant in Ukraine and Poland. This enabled individuals in exile to actively participate in cultural reflection, without being physically not present at the galleries.[22,23] Thus, multiple art forms help digital artists in Ukraine become effective in the metaverse platforms.

Communication Messages in the Metaverse

Digital artists in Ukraine work hard to communicate powerful messages in the metaverse. They reflect the war-related context, violence, identity, and activism. The most common messages may be grouped into such categories as war and resilience, cultural identity, activism and social engagement, and resistance. For instance, digital artists show the scenes of destruction, conflict, loss, and suffering, highlighting hope. One of the artists reported: "VR helps me show how Ukrainian cities look like under bombs." They use digital art in metaverse to uncover Ukrainian culture to the global community. Moreover, communication messages often aim at getting advocacy and fundraising. For instance, NFT sales relate to humanitarian efforts. Art has become a medium to deal with misinformation and challenge propaganda. In the metaverse, digital artists in Ukraine communicate messages that combine war-related activism, resistance, resilience, and cultural identity. Their art pieces transform digital spaces, making them platforms for social change and global awareness. Hence, communication messages indicate the strong power of art to impact attitudes and actions globally.

Ukrainian Artists as Catalysts

Digital art is a social change catalyst, focusing on its potential to communicate powerful messages, encourage activities, motivate, provoke thoughts, and foster empathy. The analysis of art history helps distinguish the role of art in social movements, highlights its immense impact and capability to make changes.[24] It relates to the fact that art impacts viewers' actions and thoughts, assisting in putting a face to social suffering and making art a useful tool applied by people to comprehend the complex nature of social movements. Art is a social change catalyst that confronts injustices, makes political commentaries, challenges stereotypes, increases environmental awareness, and highlights mental health. Artists, particularly digital artists, tend to use their works to confront societal injustices.[7] Art becomes a powerful tool for reporting issues that require attention. [5,25,26] Moreover, political events and movements have been inspiring artists for many decades to create works that represent the spirit of the time.[27,28] Interview participants highlighted the importance of informing the world about the war, making it visible to others. For example, Dmytro Kolvander stated: "My NFT collection help the international audience understand how we live in Ukraine. Every art piece tells a certain story of survival." The research results indicate that social media data support this idea due to the posts tagged with #NFTUkraine and #DigitalResistance, covering topics associated with humanitarian messages, fundraising campaigns, and destroyed areas. It has been found that artists do not only tell stories, but also encourage to act. One of the interview participants explained: "Each sale is a contribution to support displaced families." Ukrainian artists use digital platforms to present real-life information, counter misinformation, and inform the world about the war. One of the gallery organizers reported: "I tell people's stories and present their voices." Finally, the interview participants highlighted that AR/VR help people feel the war: "AR/VR help audience understand that the war is real." Thus, Ukrainian artists are social change catalysts as they demonstrate the war's realities, drive fundraising, use immersive technology to encourage social engagement, and promote Ukrainian identity, turning digital art into an effective tool.

Barriers to Digital Art Development

The analysis of the Ukrainian context enables identifying several barriers that affect digital art development, including technological and infrastructure barriers, economic barriers, structural and institutional barriers, and social and awareness barriers, as well as war-related constraints. Limited and unstable internet connections make many artists work from smartphones, restricting the use of metaverse platforms and AR/VR. Financial constraints cause difficulties as artists cannot buy necessary tools, while limited monetization opportunities prevent some artists from filling market knowledge gaps. Structural and institutional barriers are associated with insufficient support from cultural institutions, as well as policy and regulatory challenges. Social and awareness barriers lead to limited education and training, as well as declining public awareness. Finally, war-related constraints result in safety concerns and displacement. The work under stressful conditions affects artists' abilities to produce and promote digital work. Trauma and psychological stress impact creativity and limit digital art initiative participation. Thus, these barriers limit global visibility, cause unequal access to digital platforms, and reduce the potential social impact of digital art in the country. Targeted infrastructure

interventions, institutional support, funding, and education may help address these barriers.

Approaches to Addressing Barriers

Technologic, economic, institutional, and social approaches can be effectively applied to address barriers to digital art development. Technological approaches help improve digital infrastructure access, as stable internet connection, access to AR/VR equipment, and availability of high-performance computers provide artists with the opportunity to engage with metaverse platforms. The use of mobile solutions encourages the application of accessible digital tools that let artists work with limited hardware and under stressful conditions. Economic solutions are associated with funding, grants, partnerships, and monetization platforms. Moreover, institutional approaches ensure cultural institution support and regulatory and legal frameworks, as well as collaboration with tech companies. Finally, social initiatives help create activism through art, create online networks, and participate in global promotion campaigns. This helps attract resources from international communities. Thus, the use of the above-mentioned approaches helps address barriers, enabling Ukrainian artists to maximize their creative potential, enhancing social impact, and increasing global visibility.

Forms of Digital Art

Figure 4. Digital art in Ukraine

Digital art in Ukraine significantly intertwines and intersects with reconstruction, resistance, and remembrance (figure 4). Many artists find that artistic practice is a digital resistance form, especially as a response to political repression, war, and occupation.[29] Their works challenge displacement, violence, and aggression, offering counter-images which are deep in people's experiences. The online interview helped reveal that artists' works are not only art but also memory, evidence, and resistance. Some NFT campaigns represented torn flags, burned buildings, ruined kindergartens, and reimagined national icons in the Ukrainian landscapes. Local digital artists examined themes of trauma, identity, and national spirit. Many of them referred to digital symbolism as a way to represent exile, loss, damage, and cultural erosion. Digital artists reinterpreted traditional motifs by featuring Ukrainian folklore, embroidered traditional motifs, and orthodoxy. The results of the online interview showed that the artists work hard to digitalize their heritage, rage, and grief to show the world the current situation in the country. Finally, metaverse exhibitions enable artists to gain international acceptance and exposure.[30,31,32,33] It assists in establishing support networks among the people who support Ukraine. "MetaUkraine Gallery" is the event that allows interaction via voice chat and avatars among people in different parts of the world.

Metaverse Challenges

Ukrainian artists are innovative and creative. However, these features do not prevent them from structural limitations in digital platform participation. They experience technological barriers as high-performance equipment is barely affordable for many artists.[34,35] Moreover, poor and often unstable electricity and internet access in war-torn areas in Ukraine limit creative output and artists' activities. According to the online interview, artists in the country create during power outages. They have to use mobile data and battery packs to ensure their ability to work. Furthermore, Ukrainian digital artists experience cultural bias and platform limitations as most metaverse platforms are centered on the US, are English-dominant, and are commercially oriented. It typically results in the marginalization of non-Western narratives. Finally, sustainability and exploitation are two other challenges associated with the use of the metaverse. Some artists express worries regarding the short-term hype NFT cycles and the cultural tokenization risk.

Content Analysis

The analysis of posts from social media websites indicates that there are several narrative categories, including fundraising for Ukraine, national and cultural identity, metaverse critique, and digital memorialization. Hence, the dominant themes that relate to fundraising contain nearly 70 % of posts, while the reimagination of Ukrainian symbols, heritage, ang language are only nearly 18 % of the cultural and national identity category. Moreover, 7 % of posts address the question of fake decentralization, and 5 % focus on virtual monuments, online events associated with remembrance, and war archives (figure 5). The figure indicates that currently the topic of fundraising is extremely essential and highly discusses in Ukrainian digital art. The research results indicate that most viral posts combined the emotional influence with clear calls to action. Finally, several posts highlighted the contradiction of digital freedom in the realm of present-day violence in the country.
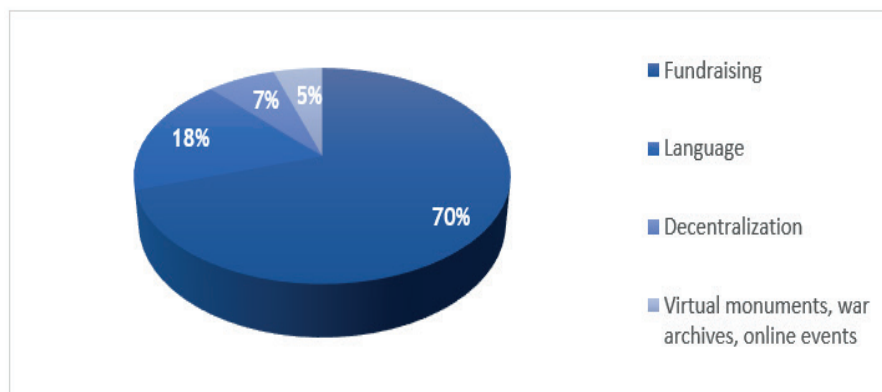

Figure 5. Dominant themes from social media websites

Main Case Characteristics

The analysis of the main case characteristics indicates that the case of Stepan Ryabchenko relates to 3D and VR art with the project titled "Virtual Mythology." The artist used a spatial platform with the endeavor to preserve national mythology. The observed influence is exhibited in international virtual spaces. Dmytro Kolyander, known for the project "WTF is Metaverse," applied NFT and glitch art. The artist used Twitter to enhance anti-war activism and encourage donations to help Ukraine. Finally, Zinaida Likhachova's project is "Transformation Rituals," related to AR performance and used on WebAR and mobile applications. The primary aim is to inform about Ukrainian cultural heritage and attract public attention to exile communities.

The Ukrainian Context

The Ukrainian context highlights tone, urgency, and form of digital art. War is a constraint and a catalyst for innovation. Digital artists are creating from different places, including shelters, ruins, or exile. They are doing their best to show visibility of the digital realm and reclaim their voice. Artists rely on cultural symbols in reinterpreting dignity, identity, and autonomy. However, economic instability and related hardships limit access to cutting-edge tools. Therefore, some artists choose minimalism, use open-source tools to create influential works, and apply mobile platforms. The online interview helped reveal that the Ukrainian artists, during the conditions of war, have learned to do more with fewer resources, making meaning in unstable and unsafe places. The Ukrainian war significantly impacted the content, aim, urgency, and dissemination of digital artworks.[7] It has impacted artists, who are often disconnected from global tech infrastructure. However, war and related events do not distract artists, and they remain committed to digital experimentation. Therefore, trauma, resistance, oppression, and cultural memory are among the common themes of Ukrainian artists identified in the study.[7] Furthermore, economic instability drives investment in VR or NFTs, enhancing unique digital art expression.

DISCUSSION

Interpretation of Findings

War poses threat to humanity and had long-term consequences. War-related stories are associated with courage, ruins, loss, and death. Mediated through news, art, and other channels, these stories create symbols of the war, which are often reproduced by artists. Implementing their usual methods and approaches, digital artists represent the reality in which they live. In war-torn Ukraine, digital artists reflect the reality to attract global attention. Hence, the turn to realism in contemporary digital Ukrainian art is a natural phenomenon.[7] The research findings highlight the multifaceted role of digital art and its capability to act as a social impact tool in the modern media and metaverse. NFTs emerged as powerful instruments for both artistic expression

and activism. It has been found that projects like MetaHistory: Museum of War demonstrate how digital assets can secure financial support and mobilize global communities to address urgent causes, such as wartime relief. Moreover, virtual galleries provide artists with the opportunity to transcend geopolitical barriers, allowing them to create a borderless space to represent marginalized population groups, express dissent, and highlight identity.[26] The research findings indicate that digital art during the time of war is a form of cultural resistance, collective memory, resilience, and activism. Adopting realism and relying on NFTs, AR/VR, and virtual galleries, digital artists in Ukraine represent how art can cope with local limitations and become an international voice for justice. Additionally, many artists experience structural barriers which imply that digital creativity is deeply intertwined with broader questions of equality, access, and power. This indicates that digital art role expands beyond Ukraine, informing the world of the current situation in the country. Thus, digital art refers to the representation of reality and the individuals who represent it, how audiences engage with it, and technological changes.

Literature Comparison

The analysis of the current sources that address the topic under investigation indicates that the study aligns with primary data that identifies digital art as an effective tool that ensures activism, social engagement, and identity-building.[24] Similar to the Western context, digital artists in Ukraine rely on the use of NFTs and AR/VR exhibitions to enhance community engagement and encourage addressing urgent issues.[36] The ongoing conflicts and underdeveloped infrastructure magnify the social influence of digital art projects and restrict artists' participation. Nevertheless, there is insignificant empirical research that addresses digital art in the war-affected Ukrainian context. This makes Ukraine an essential and underexplored case for comprehending various social-political virtual creativity dimensions in unstable environments. Hence, the research results indicate that there is a significant gap in the academic literature that focuses on the investigation of digital art in the war-affected context in Ukraine. This makes the country an essential case of virtual creativity exploration in the unstable Ukrainian environment.

The current study extends several literature strands. Hence, Tursyngaliyeva et al.[37] show how ethnic and social processes shape interactions within diverse societies, emphasizing context importance in identity formation. This supports with the research finding that digital artists in Ukraine implement the metaverse to establish cultural identity and represent marginalized voices, indicating how virtual spaces reflect and impact social dynamics. Research by Potwora et al.[38] and Riabova et al.[39] on digital marketing and technology adoption examine the application of digital marketing and AI strategies to increase personalization, audience engagement, and global reach. Similarly to these researchers, Ukrainian digital artists apply AR/VR, NFT, and social media platforms to get global support, increase awareness and visibility, as well as demonstrate practical use of these strategies during war. Moreover, Panchenko et al.[40] investigate how media strategies and social institutions facilitate cultural engagement. This is a direct parallel with the role of galleries and online platforms in Ukraine and community participation fostering. The research findings indicate that institutional support intensifies digital art impact and encourages audience interaction. Furthermore, Stender et al.[41] analyze the digital transformation of the local economy, technological challenges, and Ukrainian infrastructure. These constraints are clearly reflected in the barriers experienced by digital artists in Ukraine, complicating engagement with metaverse platforms. Hence, these sources highlight that marketing strategies and digital technologies encourage engagement and increase visibility, focusing on contextual factors that uniquely shape Ukrainian digital art. The current study contributes to a novel perspective by examining digital art during war, showing how it functions as a tool for activism, social impact, and cultural identity.

Ukrainian Context

The sociopolitical reality in Ukraine makes a significant impact on shaping its digital art scene. The current war with Russia, combined with cultural revival efforts and increasing global interest in the country, has created a fertile backdrop for the rapid development of digital art. Hence, such artists as Ryabchenko blend symbolism, methodology, and virtual landscapes, representing the shift from national to reclaiming identity using digital media. However, war causes economic instability, which limits equitable access to resources and the metaverse. Many platforms are associated with high entry barriers, for instance, technical knowledge or equipment costs. This dichotomy between accessibility and innovation highlights the need for providing support at policy levels to democratize digital creation tools.

This, an increased interest in digital art in Ukraine, is associated with the digitalization of modern society. Although it began to develop quickly and steadily, Russian aggression has suspended that process. However, it is evident that the return of the country to a peaceful life will significantly impact the development and revival of digital art, shifting its themes to a desired life without war and violence. Moreover, during the war, artists usually prepared the most interesting and engaging projects, which are freely available on the Internet.[42] The digital art share and popularity in Ukraine is likely to grow as it has public resonance.

Theoretical and Practical Implications

The current research has theoretical implications as it expands far beyond the understanding of digital art as a social practice, for instance, by positioning it within broader cultural frameworks, political engagement, and identity formation, while highlighting the role of technology in different types of creative expression. Moreover, it refers to art not only as a commercial or visual landscape. The study supports emerging frameworks that view the metaverse as a favorable space for activism, including Immersive Civi Engagement, Digital Public Sphere Framework, and Networked Activism.[43,44] The received findings may help digital artists, policymakers, and cultural institutions use art for multiple purposes, helping Ukraine attract global attention to the war and related issues. The integration of social themes into NFTs and VR works enables artists to amplify their relevance and ability to reach people worldwide. Various media channels can effectively collaborate with digital artists to highlight grassroots narratives, encouraging NGOs and the government to invest in digital art laboratories or studios, opening relevant hubs and spaces to ensure that digital art is accessible in the country. Finally, policy makers should promote global digital art campaigns, develop regulatory frameworks, and partner with cultural institutions.

Limitations and Areas for Future Research

The research is associated with several limitations. It is exploratory, which is referred to as a limitation because other types of studies will help get more reliable and generalizable information to provide well-grounded conclusion. Moreover, the sample size and online interviewing may fail to provide a full diversity of artists' experiences, attitudes, and motives. Data collection from a larger number of Ukrainian digital artists will assist in receiving extended findings. Finally, content analysis of social media sources may limit the understanding of the current situation with digital art in Ukraine.[45] However, the presence of the above-mentioned limitations has not diminished the value of the study, as the researcher met the research objectives and answered the research questions. Hence, the research limitations highlight the need and outline the course of the future research directed toward the exploration of broad demographic perspectives.[46] Also, quantitative data would help get a more precise comprehension of how digital art evolved and impact the current situation in Ukraine. Longitudinal effects of people's engagement with digital art over certain periods. Finally, the discussion of the potential place and role of digital art in the post-war recovery of Ukraine will assist in directing it in the correct niche.[47,48,49]

Directions for Future Research

The research provides qualitative insights into the link between digital art and social impact with a focus on the Ukrainian context. However, further investigation of the topic may provide a deeper insight into how digital art develops and impacts society. Systematic research on the interaction between digital art and audiences, the use of metrics to measure social media engagement and digital art effectiveness may increase public awareness, promote donations, and encourage social changes.[50] Studies relied on analytics wool might quantify public perception, behavior change, and motivation after exposure to digital artworks with clear political and social messages. Comparative studies may help learn about cross-cultural differences, common patterns, and the use of artists from economically constrained countries, for instance, Venezuela or Syria, to identify how artists use digital platforms for various social purposes.[51]

Additionally, future research should consider the possibility of conducting longitudinal studies to trace the evolution of digital art and metaverse platforms. A longitudinal approach would enable exploring digital activism evolution and sustainability. Therefore, further research should address the effectiveness of the NFT-based fundraising initiatives, digital art adaptation, digital art state under external pressures, and relationships between people and artists. It would be beneficial to examine technological accessibility to focus on ethical metaverse implications and blockchain use in digital art.[52,53,54,55] It implies that a greater emphasis should be placed on studying how limitations associated with digital art affect platform participation and prevent conveying essential messages.

CONCLUSIONS

Summary of Key Research Findings

The current study reveals that digital art has evolved due to technological development. Art is capable of enhancing changes in any society. In war-torn Ukraine, digital art is a powerful tool that assists in attracting global attention to the issue. Metaverse and NFTs platforms provide extended opportunities to Ukrainian artists, enabling them to increase public awareness. However, access to these platforms in the country is often limited or unequal and this prevents effective message representation. The metaverse is referred to as a borderless stage that allows activism and creative expression. The only challenge is that participation significantly depends on financial capabilities and technical literacy.

Research Significance

The research contributes to the discussion of art and technology combination during crisis, showing creative practices which shape digital spaces under the pressures of the modern world. It contributes to cultural and academic understanding of how digital art ensures social and political engagement, particularly in conflict-affected regions such as Ukraine.[5] Furthermore, the study emphasizes that the metaverse is a platform that encourages national identity, cultural diplomacy, and civic voice.

RECOMMENDATIONS

The analysis of the current state of digital art in Ukraine has helped to understand what is needed for Ukrainian digital art to become more powerful and effective during wartime. Hence, it is recommended to support local artists through digital platforms by funding exhibitions to attract international audiences.[47] Moreover, it would be beneficial to improve digital access to ensure a stable internet connection and affordable devices. However, this requires infrastructure investment.[48] Additionally, education in Web3 tools would help people make the access and use process easier and engaging.[14] Furthermore, the encouragement of cross-sector partnerships between art institutions, tech companies, NGOs, and government would make the metaverse more socially impactful and inclusive [49]. Finally, the use of digital art for advocacy and storytelling would be beneficial in the context of limited traditional media and censorship.

REFERENCES

1. Amwiine H, Ugwu JN. ART as Activism: The Influence of Visual Arts on Social Movements. Research Output Journal of Arts and Management. 2024;3(1):5–8. Available from: https://rojournals.org/wp-content/uploads/2024/08/ROJAM-P1.pdf.

2. Madan A, Rosca LD, Dumitru I, Canda A. The Value of Art in Persuasive Marketing Communication and Its Sustainable Effect on the Country of Origin. Sustainability. 2022 Jan 21;14(3):1228. doi: https://doi.org/10.3390/su14031228.

3. Held T. Einblick: Videotelefonie und Design. Wiesbaden: Springer Fachmedien Wiesbaden; 2024. State of the Art; p. 31-253. doi: https://doi.org/10.1007/978-3-658-44585-0_2.

4. Cotter KN, Crone DL, Rodriguez-Boerwinkle RM, Boerwinkle M, Silvia PJ, Pawelski JO. Examining the Flourishing Impacts of Repeated Visits to a Virtual Art Museum and the Role of Immersion. Behav Sci. 2022 Dec 7;12(12):500. doi: https://doi.org/10.3390/bs12120500.

5. Osadcha K, Baluta V. The influence of modern trends in digital art on the content of training in computer graphics and digital design. Ukr J Educ Stud Inf Technol. 2021 Mar 31;9(1):1-12. doi: https://doi.org/10.32919/uesit.2021.01.01.

6. Chien SY, Hwang GJ. Broad sense and narrow sense perspectives on the metaverse in education: Roles of virtual reality, augmented reality, artificial intelligence and pedagogical theories. Int J Mob Learn Organ. 2024;1(1). doi: https://doi.org/10.1504/ijmlo.2024.10058828.

7. Korneichuk L. When artist affords to be literal: Social media realism in Ukrainian Wartime Art. Artslooker. 2024. Available from: https://artslooker.com/en/when-artist-affords-to-be-literal-social-media-realism-in-ukrainian-wartime-art/.

8. Hridyayeva TO, Kohut VO, Tokar MI, Stanychnov OO, Helytovych AA. The features of Ukrainian media art in a global context. Int J Comput Sci Netw Secur. 2021;21(4):229–240. doi: https://doi.org/10.22937/IJCSNS.2021.21.4.28.

9. Hurst W, Spyrou O, Tekinerdogan B, Krampe C. Digital Art and the Metaverse: Benefits and Challenges. Future Internet. 2023 May 23;15(6):188. doi: https://doi.org/10.3390/fi15060188.

10. Art R. Rise Art. Guide to Digital Art | Rise Art; 2020 Jun 18. Available from: https://www.riseart.com/guide/2367/guide-to-digital-art?srsltid=AfmBOoohFN03eAmdjUNHE4p-zTA9aB_pZjELI5Mz7P0C6LIP_kNEstRm.

11. Caires CS, Estadieu G, Olga Ng Ka Man S. Springer Series in Design and Innovation. Cham: Springer Nature Switzerland; 2023. Design Thinking Methodology and Text-To-Image Artificial Intelligence: A Case Study in the Context of Furniture Design Education; p. 113-34. doi: https://doi.org/10.1007/978-3-031-41770-2_7.

12. MoMAA | Affordable Art Gallery & Lifestyle. The Evolution and Impact of Digital Art in the Contemporary Art World. Available from: https://momaa.org/the-evolution-and-impact-of-digital-art-in-the-contemporary-art-world/.

13. Brey A. Digital art history in 2021. Hist Compass. 2021 Jul 10;19(8). doi: 10.1111/hic3.12678.

14. Bukharova E, Urozhenko O. Artistic Reality in the Space of Digital Technologies: Towards the Problem of Art Criticism. KnE Soc Sci. 2020 Aug 25. doi: https://doi.org/10.18502/kss.v4i11.7522.

15. Dokolova A. Specifics of Modern Video Installations: Projection Mapping as a Form of Digital Art. Intellect Arch. 2021 Mar 23;10(1). doi: https://doi.org/10.32370/ia_2021_03_09.

16. Borysenko O, Diachenko M, Diachenko I, Kravchenko O, Shunevych Y. Impact of media space design on audience engagement in the digital age: A scoping review. Rev Amazon Investig. 2024 Dec 30;13(84):221-36. doi: https://doi.org/10.34069/ai/2024.84.12.14.

17. Tolmach M, Volynets V, Trach Y, Chaikovska O, Khrushch S, Kotsiubivska K, Danielienė R, Danielius P. Proceedings of Eighth International Congress on Information and Communication Technology. Singapore: Springer Nature Singapore; 2023. NFT and Digital Art: Ukrainian Experience of Using Cryptoart; p. 995-1006. doi: https://doi.org/10.1007/978-981-99-3236-8_80.

18. Lahoda O, Soboliev O, Tokar M, Ivanenko T, Budiak V. The Use of Virtual Reality in Art Education in Ukraine: A Study of the Impact on the Creative Process and Students' Perception. J Curric Teach. 2024 Jul 27;13(3):32. doi: https://doi.org/10.5430/jct.v13n3p32.

19. Mourtzis D, Panopoulos N, Angelopoulos J, Wang B, Wang L. Human centric platforms for personalized value creation in metaverse. J Manuf Syst. 2022 Oct;65:653-9. doi: https://doi.org/10.1016/j.jmsy.2022.11.004.

20. Zaeri P, Roozafzai ZS. Visual arts as a catalyst for social change: Communicating powerful messages. Int J Arts Humanit. 2024 Nov 5;6(1):268-74. doi: https://doi.org/10.25082/ijah.2025.01.001.

21. Odessa Journal | Main. Ukraine Launches Largest Digital Art Catalog with NFT Auction - Oj. Available from: https://odessa-journal.com/a-digital-art-fund-has-been-launched-in-ukraine-to-preserve-the-countrys-cultural-heritage.

22. Samarnggoon K, Grudpan S, Wongta N, Klaynak K. Developing a Virtual World for an Open-House Event: A Metaverse Approach. Future Internet. 2023 Mar 27;15(4):124. doi: https://doi.org/10.3390/fi15040124.

23. Steele M, Huxley M. Guess who's going to the gallery? A strategic audience evaluation and development study by Museums and Galleries NSW, NSW state report. Museums & Galleries of NSW. 2023 May 11. Available from: https://mgnsw.org.au/wp-content/uploads/2019/01/Guess_whos_going_to_the_gallery_nsw_full_state_report.pdf.

24. Albayatia H, Alistarbadi N, Rho JJ. Assessing engagement decisions in NFT Metaverse based on the Theory of Planned Behavior (TPB). Telemat Inform Rep. 2023 Feb:100045. doi: https://doi.org/10.1016/j.teler.2023.100045.

25. Kovalova M, Alforova Z, Sokolyuk L, Chursin O, Obukh L. The digital evolution of art: current trends in the context of the formation and development of metamodernism. Rev Amazon Investig. 2022 Oct 18;11(56):114-23. doi: https://doi.org/10.34069/ai/2022.56.08.12.

26. Down L. Artists as agents of social change past and present. Art, Artists, Artwork. 2025. Available from: https://artsartistsartwork.com/artists-as-agents-of-social-change-past-and-present/.

27. Koshelieva O, Tsyselska O, Kravchuk O, Buriak B, Miatenko N. Digital transformation in culture and art: Exploring the challenges, opportunities and implications in cultural studies. Res J Adv Humanit. 2023;4(3):41-55. Available from: https://royalliteglobal.com/advanced-humanities/article/view/1236.

28. Gallow L, Andrew G. The Art Newspaper - International art news and events. Technology for social

good: how digital artists are using their work to promote inclusivity; 2024 Jan 18. Available from: https://www.theartnewspaper.com/2024/01/18/technology-for-social-good-how-digital-artists-are-using-their-work-to-boost-inclusivity.

29. Rani S, Jining D, Shah D, Xaba S, Shoukat K. Examining the impacts of artificial intelligence technology and computing on digital art: a case study of Edmond de Belamy and its aesthetic values and techniques. AI Amp SOC. 2024 Jun 18. doi: 10.1007/s00146-024-01996-y.

30. Dwivedi YK, Hughes L, Baabdullah AM, Ribeiro-Navarrete S, Giannakis M, Al-Debei MM, et al. Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. Int J Inf Manag. 2022 Oct;66:102542. doi: https://doi.org/10.1016/j.ijinfomgt.2022.102542.

31. eMobilis. The Metaverse: Revolutionizing digital social interaction. eMobilis. 2024 Dec 6. Available from: https://emobilis.ac.ke/news-and-updates/the-metaverse-revolutionizing-digital-social-interaction.

32. Mao T, Jiang X. The Use of Digital Media Art Using UI and Visual Sensing Image Technology. J Sens. 2021 Nov 12;2021:1-11. doi: https://doi.org/10.1155/2021/9280945.

33. Grifoni E, Vannini E, Lunghi I, Faraioli P, Ginanni M, Santacesarea A, Fontana R. 3D multi-modal point clouds data fusion for metrological analysis and restoration assessment of a panel painting. J Cult Herit. 2024 Mar;66:356-66. doi: https://doi.org/10.1016/j.culher.2023.12.007.

34. Ball M. Framework for the Metaverse. MatthewBall.vc. 2023 Apr 11. Available from: https://www.matthewball.vc/all/forwardtothemetaverseprimer.

35. Hutchinson A. What is the metaverse, exactly, and how will it change digital and social connection? Social Media Today. 2022 Feb 20. Available from: https://www.socialmediatoday.com/news/what-is-the-metaverse-exactly-and-how-will-it-change-digital-and-social-c/619174/.

36. Kumar A, Shankar A, Behl A, Wamba SF. Do you believe in the metaverse NFTs? Understanding the value proposition of NFTs in the metaverse. Technol Forecast Soc Chang. 2025 Jan;210:123880. doi: https://doi.org/10.1016/j.techfore.2024.123880.

37. Tursyngaliyeva G, Sagindykov K, Konyrkhanova A, Niyazova R, Sydykkova A. Modeling the dynamical ethnic processes in multinational society. Journal of Modelling in Management. 2023;18(1):61-71. doi: https://doi.org/10.1108/JM2-11-2020-0308.

38. Potwora M, Vdovichena O, Semchuk D, Lipych L, Saienko V. The use of artificial intelligence in marketing strategies: automation, personalization and forecasting. Journal of Management World. 2024;2:41-49. doi: https://doi.org/10.53935/jomw.v2024i2.275.

39. Riabova T, Riabov I, Vovchanska O, Li T, Saienko V. Peculiarities of digital marketing in the era of globalization: an analysis of the challenges. Financial and Credit Activity: Problems of Theory and Practice. 2022;6(47):160-171. doi: https://doi.org/10.55643/fcaptp.6.47.2022.3940.

40. Panchenko S, Litovka-Demenina S, Zatsepina N, Berezivska O, Yarmolyk D. Social institutions and media strategies in the context of religious tourism development. International Journal on Culture, History, and Religion. 2025;7(SI1):100-114. doi: https://doi.org/10.63931/ijchr.v7iSI1.137.

41. Stender S, Bulkot O, Iastremska O, Saienko V, Pereguda Y. Digital transformation of the national economy of Ukraine: challenges and opportunities. Financial and Credit Activity: Problems of Theory and Practice. 2024;2(55):333-345. doi: https://doi.org/10.55643/fcaptp.2.55.2024.4328.

42. Cherniyavskyi V, Dubrivna A, Cherniyavskyi K, Galchynska O, Bilozub L. Digital art as new modern global trend in socio-cultural space of Ukraine. Rev Amazon Investig. 2022 Dec 30;11(60):150-5. doi: https://doi.org/10.34069/ai/2022.60.12.16.

43. Pasqui A. Digital culture, umwelt and aletheia an ontological introduction. In: ARQUEOLÓGICA 2.0 - 9th International Congress & 3rd GEORES - GEOmatics and pREServation; 2021 Apr 26-28. Editorial Universitat

Politécnica de Valéncia: Editorial Universitat Politécnica de Valéncia; 2021. doi: https://doi.org/10.4995/arqueologica9.2021.12063.

44. Rayes EA. Digital art for the promotion of the creative aspect in the plastic art. Glob J Arts Humanit Soc Sci. 2019;7(1):1–14. Available from: http://www.eajournals.org/wp-content/uploads/Digital-Art-for-the-Promotion-of-the-Creative-Aspect-in-the-Plastic-Art.pdf.

45. Kantaros A, Ganetsos T, Petrescu FI. Three-Dimensional Printing and 3D Scanning: Emerging Technologies Exhibiting High Potential in the Field of Cultural Heritage. Appl Sci. 2023 Apr 10;13(8):4777. doi: https://doi.org/10.3390/app13084777.

46. Hutson J, Lively J, Robertson B, Cotroneo P, Lang M. Creative Convergence. Cham: Springer Nature Switzerland; 2023. Introduction: Embracing the AI Renaissance in Art and Design; p. 1-19. doi: https://doi.org/10.1007/978-3-031-45127-0_1.

47. Bishop C. Against Digital Art History. DAHJ. 2018Jul.27;(3). Available from: https://journals.ub.uni-heidelberg.de/index.php/dah/article/view/49915.

48. Kalpokas I, Kalpokiene J. Regulating the metaverse. London: Routledge; 2023.

49. Sokolovska O. Directions of development of digital society in Ukraine. Green Blue Digit Econ J. 2020 Dec 3;1(2):62-7. doi: https://doi.org/10.30525/2661-5169/2020-2-12.

50. Kumar A, Shankar A, Behl A, Wamba SF. Do you believe in the metaverse NFTs? Understanding the value proposition of NFTs in the metaverse. Technol Forecast Soc Chang. 2025 Jan;210:123880. doi: https://doi.org/10.1016/j.techfore.2024.123880.

51. Shen J, Zhou X, Wu W, Wang L, Chen Z. Worldwide Overview and Country Differences in Metaverse Research: A Bibliometric Analysis. Sustainability. 2023 Feb 15;15(4):3541. doi: https://doi.org/10.3390/su15043541.

52. Taherdoost H, Madanchian M. Blockchain-Based New Business Models: A Systematic Review. Electronics. 2023 Mar 21;12(6):1479. doi: https://doi.org/10.3390/electronics12061479.

53. Dong S, Liu M, Abbas K. The Metaverse Review: Exploring the Boundless Ream of Digital Reality. Comput Mater Amp Contin. 2024:1-10. doi: https://doi.org/10.32604/cmc.2024.055575.

54. Rachmawanti R, Yuningsih CR. Art Exhibition in Digital Art Space as Social Interaction Arena for Artists Towards the Metaverse Era. J Sosioteknologi. 2022 Jul 30;21(2). doi: https://doi.org/10.5614/sostek.itbj.2022.21.2.3.

55. Sorrentino G. A unique digital identity in the metaverse: State of the art and future challenges. In: Proceedings of the International Congress Towards a Responsible Development of the Metaverse, Alicante. 2024 Jun 13–14. Available from: https://catedrametaverso.ua.es/wp-content/uploads/2024/07/A-unique-digital-identity-in-the-metaverse-state-of-the-art-and-future-challenges-SORRENTINO.pdf.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest

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