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DIGITAL TRANSFORMATION IN CONTEMPORARY VISUAL ART EXHIBITIONS (VAE): A COMPARATIVE CASE STUDY

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ABSTRACT

This study investigates the digital transformation of contemporary Visual Art Exhibitions (VAE) through a comparative case study analysis of five international and local venues. VAEs are clearly moving away from the traditional "white cube" model, which focuses on objects, and towards interactive, technology-driven, and user-focused experiences. This study aims to analyze the digital technologies used in selected contemporary VAEs and find similarities and differences in their implementation. The research uses a case study approach, analyzing the data from five VAE examples to identify common patterns. The main findings reveal that all cases are using digital technologies such as large-scale projection, sensors, Artificial Intelligence (AI), and Augmented Reality (AR) to enhance the audience's engagement and change the visitor's role from a passive observer to an active participant. The comparison reveals that three venues *(teamLab, ARTECHOUSE*, and *Atelier des Lumières)* are technology-driven, creating fully immersive environments, *while "Into the Frameless"* and the *13th Shanghai Fine Arts Exhibition* use technology in specific areas or as the core artistic medium. The main contribution of this study is the definition of Hybrid Reality (HR) in the context of VAE, which is described as a layered system that enhances the physical environment through computation, providing an opportunity for audience co-creation. The use of HR fundamentally challenges the traditional notions of art, raising important questions about Authorship, Authenticity, and Artistic Intention in non-linear, adaptive artworks. Future research should focus on the ongoing challenges of HR, such as the integration of multiple senses rather than just sight and sound, and the empirical validation of a specific User Experience (UX) framework for hybrid art exhibitions. Visual art exhibitions are experiencing significant evolution, a process that is accelerated by digital transformation. Hybrid reality (HR) is becoming a central element, fundamentally changing the ways in which art is experienced. Immersive technology is leading to this change, creating new opportunities for audience interaction. Projection mapping, specifically, is demonstrating its efficacy as a potent instrument in this transformation.

Keywords: Visual Art Exhibition; Digital Transformation; Hybrid Reality (HR); Immersive Technology; Audience Engagement; Projection Mapping.

INTRODUCTION

Visual Art Exhibitions (VAE) have, for many years, been curated spaces for the presentation and interpretation of artistic works. Traditionally, the exhibition was designed according to the model of the 'white cube', characterised by neutral architectural settings to reduce distractions and encourage a concentrated contemplation of the artworks. Artworks were often presented as autonomous objects, and visitors acted as passive observers, primarily engaged in visual appreciation and interpretation (O'Doherty, B. 1999).

However, exhibitions have undergone drastic changes in the last few decades, where contemporary exhibitions are becoming more participatory, experiential, and interactive, rather than just displaying objects. These changes are in line with broader trends in the cultural and creative industries, where exhibitions are expected to foster engagement, support cultural tourism, and contribute to creative economy initiatives. Consequently, exhibition spaces are becoming more dynamic environments that invite visitors to actively participate with artistic content.

This transition has been further amplified by the rapid development of digital technologies. Furthermore, the increasing use of technologies such as projection mapping, interactive sensors, augmented reality (AR), virtual reality (VR), artificial intelligence (AI), and other extended reality (XR) technologies in exhibition spaces allows exhibitions to move beyond traditional display practices and to create immersive, multisensory, and interactive experiences that change the relationship between artwork, space, and audience (Paul, 2016). Today, exhibitions are not just spaces for art displays but experiential platforms where the physical and digital worlds meet.

This technological shift has implications for audience behavior and expectations. More and more, visitors want to be involved and emotionally engaged, to be part of the environment of the exhibition rather than just observers. Prior research has demonstrated how digital technologies can be used to enhance visitors' engagement, learning, and satisfaction by providing more personalised and immersive experiences (Falk & Dierking, 2013); (Shi, et al, 2024). Such changes have led museums, galleries, and other cultural venues to explore alternative modes of exhibition design that combine technological innovation with artistic and curatorial aims.

The arrival of immersive exhibition projects and digitally augmented art spaces has also been exploited in Malaysia to lure contemporary audiences. Notably, REXPERIENCE (RXP.KL), Immersive KL, and some exhibitions at the National Art Gallery Malaysia have incorporated projection mapping, AR apps, AI-powered experiences, and interactive media systems. These efforts mirror larger global trends where digital technologies are being used more to broaden artistic interpretation, accessibility, and audience involvement in exhibition environments.

Previous research has addressed immersive exhibitions, digital museums, and tech-enhanced visitor experiences, but much of the literature is focused on individual technologies such as AR, VR, or interactive media. Less is known about the implementation of digital transformation across different exhibition contexts and institutional settings. In addition, existing research tends to emphasise visitor experience or technological functionality in isolation, creating a limited understanding of how digital technologies act collectively to shape exhibition design, curatorial practice, and audience engagement. This shortcoming illustrates the need for comparative studies to investigate wider patterns of digital transformation in contemporary visual art exhibitions.

To fill this gap, the current study adopts a comparative case study approach to analyse five contemporary visual art exhibitions from international and Malaysian contexts. The study investigates the types of digital technologies used and compares their implementation strategies in different exhibition environments. The research also advances the concept of Hybrid Reality (HR) as a framework for understanding the ways in which physical exhibition spaces are increasingly augmented by digital and interactive technologies. In so doing, the research contributes to current debates on digital transformation, immersive exhibition design, and technology-mediated audience engagement within contemporary visual art practice.

The research questions for this study are as follows:

RQ1: What kind of digital technologies are used in contemporary visual art exhibitions in the selected case studies?

RQ2: What are the similarities and differences in the use of digital technologies in the selected exhibitions?

LITERATURE REVIEW

EVOLUTION OF VISUAL ART EXHIBITIONS

VISUAL ART EXHIBITIONS: MOVING FROM OBJECT-CENTRED DISPLAY TO IMMERSIVE ENVIRONMENTS

Traditionally, visual art exhibitions have been places for the display and interpretation of artworks. The dominant exhibition paradigm was substantially defined by the "white cube" paradigm, which placed artwork into neutral spaces to encourage aesthetic contemplation and reduce external distractions (O'Doherty, 1999). In this paradigm, visitors were largely seen as spectators, and the artwork was the focus of the exhibition experience.

The practices of exhibitions have changed dramatically in recent decades. Contemporary exhibition practices are more about interaction, participation, and experience of the work of art than about passive looking. (Bishop, 2013) contends that the exhibition practices of today are less about the display of objects and more about the creation of environments that allow for dialogue between artworks, spaces, and the audience. This is in line with a larger cultural shift that audiences are looking for meaningful, participatory experiences, rather than visual ones.

Moreover, digital media and interactive technologies have made it possible to move exhibitions from traditional display spaces to experiential spaces. As a result, exhibitions are increasingly designed as dynamic spaces where artistic content, the design of the space, and audience engagement converge. This has greatly altered the relationship between artwork, exhibition space, and visitors, where experience plays an important role in contemporary exhibition practices.

DIGITAL TRANSFORMATION IN CONTEMPORARY ART EXHIBITIONS

Digital transformation is a process of integration of digital technologies into the activities, practices, and user experience of the organization, in order to create new forms of value and involvement. Digital transformation in the case of visual art exhibitions refers to the use of technologies such as projection mapping, interactive media, sensors, artificial intelligence (AI), augmented reality (AR), and virtual reality (VR) in the exhibition environment(Paul, 2016).

Previous studies (Paul, 2016); (López-Rodríguez et al., 2024) have shown how the implementation of digital technologies has expanded the frontiers of the design of exhibitions through immersive storytelling, real-time interaction, and multisensory experiences. With the

help of these technologies, the exhibitions can step away from traditional display methods and create environments in which visitors interact with artistic content.

Museums and galleries have been steadily adopting digital technologies. Some have taken the immersive and technology-led approach, while others are still struggling with problems such as funding, technical skills, organisational capacity, and strategic planning (Gherheș, et al. 2025). Thus, digital transformation should not be seen as a technological process but an institutional and curatorial transformation that influences the conception, design, and experience of exhibitions.

IMMERSIVE EXPERIENCE, AUDIENCE ENGAGEMENT, AND USER EXPERIENCE

The ideas of immersion, audience engagement, and user experience have been gaining more and more relevance in the current studies of exhibitions. While these concepts are interrelated, they reflect different dimensions of the experience of the exhibition.

The degree of immersion is the level of visitors' immersion and involvement in an exhibition environment. Most of the immersive exhibitions use digital technologies, spatial design, sound, and visual effects that create a feeling of presence and sensory involvement (López-Rodríguez, et al. 2024). Audience engagement is a cognitive, emotional, and behavioural relationship between visitors and exhibition content. Engaged visitors tend to be more actively involved, spend more time engaging with exhibits, and form more intense emotional relationships with artworks.

The user experience (UX) refers to the whole set of impressions, emotions, and responses that visitors develop when they interact with an exhibition environment. (Falk & Dierking, 2013) state that the experience of visitors is shaped by the interaction of personal, social, and physical contexts. In digitally mediated exhibitions, UX covers not only visual appreciation but also the navigation, interactivity, accessibility, and multi-sensory engagement.

Research has shown that immersive technologies can enhance visitor engagement and satisfaction. Yet, challenges like technological distraction, accessibility, and the tension between artistic integrity and technological innovation remain (Shi et al., 2025 : Gherheș et al., 2025). These challenges highlight the need for further investigation into the effects of digital technologies on exhibition experiences in various institutional contexts.

EXTENDED REALITY (XR), MIXED REALITY (MR), AND HYBRID REALITY (HR)

The rising use of digital technologies in contemporary visual art exhibitions has created the need for the emergence of several concepts to describe the combinations of physical and digital environments. The most common of them are Extended Reality (XR), Mixed Reality (MR), and Hybrid Reality (HR). These concepts are used as synonyms, but they mean different levels of interaction between physical and virtual elements and therefore need conceptual clarification.

Extended Reality (XR) is the umbrella term for Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) technologies. The goal of XR technologies is to extend or enrich human perception through the integration of digital content into real or virtual environments (Speicher et al., 2019). Virtual Reality (VR) refers to a fully computer-generated environment in which users are immersed in a digital space, while Augmented Reality (AR) superimposes digital information on the real world via mobile devices, wearable displays, or projection systems (Azuma, 1997).

Mixed reality (MR) is an extension of augmented reality with a more advanced integration, where physical and virtual objects co-exist and interact in real time. (Milgram & Kishino, 1994) describes MR as a point on the reality-virtuality continuum, where digital objects are not merely

superimposed on the real world, but are interactive with the physical environment and user actions. In the context of exhibitions, MR technologies can support visitors to interact with digital content while remaining physically located within gallery spaces.

Although XR and MR are mainly used to describe technological systems, in this study, the concept of Hybrid Reality (HR) is used to describe the experiential integration of physical exhibition environments and digitally augmented interactions. HR goes beyond individual technologies and focuses on how multiple digital components collectively transform exhibition experiences. Rather than replacing physical space, HR maintains the material presence of artworks and exhibition environments, while embedding responsive digital layers that affect the perception, participation, and engagement of the visitor.

In contemporary visual art exhibitions, HR can be realised through projection mapping, motion-tracking systems, AI-generated visual content, interactive soundscapes, AR-enhanced interpretation, and sensor-driven installations. These technologies create spaces where visitors are active participants whose movements and decisions shape the unfolding experience of the exhibition. As such, HR is a useful conceptual tool for understanding how digital transformation reshapes relationships between artworks, exhibition spaces, and audiences.

The distinction between XR, MR, and HR is particularly relevant in the sense that the current literature focuses mainly on the technological features and not on the exhibition experiences. XR and MR refer to the technical features of the technologies, while HR refers to the collective functioning of these technologies in the context of exhibition environments to produce integrated and participatory experiences. HR thus offers a more holistic framework for the analysis of digital transformation in the context of contemporary visual art exhibitions.

Table 1 shows the distinction between XR, MR, and HR.

Table 1. Distinction Between XR, MR, and HR (Azuma, 1997); (Milgram & Kishino, 1994); (Speicher et al., 2019)

Concept	Definition	Focus
XR (Extended Reality)	Umbrella term covering VR, AR, and MR technologies	Technology ecosystem
VR (Virtual Reality)	Fully computer-generated immersive environment	Complete virtual immersion
AR (Augmented Reality)	Digital information overlaid onto the physical world	Digital enhancement
MR (Mixed Reality)	Physical and digital elements interact in real time	Real-time interaction
HR (Hybrid Reality)	Integration of physical exhibition environments with multiple digital and interactive layers	Exhibition experience and audience participation

RESEARCH GAP

There is a body of research on immersive technologies, virtual exhibitions, augmented reality applications, and audience engagement in the context of museum and exhibition settings (Paul, 2016); (Shi et al., 2024); (López-Rodríguez et al., 2024). Such studies show the growing relevance of digital technologies to impact visitors' experience and expand the reach of artistic presentation.

However, there are still some limitations in the present literature. First, most of the existing research has focused on specific technologies such as AR, VR, or immersive projection systems and non-digital transformation as a more general phenomenon of exhibition. Thus, it is not well

understood how different institutions have adopted digital technologies in different exhibition settings.

Second, prior studies tend to treat visitor engagement, immersion, or technological functionality as separate areas of inquiry. Less attention has been paid to understanding how digital technologies collectively affect curatorial practice, exhibition design, institutional strategy, and audience participation. This leads to a lack of understanding of the general implications of the digital transformation for contemporary visual art exhibitions.

Third, while XR, AR, VR, and MR are much talked about, the concept of Hybrid Reality (HR) has not been much focused on in exhibition studies. Much of the existing literature focuses on technological systems and immersive environments, but there is little discussion of how these physical and digital elements work together as integrated experiential frameworks in exhibition settings.

To overcome these limitations, this study takes a comparative case study approach of five contemporary visual art exhibitions in international and Malaysian contexts. Through comparing different approaches of digital implementation, the study aims to identify common patterns, distinctions, and emerging practices in digital transformation. Furthermore, this study contributes to existing literature by proposing Hybrid Reality (HR) as a conceptual framework to understand the integration of physical and digital elements in contemporary visual art exhibitions.

METHODOLOGY

RESEARCH DESIGN

The qualitative comparative case study method is used in the present study to investigate the digital transformation in contemporary visual art exhibitions. The case study method is an appropriate method for studying complex contemporary phenomena within real-life contexts, especially when the boundary between the phenomenon and context is not clearly defined (Yin, 2018). In the realm of visual art exhibitions, digital transformation entails the interplay of technological, curatorial, spatial, and experiential elements that demand in-depth analysis rather than numerical quantification.

The comparative case study approach enables systematic exploration of similarities and differences between multiple exhibition contexts. This study compares selected exhibitions in the international and Malaysian contexts, with a view to identifying patterns of digital implementation, audience engagement, and emergent characteristics of Hybrid Reality (HR) in contemporary visual art exhibitions.

The study is guided by a conceptual framework that views digital technologies as major drivers influencing exhibition design, curatorial practices, institutional strategies, and audience engagement. The research uses a cross-case comparison to analyze how these dimensions interrelate to contribute to digital transformation in exhibition environments.

CASE SELECTION CRITERIA

The study uses purposive sampling in identifying cases that are relevant to the research objectives. Five contemporary visual art exhibitions were selected based on four criteria.

First, each exhibition demonstrates the integration of digital technologies such as projection mapping, artificial intelligence (AI), augmented reality (AR), sensors, interactive media, or immersive audiovisual systems. Second, all selected cases are recognised as contemporary visual art exhibitions that incorporate digital elements as part of the visitor experience. Third,

sufficient publicly accessible documentation was available through official websites, exhibition catalogues, media reports, and institutional publications. Fourth, the cases are selected to be diverse in terms of geographical and institutional contexts, allowing meaningful comparison across different approaches to digital transformation.

The cases selected are teamLab Borderless (Japan), ARTECHOUSE (United States), Atelier des Lumières (France), 13th Shanghai Fine Arts Exhibition (China), and Into The Frameless at the National Art Gallery, Malaysia. Together, the cases provide a broad representation of contemporary digital exhibition practices across immersive, museum-based and heritage-oriented contexts.

CASE DESCRIPTION

TEAMLAB (TOKYO, JAPAN)

Famous for its immersive digital art experiences, teamLab's Tokyo exhibition run July 7, 2018, to the end of 2027, utilizes cutting-edge technologies like projection mapping, sensors, sound design, and real-time rendering to transform physical spaces into interactive realms.

The Japanese collective teamLab shows how digital technology is altering our perception of space, turning traditional exhibition spaces into interactive, responsive ecosystems. Their projects blur the lines between art and the audience, fostering an experience of embodied interaction and active involvement. The spectator is no longer a passive observer, but a participant within a digitally reactive environment.

TeamLab Exhibitions' Core Technology

A high-resolution projection system covers walls, floors, and ceilings with ever-changing images that react to visitors' movements and trajectories. Motion and proximity sensors, including infrared devices, cameras, and depth sensors, track the location, stance, and gestures of individuals; the visuals then adjust, creating a sense of co-creation between the audience and the artwork. Real-time graphics engines generate dynamic components, such as flowing streams of light, blooming flowers, and flying birds, that never repeat identically, highlighting the "borderless" and continuously evolving nature of the art. Spatial sound systems and ambient music are synchronized with visual changes to create a multisensory environment, thereby immersing visitors within the artwork rather than merely observing it.



Figure 1. teamLab Borderless, Tokyo Art Exhibition 2024

Examples: Planets, Borderless, Biovortex

Visitors experience walking barefoot over water-filled spaces at teamLab Planets in Toyosu, where projections on the surfaces of the water and the walls around them respond to ripples and movement, creating a fusion of physical sensation and digital imagery. Artworks flow without a fixed map through the rooms at teamLab Borderless (Azabudai Hills) where light streams, flowers, and other digital elements travel through spaces and break down the boundaries between artworks, spaces, and visitors. Large installations at Bio vortex Kyoto, including flying birds projections, abstract sculptures, and "resonating lamps," change their color and behavior dynamically based on human presence, and so demonstrate proximity sensing and networked lighting in the creation of responsive environments.

How This Technology Supports Exhibition Design

Technology enables exhibitions to be interactive and participatory, where each visitor's movement contributes to the evolution of the artwork, thereby increasing engagement and perceived personal relevance. The use of continuous, room-scale projection and sensor networks turns the exhibition into an immersive space, eliminating clear boundaries between artwork and architecture. Real-time systems and algorithmic content generation mean the exhibition is non-linear and constantly changing, encouraging repeat visits and extended exploration without a fixed viewing route.

teamLab's approach demonstrates how digital technology can enhance user experience in exhibitions by enabling multi-sensory immersion, interactivity, and personalization through responsive content. For academic work, you can frame teamLab as a case where advanced interactive technologies (projection mapping, sensor-based interaction, real-time generative visuals) are strategically implemented to increase engagement, emotional impact, and dwell time in cultural spaces.

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ARTECHOUSE (UNITED STATES)

ARTECHOUSE 2015 blends art, science, and technology, with a focus on immersive storytelling via large-scale projection mapping and interactive media. Their exhibitions showcase the commercial potential of technology-enabled art spaces and emphasize user experience as a key design component. ARTECHOUSE in the United States is an immersive art organization utilizing cutting-edge digital technology—projection, sound, and extended reality (XR)—to produce experiential new-media art exhibitions.

Core Technology Use

Large projection systems turn walls and floors into moving visual environments with digital animations that wrap visitors in entire rooms. High-quality spatial audio is integrated and synchronized with visuals, making sound an active part of the artwork and enhancing the sense of immersion. XR and interactive media (with AR components) allow visitors to experience layered digital content, sometimes extended through mobile devices or a custom interface



Figure 2. ARTECHOUSE (United States) Art Exhibition

Exhibition And Venue Design

ARTECHOUSE venues (New York, Washington D.C., Miami, Houston) are purpose-built or adapted spaces designed to host room-scale digital installations, with flexible projection surfaces and controlled lighting. Exhibitions often feature surreal worlds, cosmic landscapes, anime-style scenes, or virtual concert environments, all created through real-time or pre-rendered digital animation. Some locations integrate after-hours AR cocktails, where drinks trigger augmented content, demonstrating how technology is woven into both the artwork and the visitor services.

Role Of Technology in Art Experience

Technology transforms traditional viewing into a multisensory, interactive experience where visitors move inside the artwork rather than looking at framed pieces on walls. ARTECHOUSE's use of new-media tools positions it as a venue for digital and new media artists, with a focus

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on experimentation at the intersection of art, science, and technology. For exhibition research, ARTECHOUSE can be conceptualized as a case study in the use of immersive projection, spatial sound, and XR to increase engagement, age accessibility, and the experiential value of art spaces.

ATELIER DES LUMIÈRES (FRANCE)

In a similar vein, Atelier des Lumières in Paris 2018 uses large-scale digital projection to reinterpret classical artworks in immersive environments. Together, these cases demonstrate the potential of technology to extend artistic narratives beyond static frames into experiential spatial storytelling. Atelier des Lumières in Paris is a digital art center that uses large-scale projection and sound technology to transform classical and modern artworks into immersive, room-filling experiences.

Core Technological Implementation The venue is equipped with around 140 video projectors covering an area of approximately 3,300m² with high-resolution moving images on walls, floors, and other surfaces to create a seamless visual environment. Advanced projection mapping aligns images with the architecture of the former steel foundry, allowing paintings and visual elements to "move," expand, and wrap around structural features. Synchronized music and sound design are tightly integrated with visual sequences, so changes in imagery are matched with shifts in soundtrack, enhancing emotional and sensory impact.

Exhibition Format and Visitor Experience

Exhibitions (for example, "Renaissance," featuring Da Vinci, Raphael, and Michelangelo) run as 45- to 60-minute immersive shows, where visitors stand or walk while artworks animate and evolve around them. Technology transforms static artworks into dynamic narratives, featuring zooms, pans, and animated transitions that guide the audience's attention without relying on traditional text labels or guided tours. The industrial architecture of the old foundry combined with digital projection creates a post-industrial, multisensory environment, often highlighted in visitor reviews for its strong sensory impact.

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Figure 3. Atelier des Lum Lumières (France) Art Exhibition

Role Of Technology in Exhibition Design

Technology is used to make art more accessible and engaging, especially for audiences who might find conventional museums less appealing, by focusing on immersion rather than close-up object viewing. While the physical space remains fixed, the scalable projection and sound system allows the center to reconfigure content for different themes and artists, supporting rotating shows over time. For research on art exhibitions, Atelier des Lumières is a key example of how high-density projection, soundscapes, and adaptive architecture can be effectively implemented to create large-scale, immersive storytelling experiences with canonical artworks.

THE 13th SHANGHAI FINE ARTS EXHIBITION

The 13th Shanghai Fine Arts Exhibition at the China Art Museum 2025-2026 is a large biennial survey of recent works by Shanghai-based artists, including digital and experimental media alongside traditional forms.

Use Of Technology and Media

The exhibition features digital art and experimental pieces, presented alongside Chinese painting, oil, sculpture, ceramics, illustration, and design, demonstrating the active integration of technology-based practices into a mainstream fine arts survey. By accepting open submissions across media, the curatorial framework legitimizes technology-mediated artworks (e.g., digital images, media installations) as part of the city's contemporary fine-arts ecosystem, even though detailed technical descriptions are not specified in the overview.

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Figure 4. Artist Artwork in Hybrid Platform – China Art Museum

Role Of Technology in The Exhibition Context

Technology primarily appears at the level of artworks and media types (digital art, experimental work), rather than as a fully immersive environment like teamLab or ARTECHOUSE, positioning digital practice within a broader fine-arts context. For research purposes, this exhibition can serve as an example of how a major public museum integrates digital and experimental art into a biennial platform, reflecting the growing normalization of technology-based art in contemporary exhibition practice in Shanghai.

MALAYSIA VISUAL ART EXHIBITIONS (VAE)
IMMERSIVE ("INTO THE FRAMELESS") BALAI SENI NEGARA (MALAYSIA)

"Into The Frameless" at Balai Seni Negara (National Art Gallery), Malaysia, is an immersive digital exhibition that represents national art collections using AI, AR, and projection technologies to make traditional works interactive and contemporary.

Main Technological Components

The exhibition digitizes 34 classic Malaysian artworks and presents them through three key technologies: artificial intelligence (AI), augmented reality (AR), and projection mapping/video immersion. Visitors are immersed in 31 artworks presented in an immersive video zone on themes such as coastlines, sea, paddy fields, micro flora, macro flora, and mountains, which are digital moving interpretations of paintings such as "Storm" Syed Ahmad, 1958 and "Fishing Village" Chuah Thean Teng, 1959.



Figure 5. IMERSIF Exhibition- Balai Seni Negara, Malaysia

Interactive Features

The exhibition features a digital photobooth powered by AI that allows guests to capture a portrait and transform it into a unique digital artwork, highlighting the role of AI in personalizing the museum experience. In the AR coloring area, visitors can color in provided designs and then watch their drawings come alive as animated AR content, connecting hands-on activity with screen-based immersive visuals.

Role Of Technology in the Exhibition

Technology is used to 'unframe' the original artworks, turning the static paintings into room-sized projections and interactive stations, making heritage art more engaging for younger and diverse audiences. The use of AI, AR, and projection provides an accessible, family-friendly experience that encourages participation over passivity in viewing, while still highlighting canonical Malaysian works and the history of national art.

OVERALL PATTERNS OF TECHNOLOGY USE

Through these five exhibitions, technology is used to transform art from static objects into immersive, interactive, and often multisensory experiences, but with different levels of intensity and purpose in each case. All five examples utilize digital technologies, including projection, sensors, artificial intelligence, augmented reality, and digital media. These technologies are used to enhance audience interaction and make art more accessible to a wider audience, especially younger people. Three venues (teamLab, ARTECHOUSE, Atelier des Lumières) design fully immersive environments with floor-to-ceiling projection and spatial sound, while "Into the Frameless" and the 13th Shanghai Fine Arts Exhibition integrate technology into specific zones or artworks within a broader museum context.

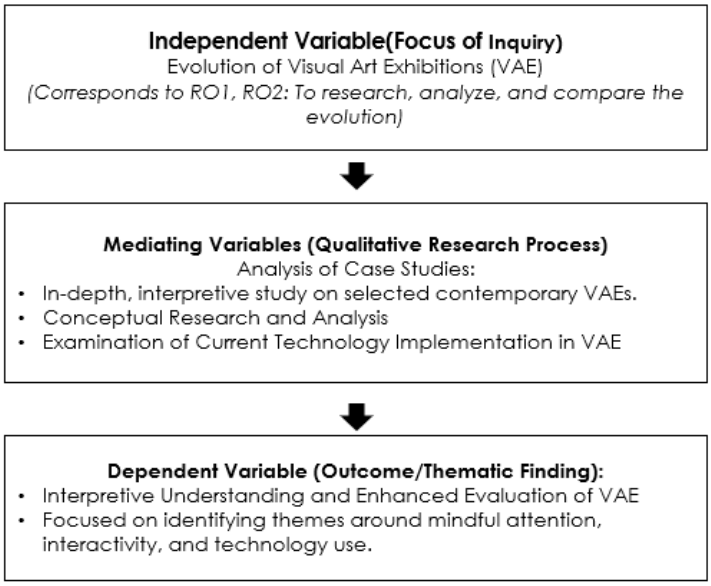


Figure 6. Conceptual Framework Model Study for Evaluation of Visual Art Exhibition

DATA COLLECTION

The data collection consisted of documentary analysis of publicly available sources related to each exhibition. The sources of data included official exhibition websites, institutional publications, exhibition catalogues, media articles, promotional materials, and publicly available visual documentation. These sources provided information on technological implementation, exhibition design, visitor interaction, curatorial approaches, and institutional objectives.

Document analysis was selected because it enables the systematic analysis of existing records and materials related to the research phenomenon. The data collected was organised according to the study's research questions and conceptual framework to facilitate cross-case comparison.

DATA ANALYSIS

The data collected were analysed using thematic comparative analysis. The analysis process involved three stages.

First, the information from each case study was reviewed, and the data was coded for common themes around the topic of digital transformation. The initial coding process comprised four analytical categories: (1) digital technologies used, (2) design and curatorial implementation of the exhibition, (3) approaches to audience engagement, and (4) characteristics associated with Hybrid Reality (HR).

Second, coded data from individual cases were grouped in thematic matrices to allow comparison across exhibitions. Similarities and differences between cases were identified and grouped in broader patterns of digital implementation.

Third, the emerged themes were interpreted in the light of the existing literature on digital transformation, immersive experiences, audience engagement, and Hybrid Reality. This process enabled insights to be developed on how digital technologies are changing contemporary visual art exhibitions.

TRUST AND DATA VALIDATION

Data triangulation was used to enhance the credibility of the findings by using multiple sources. The information from official exhibition websites was cross-checked with exhibition catalogues, institutional publications, media reports, and visual documentation where possible. The process minimised the use of one source and increased the consistency of interpretations.

In addition, a comparative analytical approach was employed in all five cases to identify common themes and mitigate subjectivity bias. The study further benefited from the use of well-articulated selection criteria and thematic coding procedures that contribute to transparency and trustworthiness.

RESULTS

Through these five exhibitions, technology is used to transform art from static objects into immersive, interactive, and often multisensory experiences, but with different levels of intensity and purpose in each case.

OVERALL PATTERNS OF COMPARATIVE TECHNOLOGY USE

The five case studies used digital technologies such as projection, sensors, artificial intelligence, augmented reality, and digital media to improve audience engagement and to make art more accessible, especially for younger audiences (Shi et al., 2024). Three of the venues, teamLab, ARTECHOUSE, and Atelier des Lumières, create fully immersive environments with projection from floor to ceiling and an encompassing soundscape. Conversely, "Into The Frameless" and the 13th Shanghai Fine Arts Exhibition employ technology within a specific area or artwork within a larger museum setting.

How Each Exhibition Implements Technology

Table 2 shows how each exhibition implements technology.

Table 2. How VAE implements technology

Exhibition	Main technologies	How technology shapes the exhibition experience
teamLab (Japan)	Large-scale projection, motion/proximity sensors, real-time graphics, spatial sound	Creates interactive, constantly changing environments where visuals and sounds respond to visitors' movements, dissolving boundaries between artwork, space, and audience.
ARTECHOUSE (United States)	Room-scale projection, immersive audio, XR/AR interactions	Turns galleries into digital landscapes and data-driven scenes; visitors move inside animated worlds and sometimes extend the experience via XR or AR (e.g., AR cocktails).
Atelier des Lumières (Paris)	140 projectors, projection mapping, synchronized music	Transforms historical artworks into moving panoramas; paintings are animated and projected across industrial architecture to create cinematic, narrative shows.
"Into The Frameless" (Malaysia)	AI portrait booth, AR colouring, immersive projection of digitised national artworks	Reinterprets 34 Malaysian works via AI and AR, and projects 31 pieces in themed immersive zones, making national collections interactive and family friendly.

13th Shanghai Fine Arts Exhibition	Digital art and experimental media within a biennial survey	Integrates technology at the artwork level (digital and experimental pieces) rather than as an entire immersive environment, normalising tech-based art in a mainstream fine-arts exhibition.

DIGITAL TECHNOLOGIES IN CONTEMPORARY VISUAL ART EXHIBITIONS

Comparative analysis showed that digital technologies are an integral part of modern visual art exhibitions. In all five case studies, different forms of digital technology were used to enhance artistic presentation, visitor engagement, and experience interaction.

Four major categories of digital technologies were identified through the analysis, including projection-based systems, interactive sensing technologies, extended reality applications, and artificial intelligence-driven features. The most ubiquitous were the projection technologies, present in all immersive exhibition environments. These systems transformed walls, floors, and architectural surfaces into dynamic visual canvases capable of rendering moving imagery and large-scale digital narratives.

Interactive sensing technologies, especially motion and proximity sensors, were most found in teamLab and ARTECHOUSE, where visitors' movements directly affected visual and auditory responses within the exhibition environment. Extended Reality (XR) applications, especially Augmented Reality (AR), were employed to provide additional layers of interpretation and interaction, as demonstrated in Into The Frameless. Artificial Intelligence (AI) applications were most prominent in visitor-centred features such as personalised portrait generation and adaptive visual content.

The results suggest that, in general, contemporary exhibitions of visual art are increasingly based on combinations of technologies rather than on single technological systems. Such combinations of technologies allow for immersive, interactive, and multisensory experiences beyond conventional object-centred display formats.

MODELS OF DIGITAL IMPLEMENTATION

The analysis revealed two different models of digital implementation across the selected exhibitions.

The first model can be described as a Fully Immersive Digital Environment. This was the case in teamLab, ARTECHOUSE, and Atelier des Lumières. In these exhibitions, digital technologies were the main structure of the exhibition experience. Projection systems, spatial audio, interactive sensors, and real-time digital content turned the entire exhibition environment into an immersive space. Visitors were positioned within the artwork itself rather than observing artworks from an external perspective.

The second model can be described as Technology-Augmented Exhibition Practice. This approach was observed in Into The Frameless and the 13th Shanghai Fine Arts Exhibition. The entire exhibition environment was not reconfigured by digital technologies but integrated into specific exhibition zones or artworks. Technology was used as a complementary layer that enhanced interpretation, interaction, and accessibility, while preserving the presence of conventional exhibition formats.

Both models are based on the use of digital technologies but differ in the way technology informs the exhibition environment. The Fully Immersive Digital Environment model is one in which technology is the primary exhibition medium; the Technology-Augmented Exhibition

Practice model has technology supporting and extending existing curatorial and artistic narratives.

AUDIENCE ENGAGEMENT THROUGH DIGITAL TRANSFORMATION

A common feature of all five case studies was the transformation of audience participation from passive observation to active engagement. Visitors could interact with the content of the exhibition through movement, participation, personalization, and sensory immersion, thanks to digital technologies.

Three types of audience engagement were revealed in the analysis. The first was spatial immersion, where visitors were physically surrounded by digital content in large-scale projection and audiovisual environments. The second was interactive participation, where the visitors' actions had an impact on digital responses through motion-tracking systems, sensors, and interactive interfaces. The third was personalised engagement, where technologies such as artificial intelligence created individual experiences for visitors.

These findings suggest that the role of the visitor in the digital transformation process is more than that of the traditional observer. Visitors are encouraged to act as participants whose actions contribute to the exhibition as a whole. It can be seen as part of a wider trend in contemporary exhibition design in which engagement, experience, and participation are valued as much as artistic presentation.

CONCEPTUALISING HYBRID REALITY IN VISUAL ART EXHIBITIONS

The results of the comparison show a common feature of the selected exhibitions: the combination of physical exhibition environments with digitally enhanced experiences. This pattern points to the conceptualisation of Hybrid Reality (HR) in contemporary visual art exhibitions.

Hybrid Reality was a multi-layered experiential framework in which physical spaces played a central role in the exhibition experience and digital technologies were employed to offer additional interactive, responsive, and immersive dimensions. In contrast to fully virtual environments, HR did not substitute the physical exhibition setting. Instead, it complemented and transformed physical environments through the use of projection systems, interactive media, sensors, artificial intelligence, and augmented reality applications.

The analysis of the selected case studies shows that Hybrid Reality unfolds in three interconnected dimensions: the co-existence of physical and digital elements in a shared exhibition space, the real-time interaction between visitors and digital content, and adaptive experiences responding to audience participation and environmental conditions.

These qualities show that Hybrid Reality is not a collection of discrete technologies and offers an experiential model for understanding digital transformation in contemporary visual art exhibitions. The concept provides a useful framework for describing the increasing synergy of physical and digital elements in shaping exhibition experiences, audience engagement, and curatorial practices.

DISCUSSION

DIGITAL TRANSFORMATION BEYOND TECHNOLOGY ADOPTION

The results show that digital transformation in contemporary visual art exhibitions is not merely the adoption of technological tools. While all five case studies involved the use of digital technologies such as projection systems, interactive sensors, artificial intelligence, and

augmented reality, the comparative analysis indicates that these technologies are embedded in larger curatorial and institutional strategies. This is in line with previous discussions that digital transformation is an organizational and experiential process, not only technological (Gherheș et al., 2025).

The two implementation models identified in this study, Fully Immersive Digital Environments and Technology-Augmented Exhibition Practices, suggest that institutions deploy digital technologies for distinct curatorial purposes. Exhibitions such as teamLab, ARTECHOUSE, and Atelier des Lumières employ technology as the primary medium through which visitors engage with artistic content, whilst Into The Frameless and the 13th Shanghai Fine Arts Exhibition use technology to augment and support existing artistic narratives. These findings imply that digital transformation is not a singular exhibition model but a continuum of technological integration.

This finding relates to previous work by(Paul, 2016), who argued that digital technologies have expanded the possibilities of artistic creation and exhibition design. The current study shows that digital transformation also affects institutional approaches to exhibition planning, visitor engagement, and the presentation of artistic content. Consequently, technology should be viewed not only as a display tool but also as a strategic mechanism that influences how exhibitions are conceptualised and experienced.

AUDIENCE ENGAGEMENT AND EXPERIENTIAL VALUE

One of the key findings of this study is the shift in audience participation from passive observation to active engagement. Visitors were invited to interact with digital content through movement, participation, and personalised experiences in each of the five case studies. This finding supports the argument of (Falk & Dierking, 2013) that visitor experiences are shaped through the interaction of physical, social, and personal contexts. The findings are also in line with previous research on the impact of immersive technology on enhancing visitors' experience, emotional influence, and satisfaction (López-Rodríguez et al., 2024); (Shi et al., 2024).

The research indicates that audience engagement is not only about technological development but also about the contextual framing of technologies in curatorial narratives and exhibition design. For example, full immersion environments offered a strong sensory engagement and the use of technology in exhibitions offered an interpretive engagement by linking digital experiences to cultural and historical narratives. The results show that the success of digital transformation is a balance between technical innovation and artistic communication. Immersive technologies have the potential to attract the audience and offer opportunities for further involvement, but their success is based on their ability to allow meaningful interpretation, not just novelty or entertainment.

HYBRID REALITY AS AN EMERGING EXHIBITION FRAMEWORK

A major contribution of this study is to conceptualise Hybrid Reality (HR) as a framework for understanding digital transformation in contemporary visual art exhibitions. While the existing literature discusses the VR, AR, MR, and XR technologies as separate technological systems (Azuma, 1997); (Milgram & Kishino,1994); (Speicher et al., 2019), the comparative findings propose that contemporary exhibitions are increasingly combining multiple technologies simultaneously within physical exhibition environments.

The notion of Hybrid Reality expands current discourses by moving the focus away from single technologies towards the full experience of the exhibition as produced by the interaction of physical and digital components. HR is not a substitute for physical exhibition spaces, but a

supplement through responsive digital layers that shape visitor perception, participation, and interpretation.

The results underscore the three integrated axes on which Hybrid Reality works, namely the mixing of physical and digital components, the real-time interaction between visitors and digital contents, and the dynamic nature of experiences according to the audience involvement. These features have emerged in all five case studies, regardless of the technological approach or curatorial goal.

This study proposes Hybrid Reality as an experiential framework that helps explain how contemporary exhibitions integrate digital technologies while maintaining the significance of physical space and embodied visitor experience. In so doing, the study extends existing exhibition literature by positioning HR as a conceptual bridge between technological innovation and audience-centred exhibition design.

CHALLENGES AND ETHICAL CONSIDERATION

Digital transformation also presents a number of practical and ethical challenges. The promise of immersive technologies for engagement and accessibility is promising, but challenges for institutions may include technological infrastructure, costs of maintenance, skills, and sustainability of staff (Gherheș et al., 2025). Highly immersive environments also risk the spectacle overshadowing artistic interpretation and thus drawing audience attention away from the conceptual content of artworks.

Additional ethical considerations can also be made with the use of artificial intelligence (AI) in exhibition spaces. Technology such as the creation of personalised content, facial recognition, and interactive visitor experiences may require the collection and analysis of visitor data. As digital tools are increasingly used in exhibitions, it is important to consider privacy, consent, transparency, and the potential for algorithmic bias. As AI-based projects become more prevalent, it is important that organisations find a way to balance technological innovation with their ethical responsibilities, to ensure the interests of visitors are protected, and confidence in the sector is maintained.

CONCLUSION

This study explored the phenomenon of digital transformation in contemporary visual art exhibitions through a comparative analysis of five selected case studies in both international and Malaysian contexts. The results show that digital technologies have been incorporated into contemporary exhibition practice, well beyond the traditional display function, to provide immersive, interactive, and participatory experiences. The cases selected showed the use of technologies such as projection mapping, interactive sensors, artificial intelligence (AI), augmented reality (AR), and extended reality (XR), in different ways to improve the artistic presentation and the engagement of the audience. The findings are in line with previous research highlighting the dynamic character of the role of digital technologies in the exhibition context and the growing possibilities for interaction and experiential engagement of the visitor (Paul, 2016); (López-Rodríguez et al., 2024).

With respect to the first research question, four main categories of digital technologies that are often employed in contemporary visual art exhibitions have been identified, namely projection-based systems, interactive sensing technologies, extended reality applications, and AI-driven features. These technologies are combined to create multisensory exhibition environments, encouraging active participation of the visitor. As has been demonstrated previously, digital technologies are increasingly used to enhance accessibility, interpretation, and visitor engagement in cultural and exhibition contexts (Shi et al., 2024).

The comparative analysis of the second research question identified two different approaches to digital implementation. The first, Fully Immersive Digital Environments, sees technology as the main tool for visitors' experience of artistic content. The second, Technology-Augmented Exhibition Practice, considers digital technologies as auxiliary tools for interpretation and engagement, while maintaining the traditional format of the exhibition. The findings indicate that digital transformation is not a one-size-fits-all solution and is contingent on curatorial goals, institutional strategies, and the nature of the visitor experience. This aligns with the argument that digital transformation is more than the application of technology and entails organizational and experiential changes within cultural institutions (Gherheș et al., 2025).

The research also contributes to the emerging discourse on technology-enhanced exhibitions, the concept of Hybrid Reality (HR). The findings suggest that HR is a useful lens to understand the interplay of the physical exhibition environments and digital technologies to create increasingly integrated and responsive experiences. The digital technologies are not replacing the physical spaces, but they are enhancing the exhibition context in new ways of interaction, participation, and interpretation. This approach extends the existing discussion of immersive and mixed reality technologies by describing the experiential relationship between the physical and digital components of an exhibition (Milgram & Kishino,1994); (Speicher et al., 2019).

This study offers useful insights into current exhibition practice, but is limited in its scope due to reliance on publicly available documentation and a small number of case studies. Future research could explore the role of digital transformation in audience engagement and cultural participation based on visitor perceptions, interviews with curators, and empirical evaluation of user experience. This will be a significant area of research for scholars, curators, and cultural institutions as digital technologies continue to develop.

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CONFLICT OF INTEREST

The authors affirm that there are no conflicts of interest associated with the conduct or publication of this research.

CONTRIBUTION OF AUTHOR

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