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Multisensory Immersive Exhibition Framework For The Preservation Of Indonesian Local Culture

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Abstract

The digital revolution of cultural displays has changed the way we preserve and present culture from static visual presentation to immersive and experience cultural engagement. Most studies of immersive cultural exhibitions, however, are technology centric and do not provide a holistic experiential framework that fully integrates multimodal interaction, emotional engagement, and cultural immersion. The purpose of this study is to establish a Multisensory Immersive Exhibition Framework for preserving local culture in Indonesia by merging sensory stimulation, emotional engagement, cultural narrative, and immersive spatial experience. The study adopted an Iterative Design-Based Framework Research (DBFR) approach using a qualitative-dominant mixed-method design, which included systematic literature mapping, emotional-sensory culture exploration, immersive prototype construction, user immersion evaluation, and expert validation. The findings suggest that the impact of multisensory interaction is considerable on emotional engagement, sensory immersion and cultural presence in immersive exhibition settings. The iterative refinement process also showed that the combination of tactile contact, immersive audio, synchronized visual projection, and experiential storytelling led to greater emotional-cultural attachment and meaningful visitor experience. The framework consists of four interconnected dimensions: sensory stimulation, emotional engagement, immersive spatial experience, and cultural narrative, which together contribute to experiencing cultural preservation. This current research contributes to the theories of immersive cultural exhibition and multisensory interaction by proposing an integrated experiential framework based on the setting of Indonesian local culture. Practically, the framework gives strategic guidance to exhibition designers, museums, and cultural institutions on how to build more human-centered, emotionally engaging, and experiencing cultural exhibition environments.

Keywords: Immersive cultural exhibition, Multisensory interaction, Emotional engagement,

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Cultural immersion, Digital heritage preservation

INTRODUCTION

Digital transformation in the fields of exhibition and cultural heritage has shifted the paradigm of cultural presentation from a static approach to a more immersive, interactive, and multisensory experience. Technological developments such as virtual reality (VR), augmented reality (AR), mixed reality (MR), and the metaverse have enabled the creation of a digital cultural environment that can deepen visitors' connection with cultural heritage through a more participatory and experiential experience. Various studies show that virtual heritage and immersive environments contribute to increased cultural learning, visitor engagement, and experiential interaction through collaborative interaction and multimodal immersion[1]. In addition, the implementation of panoramic virtual tours for cross-cultural learning, the use of augmented reality to preserve Wayang culture, and the development of virtual museums and digital heritage environments based on immersive storytelling further demonstrate the shift of cultural exhibitions toward a more dynamic and interactive cultural experience[2]. These developments show that digital technology no longer functions only as a medium for cultural documentation but also as a medium for experiential cultural communication that can build an emotional connection between visitors and cultural heritage. In line with these developments, museums and exhibitions of contemporary culture have also transformed toward more participatory and human-centered cultural spaces. Previous studies have shown that digital museums and immersive exhibition environments can increase visitor participation through virtual exhibitions, interactive communication, immersive storytelling, and embodied interaction[3]. The multisensory interaction approach is also increasingly seen as important because it can enhance engagement, immersion, and experiential retention in interactive

[1] Mafkereseb Kassahun Bekele and Erik Champion, "A Comparison of Immersive Realities and Interaction Methods: Cultural Learning in Virtual Heritage," *Frontiers in Robotics and AI* 6 (2019): 91, https://doi.org/10.3389/frobt.2019.00091.

[2] Dwi Ayu Shofiana et al., "Cultural Immersion in the Digital Age : Developing " Chinese Cultural Wonders " Virtual Tour for Cross-Cultural Understanding" 02, no. 03 (2025): 130–44, https://doi.org/10.63011/ip.v2i2.38; A Hermawan et al., "Systematic Review of Augmented Reality Applications in Wayang Heritage Preservation," *Journal of Information Systems and Informatics* 7, no. 2 (2025): 1145–62, https://doi.org/10.51519/journalisi.v7i2.959.

[3] E L Hasanah et al., "Heritage Yang Terlupakan: Analisis Tantangan Museum Warisan Budaya Di Era Museum Interaktif Dan Digital (Studi Kasus Di Museum Sri Baduga Bandung Jawa Barat)," *Nazharat: Jurnal Kebudayaan* 31, no. 1 (2025): 42–56, https://doi.org/10.30631/nazharat.v31i1.197.

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learning and exhibition environments[4]. In the context of immersive environments, Walterová emphasizes that multisensory environmental experience and embodied interaction contribute to the formation of emotional atmosphere and experiential restoration, while Gkintoni indicates that immersive and multimodal learning can enhance emotional engagement, neuroplasticity, and cultural learning[5]. In addition, Hochman emphasizes that emotional attachment and cultural experiences are influenced by social context and culturally embedded experiences through the Sociocultural Architecture Model of Willful Ignorance (SAMWI)[6]. Thus, immersive cultural exhibitions are concerned not only with the use of visual-interactive technology but also with how emotional experiences, sensory atmospheres, and cultural engagement are holistically constructed within the exhibition environment.

Although the development of immersive technology in cultural heritage has made significant progress, most previous research still shows conceptual and methodological fragmentation. Many studies have focused partially on virtual heritage, immersive technology, digital museums, or multisensory interactions without integrating the relationship between multisensory immersion, emotional engagement, and cultural preservation into a single, cohesive framework. Most immersive experiences developed are still dominated by visual-auditory interaction and have not explored embodied multisensory cultural immersion in the context of cultural exhibitions. Previous studies have generally emphasized technological implementation rather than the development of deep emotional-cultural experiences. In fact, emotional engagement plays an important role in building experiential meaning and cultural attachment in human-computer interaction and exhibition design[7]. Wang also emphasized that immersive technology and gamification have great potential to enhance visitor engagement and cultural understanding, but their implementation still faces methodological limitations and is not

[4] Yijun Fan, Daphne Khee Chong, and Yuanzhe Li, "Beyond Play: A Comparative Study of Multi-Sensory and Traditional Toys in Child Education," *Frontiers in Education* 9, no. March (2024): 1–11, https://doi.org/10.3389/feduc.2024.1182660.

[5] H Walterová, T Vylita, and S Huseynli, "Toward a Multisensory Evidence-Based Framework for Healing Environments," *International Journal of Biometeorology* 70, no. 3 (2026): 455–72, https://doi.org/10.1007/s00484-025-02844-1; Evgenia Gkintoni, Stephanos P. Vassilopoulos, and Georgios Nikolaou, "Brain-Inspired Multisensory Learning: A Systematic Review of Neuroplasticity and Cognitive Outcomes in Adult Multicultural and Second Language Acquisition," *Biomimetics* 10, no. 6 (2025), https://doi.org/10.3390/biomimetics10060397.

[6] G. Hochman et al., "Choosing Not to Know: The Emotional and Sociocultural Architecture of Pension Willful Ignorance," *Current Opinion in Psychology* 67, no. September 2025 (2026): 102181, https://doi.org/10.1016/j.copsyc.2025.102181.

[7] Wei Zhang, "Virtual Museum Scene Design Based on VRAR Realistic Interaction under PMC Artificial Intelligence Model," *Applied Mathematics and Nonlinear Sciences* 0, no. 0 (2023), https://doi.org/10.2478/amns.2023.1.00200.

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yet supported by a comprehensively structured framework[8]. This condition indicates that the development of immersive exhibitions still requires an approach capable of simultaneously integrating sensory coherence, emotional resonance, cultural storytelling, and experiential immersion.

These limitations become increasingly relevant in the context of preserving local Indonesian culture in the digital era. Most representations of local Indonesian culture are still oriented towards an informative-descriptive approach and digital documentation, thus not yet able to provide an emotional and immersive cultural experience for the contemporary digital generation. In fact, previous research shows that immersive media has the ability to build emotional geography, empathy, and affective engagement through deep sensory and narrative experiences[9]. Interactive storytelling dan projection mapping juga menunjukkan potensi dalam menghubungkan elemen budaya tangible dan intangible melalui pengalaman naratif yang lebih partisipatif[10]. In addition, the approach of digital fabrication and computational museology shows that digital technology can revitalize intangible cultural heritage through more innovative and experiential forms of interaction[11]. However, these approaches have yet to produce an immersive exhibition framework specifically designed to build multisensory-emotional cultural immersion in the context of local Indonesian culture.

Several studies have developed immersive exhibitions using VR and AR to enhance the experience of museum visitors and in cultural heritage environments. DreamVR, for example, explores interactive exhibitions in virtual reality environments with a focus on visual and auditory interaction (He et al., 2023), while CubeMuseum leverages AR to support embodied interaction with virtual museum objects[12]. Ch'ng also develops social AR applications to enhance

[8] Hanbing Wang et al., "Grand Challenges on Immersive Technologies for Cultural Heritage," 2024, https://doi.org/10.48550/arxiv.2412.02853.
[9] António Baía Reis, "Immersive Media and Social Change: The 'Empathy Machine' Is Dead, Long Live 'Emotional Geography'!," *Anàlisi: Quaderns de Comunicació i Cultura* 68 (2023): 135–54, https://doi.org/10.5565/rev/analisi.3539.
[10] Vasiliki Nikolakopoulou et al., "Conveying Intangible Cultural Heritage in Museums with Interactive Storytelling and Projection Mapping: The Case of the Mastic Villages," *Heritage* 5, no. 2 (2022): 1024–49, https://doi.org/10.3390/heritage5020056.
[11] Guanhong Liu et al., "Digital Making for Inheritance and Enlivening Intangible Cultural Heritage: A Case of Hairy Monkey Handicrafts," *International Conference on Human Factors in Computing Systems*, 2023, https://doi.org/10.1145/3544548.3581539; Sarah Kenderdine, Lily Hibberd, and Jeffrey Shaw, "Radical Intangibles: Materializing the Ephemeral," *Museum and Society* 19, no. 2 (2021): 252–72, https://doi.org/10.29311/MAS.V19I2.3638.
[12] Qing-ling He, Ray Lc, and Xin Tong, "DreamVR: Curating an Interactive Exhibition in Social VR Through an Autobiographical Design Study," *International Conference on Human Factors in Computing Systems*, 2023, https://doi.org/10.1145/3544548.3581362; Sining Li, "The Co-Evolution of Museum User Experience and

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social communication during cultural heritage experiences, while SensiMar integrates visual, audio, and olfactory interaction elements within the context of maritime heritage experiences[13]

However, these approaches remain fragmented because they have not integrated emotional engagement, sensory coherence, immersive storytelling, and cultural embodiment into a holistic experiential framework. Thus, there remains a research gap in the form of an immersive exhibition framework based on multisensory-emotional interaction, specifically designed to present an authentic, emotional, and immersive Indonesian local cultural experience.

Based on this research gap, this research offers novelty by developing a Multisensory Immersive Exhibition Framework for the preservation of local Indonesian culture that integrates multisensory interaction, emotional engagement, immersive spatial experience, and cultural storytelling into a single experiential cultural immersion model based on Iterative Design-Based Framework Research (DBFR). In contrast to previous research that tended to be oriented toward technology or visual immersion alone, this study positions emotional-cultural immersion and embodied multisensory experience as the core of immersive exhibition design. The developed framework also shifts the paradigm of cultural preservation from mere passive digital documentation to preservation-through-experience through participatory, emotional, and multisensory cultural experiences. This approach is supported by various studies showing that immersive storytelling, spatial interaction, and multisensory stimulation can increase user engagement in the exhibition environment. Doonan emphasized that immersive VR experiences can create phenomenological experiences that strengthen visitors' awareness of the cultural environment[14]. Park also shows that immersive displays can enhance visitor satisfaction through more dynamic and interactive experiences[15]. In addition, the concept of spatial dialogue in local museums shows that spatial engagement plays an important role in building cultural sustainability and community involvement[16]. The concept of radical intangibles introduced by

Technology: A Systematic Literature Review," *AHFE International* 199 (2025), https://doi.org/10.54941/ahfe1006858.

[13] Anabela Marto et al., "Development and Evaluation of an Outdoor Multisensory AR System for Cultural Heritage," *IEEE Access* 9 (2021): 16419–34, https://doi.org/10.1109/ACCESS.2021.3050974; Eugene Ch'ng et al., "Social Augmented Reality: Communicating Via Cultural Heritage," *Journal on Computing and Cultural Heritage*, 2023, https://doi.org/10.1145/3582266.

[14] Natalie Doonan, "Expanding the Magic Circle: Immersive Storytelling That Trains Environmental Perception," *Convergence*, 2023, https://doi.org/10.1177/13548565231178917.

[15] Jihye Park et al., "Do Immersive Displays Influence Exhibition Attendees' Satisfaction?: A Stimulus-Organism-Response Approach," *Sustainability* 14, no. 10 (2022): 6344, https://doi.org/10.3390/su14106344.

[16] Nuttinee Karnchanaporn and Chanida Lumthaweepaisal, "Spatial Dialogues between Exhibited Interiors and Cultural Exteriors: How Local Museums Connect to the Community," *Interiority* 6, no. 1 (2023), https://doi.org/10.7454/in.v6i1.258.

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Kenderdine further underscores the importance of integrating digital materiality, cultural storytelling, and experiential interaction in contemporary cultural transmission. Therefore, this research seeks to build a more human-centered, experiential, and culturally embedded approach to cultural exhibition by integrating sensory, emotional, and spatial elements within an immersive cultural environment[17].

Building on this background, this research aims to design, develop, and validate the Multisensory Immersive Exhibition Framework, which uses multisensory interaction and emotional engagement to enhance cultural presence and immersive experience in the preservation of local Indonesian culture. This study adopts an Iterative Design-Based Framework Research (DBFR) approach, enabling the framework's development to proceed iteratively through literature mapping, emotional-sensory cultural exploration, prototype development, user immersion evaluation, and expert validation. This approach was chosen because it integrates user experience, experiential immersion, and framework refinement in a sustainable manner, producing an immersive exhibition framework that is more adaptive and human-centered. Theoretically, this research is expected to contribute to the development of immersive cultural exhibitions, multisensory interaction, and experiential heritage preservation studies by introducing conceptual relationships among sensory stimulation, emotional engagement, immersive spatial experience, and cultural preservation within a single integrated experiential framework. Practically, the resulting framework is expected to serve as a strategic reference for exhibition designers, museums, cultural institutions, and immersive media developers in designing cultural exhibitions that are more participatory, emotional, and relevant to the needs of cultural preservation in the digital era.

RESEARCH METHODS

The research method contains the research specifications, type of research, approach method, data collection techniques, and data analysis methods used in the study. The research method is written descriptively and is presented in one paragraph.

1 Research Design

This study uses an Iterative Design-Based Framework Research (DBFR) approach with a mixed-methods orientation, dominated by qualitative methods. The selection of this design is based on research objectives that not only explore the phenomenon of immersive cultural exhibition but also develop, evaluate, and refine the multisensory cultural immersion framework through an iterative experiential validation process. This research integrates framework

[17] Kenderdine, Hibberd, and Shaw, "Radical Intangibles: Materializing the Ephemeral."

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development, immersive exhibition prototype design, user experience evaluation, and expert validation into one continuous development cycle. The DBFR approach was chosen because the research focuses on a design process that is human-centered and experience-oriented. The framework is developed through an iterative cycle involving prototype development, user immersion evaluation, and refinement based on the results of expert evaluation and validation. This approach allows the research to produce a framework that is not only conceptually strong but also experientially relevant and applicable in the context of preserving Indonesia's local culture. Overall, the research consists of eight iterative phases, starting with problem and literature exploration, emotional-sensory culture mapping, initial framework construction, prototype development, user immersion evaluation, prototype refinement, and ending with expert validation and final framework synthesis. The entire research process is directed toward building a relationship among multisensory stimulation, emotional engagement, immersive experience, and cultural preservation.

2 Systematic Literature Mapping

The initial stage of the research was conducted through systematic literature mapping to identify developments in immersive exhibition, multisensory interaction, emotional engagement, cultural immersion, and exhibition experience design. This stage aims to establish the state of the art, identify research gaps, and lay the conceptual foundation for the framework developed in the research. Literature data were obtained from Google Scholar, Scopus, DOAJ, and the Garuda databases. The selected articles are limited to peer-reviewed journal publications in English and Indonesian from 2019–2026. The inclusion criteria focus on research related to immersive media, multisensory experience, virtual heritage, museum interaction, and cultural exhibition design. Literature analysis was conducted using comparative thematic mapping to identify dominant patterns and conceptual relationships across previous studies. The analysis focused on immersion strategies, sensory interaction patterns, emotional engagement mechanisms, and cultural storytelling approaches. The results of this stage serve as the basis for preparing the research gap matrix and developing the initial research framework.

3 Emotional-Sensory Cultural Mapping

The second phase of the research focused on emotional-sensory cultural mapping to identify cultural elements, sensory stimuli, and emotional triggers capable of building an immersive cultural experience. The study concentrated on one of Indonesia's local cultures that has a strong performative and multisensory character, such as Saman Dance, Kecak Dance, or Tor-Tor Dance. Data collection was conducted through cultural observation, semi-structured interviews, audiovisual documentation, and analysis of cultural artifacts. Observation was used to identify

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performative elements, cultural atmosphere, and sensory experiences that emerge during cultural practices. Meanwhile, interviews were conducted to explore emotional memories, sensory impressions, cultural atmosphere, and the potential immersive experiences felt by participants.

Table 1. Informants and Data Mining Focus

Informant	Excavation Focus
Cultural experts	Cultural authenticity and significance
Cultural actors	Emotional and performative experiences
Cultural curator	Cultural representation and storytelling
Desainer exhibition	Potensi immersive exhibition

The data obtained were analyzed using thematic coding analysis through the stages of open coding, axial coding, and selective coding. This analysis resulted in an Emotional-Sensory Cultural Matrix that maps the relationship between the sensory layer and emotional responses in the experience.

4 Iterative Prototype Development

The next stage is the development of a prototype immersive exhibition based on multisensory interaction, emotional engagement, and cultural immersion. Prototypes serve as an experiential representation of the conceptual framework developed in the previous stage. The prototype integrates elements of the exhibition storyboard, spatial layout, visual projection, audio immersion, and tactile interaction to build an immersive, multisensory cultural environment. The design process uses an experience-centered approach with an emphasis on emotional flow, sensory sequencing, spatial immersion, and cultural authenticity. Prototype development is done iteratively through initial prototype development cycles, user experience evaluation, design refinement, and redevelopment. This iterative approach allows for gradual improvement in the quality of the immersive exhibition experience during the research process.

5 User Immersion Evaluation

User immersion evaluation was conducted to measure emotional engagement, sensory immersion, cultural presence, and the visitor experience generated by the immersive exhibition prototype. The research participants consisted of students, general visitors, and cultural communities, totaling approximately 25–40 participants. The evaluation process used a combination of observation, walkthrough testing, questionnaires, and interviews. Observation and walkthrough testing were used to identify participants' immersion behaviors and interaction patterns during the exhibition experience. Meanwhile, interviews were conducted to explore

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participants' emotional responses and cultural experiences. The questionnaire employed a five-point Likert scale to evaluate the immersion variables, including emotional engagement, sensory immersion, and cultural presence.

Tabel 2. Variabel Evaluasi Pengalaman Immersion

Variable	Evaluation Focus
Emotional engagement	Emotional and cultural connectedness
Sensory immersion	Depth of multisensory experience
Cultural presence	Perception of authenticity and cultural atmosphere

Qualitative data were analyzed using *thematic analysis* and interpretation of emotional responses, while quantitative data were analyzed descriptively through average scores, percentages, and comparison of immersion scores between prototype iterations.

6 Expert Validation and Refinement Framework

The final stage of the research focuses on expert validation and refinement of the framework to ensure its conceptual validity, immersion quality, cultural authenticity, and feasibility of implementation. Validation involves experts in exhibition design, user experience, cultural studies, and immersive media. The validation process evaluates immersion quality, coherence of multisensory interaction, cultural representation, and the potential for implementing the immersive exhibition framework. Feedback from validators is analyzed using comparative refinement analysis to identify weaknesses in the framework and determine aspects that need improvement. The integration of user immersion evaluation results and expert validation resulted in a final framework in the form of a Multisensory Cultural Immersion Framework for the preservation of Indonesian local culture based on immersive exhibitions.

7 Data Analysis

This study uses several data analysis approaches to accommodate the multidimensional character of the immersive cultural exhibition experience. Thematic analysis is used to analyze interview, observation, and emotional response data to identify themes of experience related to sensory interaction and cultural immersion. In addition, comparative experience analysis is used to compare conventional exhibition experiences and immersive exhibitions across the aspects of emotional engagement, sensory richness, and cultural presence. Descriptive statistical analysis was used to evaluate immersion, engagement, and sensory richness scores obtained from participants' questionnaires. The final stage of analysis was carried out using a synthesis analysis framework to integrate qualitative and quantitative findings into the final framework of multisensory cultural immersion and sensory-emotional interaction relationship

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models.

RESULTS OF RESEARCH AND DISCUSSION

1 Overview of Research Results

This research resulted in a Multisensory Immersive Exhibition Framework designed to support the preservation of local Indonesian culture through an immersive exhibition experience grounded in emotional engagement. The framework was developed through the Iterative Design-Based Framework Research (DBFR) process, which integrates systematic literature mapping, emotional-sensory cultural exploration, immersive prototype development, user immersion evaluation, and expert validation. The results of the study show that integrating multisensory interaction, emotional engagement, cultural storytelling, and immersive spatial experience can create a more participatory and experiential cultural exhibition environment.

2 Research Gap Mapping and Conceptual Synthesis

The systematic literature mapping process identifies several dominant trends in the study of immersive cultural exhibitions, particularly in virtual heritage, multisensory interaction, immersive learning, and digital museum transformation. Previous studies have generally shown an increase in the use of immersive technology to support visitor interaction and cultural learning experiences. However, the analysis also reveals conceptual fragmentation among multisensory immersion, emotional engagement, and cultural preservation. Most previous research has focused on visual-auditory interaction and technology implementation, while emotional-cultural immersion and embodied multisensory experiences have not been comprehensively developed. In addition, previous studies have generally used a linear development approach without integrating iterative refinement of user-centered frameworks. The results of comparative thematic mapping produced four main conceptual domains that form the basis for the development of this research framework.

Table 3. Conceptual Mapping of Previous Research

Conceptual Domains	Dominant Focus of Previous Research	Identified Limitations
Immersive technology	VR, AR, virtual tour	Technology-oriented
Multisensory interaction	Interaksi visual dan audio	Minim embodied sensory integration
Emotional engagement	Visitor engagement	Emotional-cultural immersion is still limited

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Cultural preservation	Digital documentation	Cultural representation is still passive

The synthesis process then produces an initial conceptual structure that integrates sensory stimulation, emotional engagement, cultural storytelling, and immersive exhibition experience into a cohesive experiential framework.

3 Result Emotional-Sensory Cultural Mapping

The emotional-sensory cultural mapping stage identifies the sensory and emotional dimensions present in Indonesian local cultural performances. The study shows that cultural immersion is strongly shaped by the interplay among sensory atmosphere, performative movement, ritual soundscape, spatial configuration, and collective emotional perception. Observations and interviews indicate that ritual music, synchronized body movement, dynamic lighting, and tactile cultural materials consistently elicit emotional responses, including a sense of sacredness, intimacy, admiration, and cultural attachment. Participants also emphasized that multisensory exposure enhances perceptions of cultural presence and experiential authenticity.

Table 4. Results of Emotional-Sensory Cultural Mapping

Sensory Components	Cultural Representation	Dominant Emotional Response
Ritual soundscape	Traditional music and chanting	Atmosphere sacral
Synchronized movement	Traditional collective dance movements	Admiration and emotional intensity
Spatial lighting	Composition of low and focused lighting	Intimacy and immersion
Tactile material	Traditional textures and fabrics	Cultural attachment
Environmental aroma	Aroma of ritual and incense	Authentic atmospheric

The thematic coding analysis further identifies four dominant immersion dimensions that emerge from the cultural mapping process.

Table 5. The Dominant Dimension of Cultural Immersion

Dimensi Immersion	Features
Emotional immersion	Emotional resonance and empathy
Sensory immersion	Environmental multisensory engagement

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Spatial immersion	Perceived environmental presence
Cultural immersion	Cultural authenticity dan embodiment

These findings show that immersive cultural experiences are not only built through digital visualization, but through the integration of sensory atmosphere, emotional triggers, and embodied cultural interactions.

4 Immersive Multisensory Exhibition Prototype Development

Based on conceptual synthesis and cultural mapping findings, this study developed a semi-functional immersive exhibition prototype that integrates multisensory interaction with emotional and cultural immersion. The prototype was designed using an experience-centered approach that emphasizes emotional flow, sensory sequencing, cultural storytelling, and immersive spatial navigation. The prototype exhibition comprises several integrated components, including an exhibition storyboard structure, spatial layout configuration, visual projection system, immersive audio environment, and tactile interaction zones.

Tabel 6. Immersive Exhibition Prototype

Prototype Component	Function
Exhibition storyboard	Organizing the emotional journey of visitors
Spatial layout	Building Immersive Flow
Visual projection	Strengthening the cultural atmosphere
Audio immersion	Supports an emotional-cultural atmosphere
Tactile interaction	Increase tangible cultural engagement

The prototype development process is carried out iteratively through two main refinement cycles involving user immersion evaluation and design improvement.

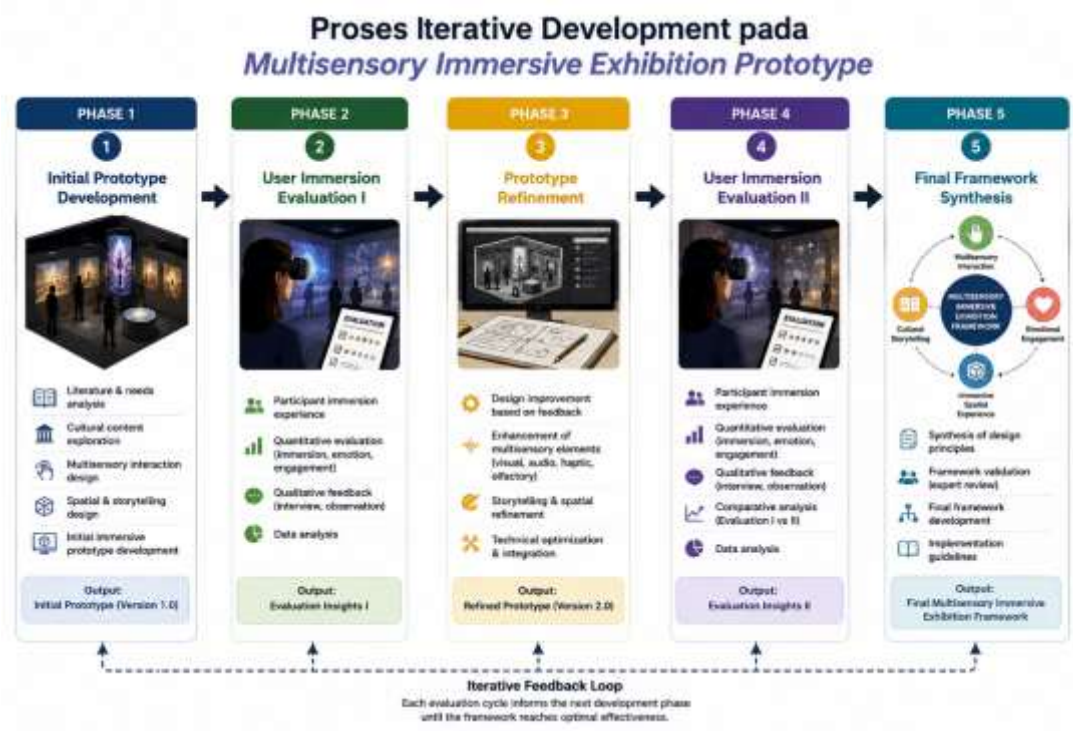
Figure 1. Iterative Development Process on Multisensory Immersive Exhibition Prototype

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The first prototype primarily emphasizes visual and auditory immersion. The evaluation of the initial iteration showed that users experienced high visual engagement, but tactile and environmental immersion remained relatively limited. Based on these findings, the second prototype integrates tactile interaction zones, enhanced environmental sound layering, and improved sensory sequencing to create a more coherent multisensory experience. The refinement process also improves emotional flow continuity by reorganizing the exhibition narrative structure from informational sequencing to experiential storytelling sequences that emphasize an emotional-cultural progression.

5 User Immersion Evaluation Results

User immersion evaluation assesses emotional engagement, sensory immersion, and cultural presence generated by immersive exhibition prototypes. Observations showed that participants had longer interaction durations, more focused sensory attention, and stronger emotional responses when interacting with immersive exhibitions compared with conventional exhibition interaction patterns. Walkthrough testing showed that multisensory interaction significantly contributed to the perception of "being inside" a cultural environment. Participants reported that immersive soundscapes, synchronized visual projections, and tactile cultural materials increased experiential realism and emotional attachment to cultural content.

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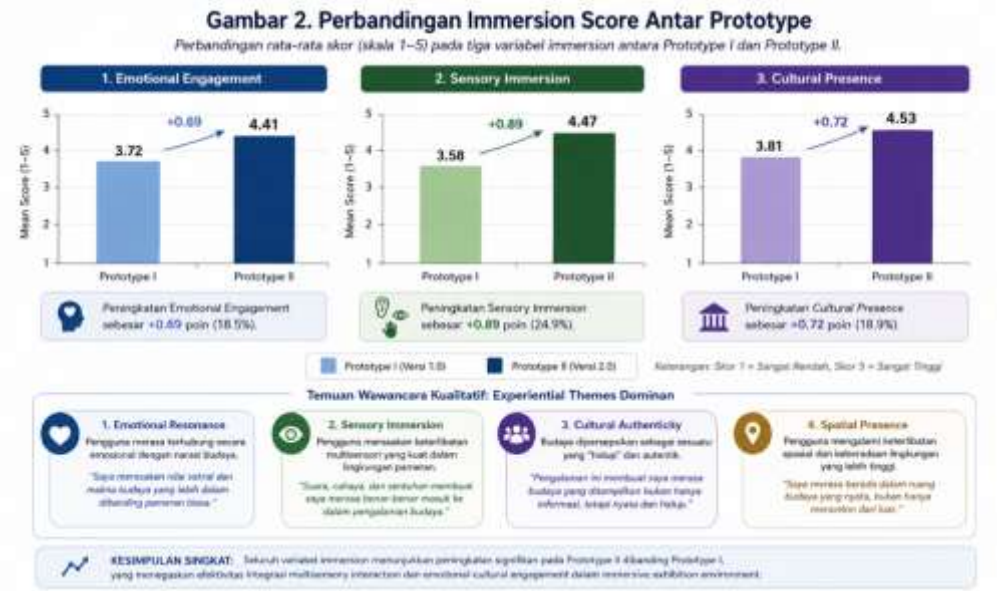
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Quantitative descriptive analysis showed an increase in the overall immersion variable between the first and second iterations of the prototype.

Tabel 7. Immersion Comparation Immersion Evaluation Results

Variable Evaluation	Mean Score Prototype I	Mean Score Prototype II
Emotional engagement	3.72	4.41
Sensory immersion	3.58	4.47
Cultural presence	3.81	4.53

The sil indicates that the refinement process significantly contributes to the improvement of emotional-cultural immersion and multisensory coherence.



Tabel 8. Dominant User Experience Themes

Dominan Theme	User Experience Description
Emotional resonance	Users feel emotionally connected to cultural narratives
Sensory immersion	Users feel a strong immersion environment
Cultural authenticity	Culture is perceived as something "living" and experiential
Spatial presence	Users experience higher environmental engagement

Participants consistently describe the immersive exhibition environment as a more emotional and meaningful cultural experience compared to conventional exhibitions.

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6 Expert Validation dan Framework Refinement

The expert validation stage was conducted to evaluate the framework's conceptual quality, sensory coherence, cultural authenticity, and practical feasibility, as well as the developed immersive exhibition prototype. Validation involved experts in exhibition design, immersive media, user experience, and cultural studies. The results show that the framework successfully integrates multisensory interaction, emotional engagement, and cultural storytelling into a coherent immersive exhibition structure.

Tabel 9. Expert Validation Results

Validation Aspects	Evaluation Results
Immersion quality	High
Sensory coherence	High
Cultural authenticity	High
Practical feasibility	Medium to high

Several recommendations emerged during the validation process, particularly those focused on improving the adaptive interaction system, expanding the tactile sensory zone, and optimizing visitor flow management in immersive exhibition spaces. The refinement process then integrates expert feedback into the final framework structure to produce a Final Validated Multisensory Immersive Exhibition Framework for the preservation of local Indonesian culture.

7 Final Framework Synthesis

The final framework synthesis integrates all findings obtained from literature mapping, emotional-sensory cultural exploration, prototype development, user immersion evaluation, and expert validation into an integrated experiential exhibition framework. The final framework consists of four main interconnected dimensions, namely sensory stimulation, emotional engagement, immersive spatial experience, and cultural storytelling. These four dimensions collectively support the formation of an immersive cultural environment that is able to increase cultural presence and emotional attachment.

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Gambar 3. Final Multisensory Immersive Exhibition Framework

Framework ini menggambarkan alur keterkaitan lima dimensi utama yang membentuk pengalaman budaya imersif dan mendukung pelestarian budaya.



THE FINAL FRAMEWORK SHOWS THAT THE PRESERVATION OF IMMERSIVE CULTURE CAN BE STRENGTHENED THROUGH EXPERIENTIAL EXHIBITION ENVIRONMENTS THAT EMPHASIZE MULTISENSORY INTERACTION, EMOTIONAL RESONANCE, AND EMBODIED CULTURAL ENGAGEMENT, RATHER THAN RELYING SOLELY ON DIGITAL DOCUMENTATION OR PASSIVE VISUAL PRESENTATIONS.

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DISCUSSION

The findings of this study show that integrating multisensory interaction, emotional engagement, and immersive spatial experience significantly strengthens cultural presence in an immersive exhibition environment. Compared to conventional exhibition approaches that generally rely on visual presentation and passive information, the framework developed in this study emphasizes embodied and experiential cultural interaction that can produce a deeper emotional attachment to culture among visitors. These findings suggest that the preservation of immersive culture is no longer limited to digital documentation or static representation but is beginning to shift toward a preservation-through-experience approach, which is cultural preservation through participatory multisensory and emotional experiences. These results are in line with previous research that emphasizes the importance of immersive interaction and experiential engagement in virtual heritage and cultural learning environments.[18]

The results of emotional-sensory cultural mapping also show that immersive cultural experiences are formed through the simultaneous interaction of sensory stimuli, performative atmosphere, embodied movement, and emotional resonance. Soundscape rituals, synchronized body movements, environmental lighting, and tactile cultural materials consistently evoke emotional responses such as a sense of sacredness, intimacy, awe, and cultural attachment.These findings reinforce the argument that cultural immersion is fundamentally multisensory and embodied, not just visual or informational. In an immersive environment, emotional engagement arises not only through cognitive understanding but also through sensory experiences and atmospheric interactions[19]. This phenomenon is in line with the embodied cognition theory, which states that human emotional understanding and perception are closely related to bodily and sensory experiences within the spatial environment[20].

Research findings also indicate that experiences in multisensory interaction-based exhibitions significantly contribute to increased emotional engagement and sensory immersion among visitors. Participants reported stronger emotional resonance, deeper environmental presence, and higher perceptions of cultural authenticity after interacting with the refined immersive exhibition prototype. The increase in scores for emotional engagement, sensory

[18] Bekele and Champion, "A Comparison of Immersive Realities and Interaction Methods: Cultural Learning in Virtual Heritage"; Erik Champion, *Critical Gaming: Interactive History and Virtual Heritage* (Routledge, 2015), https://doi.org/10.4324/9781315405300.

[19] Walterová, Vylita, and Huseynli, "Toward a Multisensory Evidence-Based Framework for Healing Environments."

[20] Mina C Johnson-Glenberg et al., "Collaborative Embodied Learning in Mixed Reality Motion-Capture Environments: Two Science Studies," *Journal of Educational Psychology* 106, no. 1 (2014): 86–104, https://doi.org/10.1037/a0034008.

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immersion, and cultural presence between the first and second prototypes highlights the importance of sensory coherence in immersive cultural environments. These results support previous studies stating that multisensory interaction can enhance engagement, immersion, memory retention, and experiential learning in both educational and cultural interactive environments.[21]

Additionally, this finding shows that immersive cultural environments not only convey information but also function as an emotional-cultural ecosystem that creates more meaningful cultural experiences. This research also demonstrates that immersive exhibition environments become more effective when emotional flow and sensory sequencing are systematically designed. The iterative refinement process enhances visitors' immersive experience by shifting the exhibition structure from informational storytelling to experiential storytelling. This transformation strengthens the continuity of emotional and cultural experiences as visitors interact within the exhibition space. This finding aligns with previous research emphasizing the importance of narrative immersion and spatial storytelling in shaping meaningful virtual heritage experiences.[22]. The emotional sequencing applied in the refined prototype allows visitors to experience a progressive emotional transition compared to fragmented sensory experiences, thereby enhancing the overall coherence of the immersive environment. This research finding strengthens previous discourses on immersive cultural learning and multisensory interaction while also expanding earlier studies by integrating emotional engagement and experiential preservation into a more holistic framework. Previous research on virtual heritage and immersive exhibitions generally focused on technology implementation, visual interaction, and digital accessibility.[23]. Similarly, studies on museum digitization tend to focus more on virtual exhibition systems and interactive communication strategies without deeply integrating embodied multisensory immersion and emotional-cultural engagement[24]. Conversely, this research positions emotional resonance and sensory-cultural embodiment as the main

[21] Fan, Chong, and Li, "Beyond Play: A Comparative Study of Multi-Sensory and Traditional Toys in Child Education"; Gkintoni, Vassilopoulos, and Nikolaou, "Brain-Inspired Multisensory Learning: A Systematic Review of Neuroplasticity and Cognitive Outcomes in Adult Multicultural and Second Language Acquisition."
[22] Maria Economou and Elpiniki Meintani, "Promising Beginning? Evaluating Museum Mobile Phone Apps," in *Museums and the Web 2011 Proceedings*, 2011, https://mw2011.museumsandtheweb.com/paper/promising-beginnings-evaluating-museum-mobile-phone-apps/.
[23] Bekele and Champion, "A Comparison of Immersive Realities and Interaction Methods: Cultural Learning in Virtual Heritage"; Hermawan et al., "Systematic Review of Augmented Reality Applications in Wayang Heritage Preservation."
[24] Enny Lisdayanti Hasanah et al., "Heritage Yang Terlupakan Analisis Tantangan Museum Warisan Budaya Di Era Museum Interaktif Dan Digital," *Nazharat: Jurnal Kebudayaan* 31, no. 1 (2025): 42–56, https://doi.org/10.30631/nazharat.vxix...xxx.

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mechanisms in immersive cultural preservation. Additionally, the framework developed in this research expands the literature on multisensory learning and immersive interaction by introducing a more holistic relationship between sensory stimulation, emotional engagement, cultural storytelling, and spatial immersion. Although previous studies have demonstrated the effectiveness of immersive learning environments in enhancing engagement and cognitive outcomes, this research specifically contextualizes these mechanisms within the preservation of Indonesian local culture. Therefore, the framework developed not only contributes to the study of immersive exhibitions but also broadens the discourse on experiential heritage preservation and culturally embedded interaction design. From a methodological perspective, the implementation of the Iterative Design-Based Framework Research (DBFR) allows the framework to develop adaptively through continuous evaluation and refinement cycles. Unlike the linear prototype development approach commonly used in immersive exhibition research, the DBFR approach enables the direct integration of user immersion feedback and expert validation into the framework development process. This iterative mechanism strengthens both the conceptual validity and the relevance of the resulting experiential framework, making it more responsive to the dynamics of user-centered immersion. These findings highlight the importance of an iterative, experience-centered design approach in developing immersive cultural exhibitions, especially when emotional engagement and multisensory interaction are the main focus of the research.

Theoretically, this research contributes to the development of immersive cultural exhibition studies through the introduction of an integrated conceptual relationship between sensory stimulation, emotional engagement, immersive spatial experience, and cultural preservation. The resulting framework shows that cultural immersion is built through the interconnectedness of experiential dimensions, rather than through standalone technological components. This contribution expands upon previous immersive heritage frameworks, which mostly emphasized aspects of interaction technology or visual immersion alone [25]. In addition, this framework also strengthens the sociocultural perspective that places emotional engagement and cultural attachment as the results of experience and social interaction constructs within an immersive environment[26].

This framework also contributes to the development of multisensory interaction theory by demonstrating that sensory coherence plays an important role in shaping cultural

[25] Champion, *Critical Gaming: Interactive History and Virtual Heritage*.
[26] Hochman et al., "Choosing Not to Know: The Emotional and Sociocultural Architecture of Pension Willful Ignorance."

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authenticity and emotional immersion. The research findings show that immersive environments become more effective when sensory stimuli are designed as an integrated experiential sequence, rather than as fragmented sensory outputs. This supports the previous argument that multisensory environments can generate deeper emotional and cognitive engagement through the synchronization of environmental stimuli[27]. Therefore, this research positions multisensory immersion not only as a technological strategy but also as an experience design strategy within the context of cultural exhibitions. Practically, the developed framework provides important implications for exhibition designers, museums, cultural institutions, and immersive media developers. This framework can be used as a reference model in designing cultural exhibitions that emphasize emotional engagement and embodied interaction rather than just presenting cultural information. In the context of museum transformation and digital heritage development, this framework offers alternative strategies to enhance visitor participation and cultural relevance for contemporary digital-era audiences. The integration of immersive storytelling, multisensory interaction, and emotional-cultural engagement also has the potential to support the development of more participatory cultural learning environments that can increase awareness and appreciation of cultural heritage. The main novelty of this research lies in the integration of multisensory interaction, emotional engagement, cultural storytelling, and experiential preservation into a human-centered immersive exhibition framework. Unlike previous immersive exhibition studies that are more focused on technological immersion, this research conceptualizes immersive cultural preservation as an experiential and emotionally embedded process. The developed framework thus shifts the paradigm of cultural preservation from passive digital representation to participatory experiential engagement. This originality positions the research as a conceptual advancement in the fields of immersive exhibitions and cultural heritage research, particularly in the context of preserving Indonesian local culture.

Nevertheless, this research still has some limitations. The immersive exhibition prototype developed is still implemented in a limited experimental environment, so contextual generalization still requires further testing. The number of evaluation participants for immersion is also relatively limited and still focuses on certain visitor categories. Additionally, the cultural exploration in this study is still focused on specific performative cultural forms, so it does not yet represent the full diversity of Indonesian culture. Therefore, future research can expand the

[27] Walterová, Vylita, and Huseynli, "Toward a Multisensory Evidence-Based Framework for Healing Environments."

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implementation of the framework in a larger immersive exhibition context and involve a more diverse cultural representation.

Future research can also explore the integration of adaptive immersive technology, biosensory interaction systems, real-time emotional analytics, and AI-enhanced cultural environments to strengthen multisensory cultural immersion experiences. Additionally, further studies can investigate long-term emotional retention, cross-cultural immersion dynamics, and personalized immersive exhibition experiences within digital heritage environments. These development directions have the potential to expand immersive cultural preservation studies toward increasingly interactive and intelligent exhibition ecosystems.

Overall, this research shows that the preservation of local culture in the digital era can be reconstructed through a preservation-through-experience approach that places multisensory immersion, emotional resonance, and embodied cultural interaction at the core of contemporary cultural exhibitions. The developed framework affirms that immersive exhibition environments not only serve as technological interfaces but also as experiential cultural spaces capable of fostering meaningful emotional-cultural engagement while maintaining cultural relevance within contemporary digital society.

CONCLUSION

This research successfully developed the Multisensory Immersive Exhibition Framework for the preservation of Indonesian local culture through the integration of multisensory interaction, emotional engagement, cultural storytelling, and immersive spatial experience into an experience-based exhibition model (experiential exhibition model). The results indicate that an immersive cultural environment emphasizing sensory coherence and emotional-cultural resonance can build a stronger cultural presence, deeper emotional attachment, and more meaningful visitor engagement compared to conventional exhibition approaches that still predominantly present visual and informational content passively.

Research findings show that cultural immersion is formed through interactions among sensory atmosphere, embodied cultural interaction, emotional sequencing, and experiential storytelling. The iterative prototype refinement process also indicates that integrating tactile interaction, immersive soundscape, synchronized visual projection, and environmental atmosphere significantly enhances emotional engagement, sensory immersion, and perceptions of cultural authenticity among participants. These results confirm that an immersive exhibition experience functions not only as a digital cultural representation system but also as an

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experiential cultural ecosystem capable of fostering participatory and emotional cultural preservation.

Theoretically, this research contributes to the development of immersive cultural exhibition studies by introducing an integrated conceptual relationship between sensory stimulation, emotional engagement, immersive spatial experience, and cultural preservation within a comprehensive experiential framework. The resulting framework expands upon previous immersive heritage and multisensory interaction studies, which generally focused on technological immersion, by positioning emotional-cultural embodiment and multisensory coherence as the main mechanisms in immersive cultural preservation.

Practically, this framework provides strategic guidance for exhibition designers, museums, cultural institutions, and immersive media developers to design more human-centered, experiential, and emotionally resonant cultural exhibitions. It also offers an alternative approach to strengthen cultural relevance and visitor participation in the context of contemporary digital heritage transformation.

The main novelty of this research lies in the integration of multisensory interaction, emotional engagement, and experiential preservation into an immersive exhibition framework that is culturally embedded and specifically contextualized within Indonesian local culture. This approach shifts the cultural preservation paradigm from passive digital documentation to preservation-through-experience, where visitors actively interact with culture through embodied multisensory interaction and emotional immersion.

Nevertheless, this research still has limitations in the scale of prototype implementation, the number of evaluation participants for immersion, and the cultural contexts explored during the research process. Therefore, future studies are recommended to expand the implementation of the framework in a broader immersive exhibition environment and to integrate adaptive immersive technology, biosensory interaction systems, and AI-enhanced cultural environments to strengthen multisensory cultural immersion experiences.

Overall, this research shows that the preservation of local culture in the digital era can be reconstructed through an immersive experiential approach that places multisensory engagement, emotional resonance, and embodied cultural interaction as the main foundations of contemporary cultural exhibitions. The resulting framework affirms the transformative potential of immersive exhibition environments as experiential cultural spaces capable of maintaining cultural relevance while also strengthening emotional-cultural attachment within contemporary digital society.

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Statement on the Use of Artificial Intelligence (AI)

The author states that all research ideas, problem formulation, research design, development of the framework, data analysis, interpretation of results, discussion, and drawing of conclusions in this article are the original thoughts and work of the author. Artificial Intelligence (AI) is used limitedly only as a tool to assist in language editing, grammar checking, improving manuscript readability, and refining the structure of academic writing. AI is not used to generate research data, perform data analysis, compile research results, make scientific interpretations, or make academic decisions related to the substance of the research. The entire content of the article has been reviewed, verified, and fully accountable by the author.

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