

A Systematic Review of Mixed Reality Applications in Creative Motion Design for Preserving Mak Yong as Intangible Cultural Heritage

Intan Radhiyah Yazim @ Ahmad Yazim¹, Sharkawi Che Din²

^{1,2} Faculty of Arts & Design, Universiti Teknologi MARA, Selangor Branch, Puncak Alam Campus, Selangor, Malaysia

intanryazim03@gmail.com¹, sharkawi237@uitm.edu.my²

*Corresponding author

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ABSTRACT

Mak Yong is the Malay dance-theatre, which is the Intangible Cultural Heritage as listed by UNESCO, but is increasingly losing its popularity due to modernisation, less hands-on instruction, and a decline in visits by viewers. Conventional methods of capturing it tend to overlook the entire embodied, performative, and multi-sensory feel that characterises Mak Yong. This paper will provide a concise survey of the literature on the application of Mixed Reality (MR) and other immersive technologies to preserve intangible cultural heritage, with a specific focus on the case of creative motion design in Mak Yong. According to the PRISMA 2020 structure, the author filtered through large scholarly databases, selected studies, and ultimately chose ten articles, which we examined in detail. The findings indicate that MR technologies such as motion capture, facial animation, immersive environments, and metaverse platforms can be largely utilized to enhance cultural documentation, accessibility, and engagement among the audience. However, challenges related to authenticity, embodiment, technological limitations, and ethical considerations remain. The review concludes that MR is most effective as a complementary tool that supports cultural education, awareness, and continuity rather than replacing live performances. This study contributes to the body of research on MR applications for Southeast Asian intangible cultural heritage and provides insights for future culturally sensitive and ethically informed MR-based preservation initiatives for Mak Yong.

Keywords: Mixed Reality, Mak Yong, Intangible Cultural Heritage



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1 INTRODUCTION

Mak Yong is an ancient dance-theatre form incorporating the elements of ritual, stylized dance and acting, vocal and instrumental music, song, story, and formal as well as improvised spoken text (Yousof, 2017). Mak Yong has been acknowledged as an Intangible Cultural Heritage (ICH) in 2005 by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Despite its UNESCO recognition, Mak Yong has gradually declined in the 20th century (Lee Suan & Rudyansjah, 2018).

Mixed Reality (MR) is a particular subset of Virtual Reality (VR) related technologies that involve the merging of real and virtual worlds somewhere along the "virtuality continuum", which connects completely real environments to completely virtual ones. (Milgram & Kishino, 1994). Within the field of visual communication, MR is widely recognised as a tool that can preserve cultural heritage in a more dynamic way than traditional preservation methods. The author has seen how the digital versions of traditional performance can be created in detail, being interactive and capturing not only the appearance, but also movement and feel, with techniques such as motion capture and 3D scanning. MR

technologies enable users to delve deeper into history by viewing virtual reconstructions of cultural locations and artefacts in immersive digital environments (Dimara et al., 2024).

This study aims to analyse existing literature on MR applications in Malay cultural heritage preservation as ICH. Nonetheless, the biggest gap in research concerns the application of MR to Southeast Asian ICH, particularly to performative traditions like Mak Yong. While MR has been successfully employed in preserving crafts and rituals in other cultural settings (Park et al., 2022), its integration into Malay heritage remains underexplored. Moreover, existing documentation efforts often rely on static archives or scripted performances, which fail to capture the multisensory and spiritual essence of Mak Yong (Khan et al., 2023).

The gap addressed by this research lies in the minimal application of Mixed Reality technologies to the preservation of Southeast Asian Intangible Cultural Heritage, particularly performative cultures such as Mak Yong. Conventional preservation strategies tend to prioritise statues and script-based documentation, approaches that are insufficient for conveying the embodied and multisensory experiences central to performative traditions. Through the systematic review of literature on MR use in cultural heritage and with the emphasis on creative motion design to apply to Mak Yong, this study examines the effectiveness of how MR can be used to preserve Mak Yong, reverse its cultural loss, and present traditional performance in more engaging and immersive forms.

2 MATERIALS AND METHODS

This study utilises PRISMA 2020, a systematic literature review model, to analyse previous studies related to the applications of MR in creative motion design in preserving and promoting Malay heritage according to the three main stages: identification, screening, and eligibility. This approach is regarded as appropriate, as the emerging field of MR technologies provide capability to couple the virtual and physical realms in design prototyping (Kent et al., 2021). It highlights how immersive technologies can enhance the preservation of the Malay heritage of Mak Yong using online databases such as Google Scholar, Scopus, Springer Nature Link, and IEEE Xplore as stated in Table 1.

Table 1 The search keywords

Category	Description
Google Scholar	Search Terms: ("Mixed Reality" OR "Virtual Reality" OR "Augmented Reality" OR "XR") AND ("Mak Yong" OR "Mak Yung") AND ("Intangible Cultural Heritage" OR "Cultural Preservation")
Scopus	Search Terms: (TITLE-ABS-KEY ("Mixed Reality" OR "Virtual Reality" OR "XR") AND TITLE-ABS-KEY ("Intangible Cultural Heritage" OR "Cultural Preservation")) AND (LIMIT-TO (SUBJAREA , "ARTS")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp"))
IEEE Xplore	Search Terms: ("Mixed Reality" OR "Virtual Reality" OR "XR") AND ("Intangible Cultural Heritage" OR "Cultural Heritage") AND ("Malaysia" OR "Mak Yong")
Springer Nature Link	Search Terms: ("Mixed Reality" OR "Virtual Reality" OR "Augmented Reality") AND ("Mak Yong" OR "Mak Yung" OR "Cultural Heritage") AND ("Intangible Cultural Heritage" OR "Cultural Preservation")

2.1 Identification

Finding linked, similar terms using dictionaries, thesauruses, encyclopaedias, and past research represents the initial step in keyword recognition for systematic reviews. In this study on the main keywords “Mixed Reality”, “Mak Yong”, and “Intangible Cultural Heritage”. As detailed in Table 1, search strings were applied to Google Scholar, Scopus, IEEE Explore, and Nature Springer Link databases resulted in 778 publications based on the relevant keywords.

2.2 Screening

The screening step in a systematic review is a critical process that involves evaluating the initially identified articles to determine their eligibility for further analysis. In this phase, titles and abstracts are carefully examined against predefined inclusion and exclusion criteria: publications from 2010-2025, non-English articles, in-press publications, and non-open access articles. Duplicates are also removed

to prevent redundancy. Studies that meet these criteria after this screening phase proceed to full-text evaluation, ensuring a refined and relevant pool of articles for systematic synthesis. After evaluating the contents of the records, they are then removed according to specific criteria, such as being outside the field of the topic and inaccessible due to the lack of full text, which totals 20 records. Ultimately, 30 articles remained open for evaluation and assessed for eligibility.

2.3 Included

In this included phase, the third step of the PRISMA 2020 systematic review process, 10 articles were selected from full text analysis to verify in-depth coverage of the core research keywords: Mixed Reality, Mak Yong and Intangible Cultural Heritage, ensuring direct alignment with the study's objectives on MR applications for preserving cultural heritage.

Table 2 The selection criterion in searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Open Access	All	Non-open access
Relevance to the research topic	Relevant to Mixed Reality, Mak Yong, and Intangible Cultural Heritage	Not related to the research keywords
Year of publication	2010-2025	<2010

3 RESEARCH DESIGN

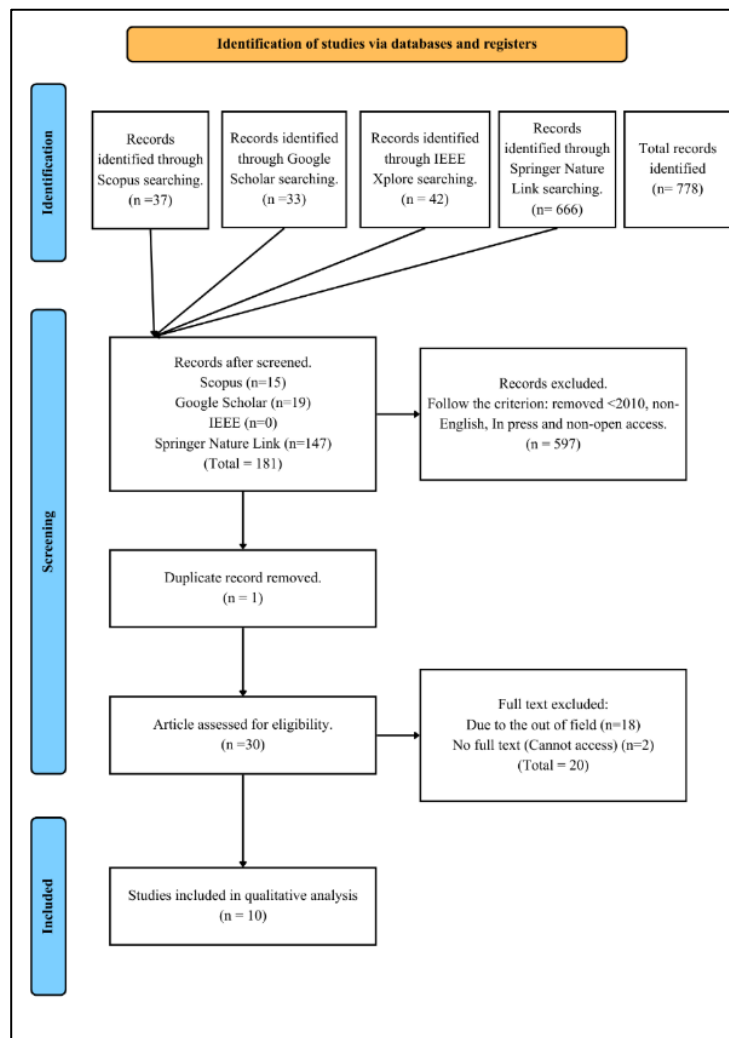


Figure 1 PRISMA 2020 diagram

4 FINDINGS

This study is based on 10 selected articles, which were manually analysed for the research objectives. The article was reviewed to understand how MR has been applied in heritage work and how effective MR is in preserving cultural heritage. The findings are categorised into three major themes: (1) Motion Design in Mak Yong, (2) Mixed Reality in preserving cultural heritage, and (3) Others. The others category is for topics that are closely related but not suitable for the inclusion exclusion criteria as mentioned above.

4.1 The Effectiveness of Mixed Reality in Mak Yong

Table 3 The Effectiveness of Mixed Reality in Mak Yong

Authors	Journal Title	Methodology	Results	Advantages
Noraisyah Abd Rahman Siti, Izwan Jamal Jazmi, Ayob Juhara, Adlyna Sidek Husna, Abdullah Fatimah, Farhan Mohamad Mohamad, Azmir Mohd Ghazali Fariz, Rasfan Abu Bakar Muhammad, Abdullah Marzuki (2023)	Makyung in Metaverse: Issues and Challenges of Delivering Performing Arts Education in The Virtual Worlds	The study employed a cross-sectional qualitative design using methodological triangulation. The interview data were transcribed verbatim and analysed using thematic analysis, with interpretation guided by the Arts Audience Experience Index framework. The study was contextualised through a pilot metaverse programme observing Mak Yong via platforms such as Google Meet and Spatial.io.	The findings indicate that experts converged on four key audience experience components: authenticity, collective engagement, knowledge, and risk. While the metaverse enabled immersive viewing, shared virtual presence, and improved access to cultural knowledge, major limitations were identified. This paper has demonstrated that Design Thinking could be applied to the digital preservation process of Mak Yong performance. The prototype-stage 3D animation can be viewed as a viable technique in the development process for simulating local or traditional performance in new media such as animation, virtual reality, and digital games.	The study concludes that the metaverse has a positive impact as a complementary tool for Mak Yong preservation and dissemination. It broadens access beyond physical and geographical constraints, supports cultural education and awareness, encourages social gathering and discourse in virtual spaces, and contributes to the safeguarding of intangible cultural heritage in line with UNESCO
Musa Naimah, Idris Muhammad Zaffwan (2023)	Design Thinking in Digital Preservation of Mak Yong's Facial Expression Performance	The study employed a mixed-methods approach, which involves a qualitative methodology combined with interviews. It involved, five Māori participants on-site at the marae and semi-structured interviews (22–36 minutes each) were conducted and audio-recorded.		The approach enhances knowledge transfer and cultural continuity by preserving stories in an immersive, authoritative form where mana is conveyed through the presence of respected knowledge holders.
Idris Muhammad Zaffwan, Musa Naimah (2020)	Beyond Digitalisation: Facial Motion Capture for Mak Yong through the Perspective of Aesthetic Experience and Uncanny Valley	The study adopts a qualitative, exploratory research approach situated at a preliminary stage of a larger project. It employs facial motion capture (MoCap) as the primary technical method to digitally record Mak Yong	The results show that facial movement capture has a high potential in maintaining expressive and emotional aspects of Mak Yong that play a main role in	The paper continues the argument about Mak Yong preservation outside the documentary and places the facial MoCap as the means of future use, i.e. 3D animation, virtual characters, and immersive exhibits.

performers' facial expressions, particularly those of the Pak Yong character.	its structure of a dance-drama.
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The role of mixed reality-related technologies in the preservation of Mak Yong as an intangible cultural heritage has been the subject of several studies. Abd Rahman et al. (2023) examines the application of a metaverse platform to view Mak Yong performances and are interested in the experience of the audience and social gathering in a virtual environment. They find that immersive platforms have the capacity to enhance access, sharing of knowledge and cultural sensitivity among the audiences who might not be able to access live performances. The research identifies authenticity, collective activity, knowledge and risk as some of the most important factors in terms of audience experience and indicates that mixed reality may be an effective supplemental media in terms of preserving and promoting Mak Yong in an educational and awareness-based setting.

Nonetheless, embodiment and sense of presence present challenges that reduce the effectiveness of mixed reality. According to Abd Rahman et al., (2023) live performance aura (angin) of Mak Yong can hardly be modelled into avatar-like representations because of technological limitations, including fewer motion trackers and limited interaction between the performers and the audience. This indicates that although the mixed reality environment has the potential to assist in documentation and virtual observation, it might not achieve the same level of emotional and spiritual intimacy as the traditional Mak Yong performance does. This makes mixed reality a better complementary tool, and not a substitute for live cultural practices.

On a more specific performative scale, Idris & Musa, (2020) investigates the application of facial motion capture in the digitisation of Mak Yong, specifically, at the matter of facial expressions as one of the most significant aspects of storytelling and characterisation. Their study highlights the potential of motion capture to enhance realism and aesthetic experience in digital Mak Yong representations, contributing to more expressive and emotionally accurate virtual performances. However, the authors also caution against the risk of the uncanny valley, where overly realistic digital characters may reduce audience acceptance. Together, these studies suggest that the effectiveness of mixed reality in preserving Mak Yong depends not only on technological accuracy but also on careful design choices that balance realism, emotional engagement, and cultural authenticity.

4.2 Mixed Reality in Preserving Cultural Heritage

Table 4 Mixed Reality in cultural preservation

Authors	Journal Title	Methodology	Results	Advantages
Dimara Asimina, Psarros Doukas, Vrochidis Alexandros, Papaioannou Alexios, Krinidis Stelios, Anagnostopoulos Christos-Nikolaos (2024)	Mixed reality and 3D modelling role in cultural heritage preservation as a pathway to sustainable heritage and management	This study outlines a qualitative content analysis for MR and 3D modelling applications in cultural heritage preservation. Key aspects include using photogrammetry, LiDAR laser scanning and 3D modelling to improve documentation and public engagement.	The results demonstrate that detailed 3D models and MR visualisations support non-invasive recording, remote access, immersive interpretation, and enhanced public understanding, while also enabling proactive conservation through computer vision and data-driven monitoring of deterioration. The mixed reality application was positively received and culturally appropriate for the Māori community. Participants reported strong alignment with Māori customs and values, particularly in supporting maintaining relationships, face-to-face presence, authority of elders, and sustaining cultural continuity. The system was also considered as a strong tool of passing culture knowledge particularly through oral storytelling and this allows the young generations to be strong in identity and attachment to the past	The integration of Mixed Reality (MR) and 3D modelling significantly improves cultural heritage preservation by enabling highly accurate digital documentation of both terrestrial and underwater artefacts, overcoming limitations of traditional methods in accessibility, detail capture, and engagement.
Park Noel, Regenbrecht Holger, Duncan Stuart, Mills Steven, Lindeman Robert W., Pantidi Nadia, Whaanga Hemi (2022)	Mixed Reality Co-Design for Indigenous Culture Preservation Continuation	The study employed a qualitative, participatory co-design methodology combined with semi-structured interviews. It involved, five Māori participants on-site at the marae and semi-structured interviews (22–36 minutes each) were conducted and audio-recorded. Interview transcripts were analysed using General Inductive Analysis and thematic analysis, following a bottom-up approach to derive themes directly from participants' responses.	Participants reported strong alignment with Māori customs and values, particularly in supporting maintaining relationships, face-to-face presence, authority of elders, and sustaining cultural continuity. The system was also considered as a strong tool of passing culture knowledge particularly through oral storytelling and this allows the young generations to be strong in identity and attachment to the past	The practice also boosts knowledge sharing and continuity of culture by storing stories in an authentic, immersive way where mana is shared by the existence of the esteemed knowledgeable individuals. Mixed reality also serves as a cultural catalyst or calling, as it helps bring together the geographically dispersed or culturally closed, and offers a safe and future-focused media that other generations can connect with.
Idris Muhammad Zaffwan, Mustaffa Norsimaa, Othman Ahmad Nizam, Abdullah	Exploring Principle Components for Digital Heritage	The study adopts a qualitative approach by reviewing existing literature on intangible cultural heritage,	The findings demonstrate that Malay folk dances share common structural	The approach enhances long-term preservation, improves accessibility and

Muhammad Fadhil Wong (2017)	Preservation on Malay Folk Dances	Malay folk dances, and digital preservation technologies.	components while retaining distinct stylistic identities across genres. It demonstrates that movements, music, and costumes could be organised and represented digitally with the help of the necessary technologies.	dissemination, and supports cultural education for younger generations.
Mazian Amir Irfan, Rizhan Wan, Rahim Normala, Jamal Azrul Amri, Ismail Ismahafezi (2023)	A Theoretical Framework for Creating Folk Dance Motion Templates using Motion Capture	The study employs a mixed-methods research, incorporating qualitative technical stages, and interviews with folk dance experts and cultural institutions	The framework shows that, while preserving structural and cultural integrity, motion capture can precisely digitize complex folk-dance movements into reusable motion templates.	The framework preserves intangible cultural heritage by digitally preserving folk dance movements with expert-validated authenticity, enabling cross-platform reuse, supporting standardized teaching and performance, and encouraging cultural sustainability through documentation, copyright protection, broader dissemination, and engagement of younger, tech-savvy audiences. Its detailed structure that brings together disparate research on XR in a concise package specifically designed to suit the cultural heritage industry. By narrowing down the scope of discussion to immersive headset-based solutions, the paper provides a clear illustration of their value added to handheld devices in engagement, immersion and learning.
Innocente Chiara, Ulrich Luca, Moos Sandro, Vezzetti Enrico (2023).	A framework study on the use of immersive XR technologies in the cultural heritage domain	The authors conducted a systematic literature review following PRISMA guidelines. An extensive search was performed across major academic databases (Google Scholar, Scopus, IEEE Xplore, ACM Digital Library, and Wiley Online Library), covering English-language publications from January 2018 to September 2022.	The review concluded that the majority of immersive XR applications in cultural heritage are applied in education, entertainment, and edutainment, with VR as the most popular technology.	

According to the literature reviewed, the application of Mixed Reality (MR) and other immersive technologies has been well accepted as a significant means of preservation and communication of cultural heritage, especially in situations where they are constrained by traditional means. As

highlighted by Dimara et al., (2024), MR and 3D modelling can positively impact the accuracy of documentation, its accessibility, and its engagement with the audience by providing users with the opportunity to engage with a digital reconstruction of a heritage object in more immersive and participatory manners. This is in line with the overall XR framework by Innocente et al., (2023) that identifies that immersive MR systems have the potential to enhance the sense of presence, emotional involvement, and learning results in the context of cultural heritage, which makes them appropriate tools to preserve both tangible and intangible heritage.

Several publications also reflect the significance of cultural sensitivity and community engagement in the implementation of MR to intangible cultural heritage. Park et al. (2022) demonstrate that the practice of MR co-design (that is, created in partnership with indigenous communities) can be effective in supporting cultural continuation, as it can integrate local values, stories, and worldviews into the digital experience. This method is particularly applicable in performance-based traditions, which go beyond the occurrence of a static representation and rather facilitate an experience of learning that embodies lived cultural practices. The findings are relevant to Mak Yong because they indicate that MR applications are supposed to emphasise authenticity, contextual meaning, and community involvement.

Regarding the topic of dance and motion-based heritage, Idris et al., (2017) and Mazian et al., (2023) emphasise that digitisation in terms of motion capture and organised digital systems can help preserve the originality, quality of movement, and cultural codes in traditional dances. These papers justify the assimilation of creative motion design with MR space, where the recorded dance figures can be visualised, explored, and passed to younger generations. Together, the literature indicates that MR, in combination with motion design and culturally informed frameworks, has good potential in the preservation of Mak Yong as intangible cultural heritage by providing continuity, involvement, and relevance of cultural representations.

4.3 Others

Table 5 Others

Authors	Journal Title	Methodology	Results	Advantages
Lampropoulos Georgios (2025)	Combining artificial intelligence with augmented reality and virtual reality in education: Current trends and future perspectives	The study adopts a systematic literature review following PRISMA guidelines to ensure transparency and reproducibility. A total of 201 relevant documents published between 2015 and 2024 were systematically selected from Scopus and Web of Science using a broad, carefully constructed keyword query covering AI, AR, VR, XR, and education.	Virtual reality combined with AI has been more extensively researched than augmented reality, particularly in higher education and medical or healthcare training contexts.	By combining systematic literature review with scientific mapping and topic modelling, it provides researchers, educators, and policymakers with a structured foundation for understanding how AI-enhanced AR and VR can support personalized, immersive, and interactive learning across educational contexts.
Yusnita bt Yusof (2024)	The Impact of Artificial Intelligence in Managing Intangible Cultural Heritage in Malaysia: A Review	The study adopts a mixed-methods approach, involving analyses on studies involving AI-driven heritage initiatives, and interviews with ICH practitioners, heritage institutions, AI researchers, and policymakers in Malaysia.	The findings indicate a growing adoption of AI technologies such as machine learning, natural language processing, and virtual reality in Malaysian ICH management, was found to significantly improve efficiency, accuracy, and accessibility of cultural data, including the transcription of oral traditions and analysis of traditional music and dance.	The presence of voices of stakeholders makes the study more practical to the policy makers and heritage practitioners. The paper also contributes to critical discourse by not only bringing out the advantages of AI, but also clearly outlining its drawbacks and ethical dangers, thus facilitating a responsible, inclusive, and sustainable attitude towards AI-driven ICH management.

Artificial intelligence (AI) is a significant contributor to the improvement of mixed reality (MR) application as it allows creating immersive, interactive, and personalised experiences. (Lampropoulos, 2025) reviews the integration of AI with extended reality technologies, including virtual reality, augmented reality, and mixed reality, especially in learning. Though the research does not identify intangible cultural heritage as the direct object of study, the findings can be applied to Mak Yong preservation because they emphasise how AI-based systems can facilitate embodied learning, engagement, and immersion. These characteristics are close to the performative and movement-oriented character of Mak Yong, which presupposes that AI can be used to complement MR-based creative motion design applications to promote the experiential learning of traditional performances.

Comparatively, Yusof, Y., (2024) specifically analyses how AI can be used to manage and conserve intangible cultural heritage in Malaysia, such as traditional performing arts. According to the authors, AI technologies, including machine learning, natural language processing, and AI-driven AR and VR applications, are useful in recording and distributing complex cultural manifestations, including dance movements and oral stories. This applies especially to Mak Yong that is based on oral tradition and embodied performance. The research also mentions the possibilities of immersive technologies in assisting cultural education and the transfer of knowledge between generations.

Nevertheless, Yusof, Y., (2024) focus on ethical and sociocultural issues, such as consent issues, cultural misrepresentation, and marginalisation of traditional practitioners. Both studies together confirm that AI should be included as one of the central themes in this systematic literature review. Lampropoulos (2025) offers an underlying technological basis to AI-enhanced MR systems, whilst Yusof, Y., (2024) contextualises AI in the Malaysian practises of intangible cultural heritage, and thus the importance of culturally sensitive and ethically informed AI-driven mixed reality applications to preserve Mak Yong.

5 DISCUSSIONS

This systematic review indicates that MR and associated immersive technologies have great potential in sustaining Mak Yong as an intangible cultural heritage especially with creative motion design. The analysed papers all suggest that MR-based methodologies such as motion capture, facial animation, and immersive environments are more efficient than traditional documentation techniques in reflecting the embodied, performative, and expressive features of traditional performances. These technologies make cultural representation more dynamic that facilitates engagement, learning, and accessibility, particularly to younger and geographically remote audiences.

The results further imply that MR can be best implemented as a supplementary preservation instrument and not as an alternative to live Mak Yong performances. Immersive platforms such as the metaverse enhances cultural awareness and provides broad access to outside audiences; however, it still faces limitations in conveying the spiritual, emotional, and ritual dimensions of Mak Yong, particularly the sense of presence and performer–audience interaction. Technical constraints, including motion tracking accuracy and the risk of the uncanny valley, further highlight the need for careful design decisions that balance realism with cultural authenticity.

The participation and co-design process make sure that digital representations are done with consideration of the cultural values, authority of the practitioner, and their ethical concerns. Additional opportunities of personalised and embodied learning by the inclusion of artificial intelligence in the MR systems can be realised, but the issues concerning consent, cultural misrepresentation, and marginalisation of traditional practitioners should be resolved.

CONCLUSION

In conclusion, Mak Yong's preservation, promotion and conservation is effective when using MR-based creative motion design. By integrating immersive technologies with cultural frameworks, MR can significantly contribute to the preservation of this performative tradition. Besides laying down the groundwork for future studies and practices, this study also fills the research gap in Southeast Asian ICH that aims to create MR preservation strategies that are inclusive, sustainable, and culturally authentic.

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CONFLICT OF INTEREST

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