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A COMPARATIVE STUDY ON INNOVATIVE DISPLAY TECHNOLOGY FOR MALAYSIAN TEXTILE EXHIBITION GUIDELINES

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ABSTRACT

The integration of technology into cultural institutions is increasingly vital in modern architecture. This research focuses on creating a conceptual framework for innovative display technologies tailored to Malaysia's heritage textile exhibitions. The goal is to enhance exhibition quality, engage visitors, and address challenges like modernization and cultural identity loss. Malaysia's textile heritage, including batik and songket, plays a significant role in its cultural and tourism landscape. However, the lack of research on display technologies in cultural exhibitions has hindered the development of immersive experiences. Most studies focus on commercial or residential architecture, leaving a gap in the cultural sector. This study bridges that gap by reviewing existing literature, analysing Malaysian exhibition spaces, and exploring global best practices. Quantitative research further identifies display technologies suited to Malaysia's textile heritage by comparing overseas precedent studies from literature reviews with local case studies in Malaysia. The guidelines emphasize cultural sensitivity and community involvement, ensuring exhibitions are authentic and engaging. By integrating modern innovations, the findings offer practical solutions for architects, planners, and stakeholders to design spaces that celebrate heritage textiles and enhance visitor experiences. These technologies can preserve traditions, enrich cultural narratives, and set new standards for exhibition design in Malaysia. This research highlights the importance of

balancing technology with cultural preservation, creating spaces that reflect and sustain Malaysia's identity.

Keywords: *Innovative, Display technologies, Heritage textiles, Exhibition design*

INTRODUCTION

The creative industries are essential not only as economic drivers but also as key players in preserving cultural heritage. As globalization advances, traditional crafts face growing challenges in staying relevant, making it critical to explore proactive solutions for their preservation (Hani et al., 2012). In Malaysia, the textile industry, particularly batik, represents a rich cultural legacy that has struggled to maintain public interest in recent years. Despite batik's potential as a unique artistic medium, its appeal has waned, raising concerns about cultural identity loss and economic viability (Razali et al., 2021) Addressing these challenges requires innovative strategies to attract and engage modern audiences. Recent studies highlight the transformative potential of cutting-edge display technologies in revitalizing cultural institutions. For instance, interactive installations and digital media have been shown to enhance visitor engagement by creating dynamic and immersive environments (Vaz et al., 2017a). The centuries-old textile and craft traditions that have developed into vibrant local industries today form the foundation of Malaysia's craft sector. Batik, a traditional fabric art with eye-catching hand-drawn and stamped motifs, was commercially introduced to the East Coast around 1930 through screen-printing techniques. In addition to batik, Songket weaving a sumptuous silk or cotton brocade that is intricately woven with gold or silver is prized for ceremonial use in Malay weddings and celebrations, supporting the local economies of Kelantan and Terengganu.(Maaruf et al., 2020). This research aims to address this gap by developing a comprehensive guideline for innovative display technologies tailored to textile exhibitions in Malaysia. The study focuses on identifying and evaluating technologies that align with Malaysia's cultural context and provide actionable solutions to enhance public engagement with heritage crafts. The objectives of this research are to identify the types of innovative display technologies for textile exhibitions, to evaluate the suitability of these technologies for the Malaysian context and to develop a guideline

for integrating innovative display technologies into textile exhibitions in Malaysia. By synthesizing insights from global best practices, case studies, and local expertise, this research seeks to create a framework that revitalizes Malaysia's textile heritage, fosters cultural appreciation, and boosts tourism and economic growth. This effort will bridge the gap between tradition and modernity, ensuring that Malaysia's rich cultural identity continues to thrive in the digital age.

Overview of Emerging Display Technologies

The rapid advancement of technology has transformed how museums and cultural institutions engage with their audiences. Technologies such as digital storytelling, virtual reality (VR), augmented reality (AR), and interactive kiosks are at the forefront of this evolution, offering dynamic ways to explore cultural artifacts and exhibitions. Digital storytelling, for instance, provides narrative-driven experiences that immerse visitors in culturally rich and customized content (S. Wang et al., 2023). AR enhances physical exhibits by overlaying digital data, providing additional layers of historical or cultural context, while VR transports users to virtual environments, enabling them to experience historical sites or artifacts in new and engaging ways. Interactive kiosks, equipped with touchscreens and videos, allow users to curate their exploration, further enhancing the adaptability and educational value of museum displays. Emerging technologies, such as "smart pixels" with enhanced rendering and interactivity, are transforming traditional displays into sensory-rich platforms. These developments improve imaging quality and enable real-time user interaction, creating more immersive environments (Simon et al., 2005). Beyond museums, these innovations are finding applications in education, entertainment, and healthcare, demonstrating their potential to revolutionize user engagement and functionality.

The Role of Technology in Enhancing Visitor Experience

Museums are increasingly adopting cutting-edge technologies like AR and VR to create active, engaging visitor experiences. VR immerses visitors in historical recreations, while AR provides contextual information hidden within or around exhibits, enhancing both educational value and engagement (G. Wang, 2023). These technologies are particularly appealing

to younger, tech-savvy audiences, who value personalized and interactive experiences. Moreover, tools like blockchain add authenticity to digital exhibits, ensuring visitors interact with verified content (Hu et al., 2023). Research highlights how AR and VR enhance accessibility, engagement, and the overall relevance of cultural heritage in the modern era. A review of 46 studies by (Hijazi & Baharin, 2022) further identifies wearable technologies, gesture-based interactions, and mobile applications as effective tools for improving visitor engagement. These technologies transform static museum settings into dynamic environments, enabling immersive exploration of historical artifacts and personalized visitor experiences. Additionally, virtual tours and cloud-based platforms extend museum accessibility beyond geographical limitations, enhancing cultural appreciation worldwide. Today's creative industries are also greatly aided by technology, which makes it possible to transform traditional handicrafts into new goods and experiences. For example, the Batik Merbok project's designers were able to precisely replicate traditional textile motifs like mangrove roots or bird feathers in porcelain form by using 3D CAD technology. This created new opportunities for product variety and mass customization. Designers and artists can quickly experiment with intricate designs, maximize material use, and produce one-of-a-kind display items that appeal to contemporary viewers without sacrificing cultural authenticity by combining digital models and fabrication technologies (Ayn et al., n.d.).

Technological Trends in Museum Exhibitions

Recent advancements in exhibition design emphasize interactive displays, AR, VR, and digital storytelling to enhance visitor interaction with collections. Static displays have evolved into dynamic environments, where technologies like projection mapping and immersive installations bring exhibits to life. For instance, projection mapping animates textiles, presenting complex patterns or historical scenes that enrich storytelling and visitor engagement (Vaz et al., 2017b). Digital storytelling combines audio, video, and animations to create emotionally resonant narratives, helping visitors better understand the cultural and historical significance of artifacts (S. Wang, 2023). These innovations allow museums to cater to a broader audience while preserving cultural heritage for future generations.

Innovative Display Technologies for Textile Exhibitions

AR and VR technologies are transforming textile exhibitions by offering immersive and educational experiences. AR overlays digital information on textiles, revealing historical, geographic, or industrial contexts, while VR allows visitors to virtually experience textile-making processes or historical workshops (Vaz et al., 2017a). Studies have demonstrated its potential to enhance visitor understanding and appreciation of cultural heritage (Mo et al., 2024). (Hui1 et al., 2024)provide examples of how textile heritage can be reimagined by combining new display technology with historical motifs in creative exhibition models. Such intercultural exhibitions enable visitors to view the intricate wax-resist patterns illuminated from behind by covering batik fabric with modular panels that incorporate LED backlighting and interactive touchscreens. Demand-driven digital kiosks also overlay production videos and historical context. These hybrid commissions preserve the cultural integrity of the craft while transforming static textiles into living narratives that engage the audience both physically and visually.

Experiential Learning Theory

According to David Kolb's experiential learning theory from Figure 1, learning is a cyclical process in which knowledge is gained from experience. The four phases of the cycle are: Concrete Experience, in which students actively engage with novel experiences; Reflective Observation, in which they pay attention to and consider their experiences; Abstract Conceptualization, in which they develop theories or conceptual models; and Active Experimentation, in which they put their knowledge to tangible use. Through an iterative process that applies to various contexts, the practice combines action, reflection, and knowledge (Harcourt Brace Jovanovich, 2023). By considering the many learning styles converging, diverging, absorbing, and accommodating this teaching/learning approach, which draws its primary inspiration from Dewey and Piaget, stresses an individual's active and reflective participation. It is currently a popular strategy for developing critical thinking with practical abilities in both educational and professional settings. In accordance with its phases of providing experiences in immersions, hands-on experiences, and reflectivity, ELT improves visitor interaction in textile exhibitions through augmented reality, multimedia

technology, and interactive activities like hands-on workshops. (Harcourt Brace Jovanovich, 2023).

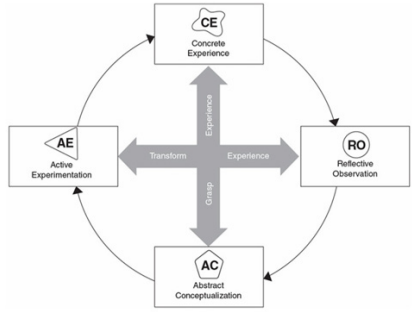

Figure 1. Experiential Learning Cycle

Source: Harcourt Brace Jovanovich, (2023)

METHODOLOGY

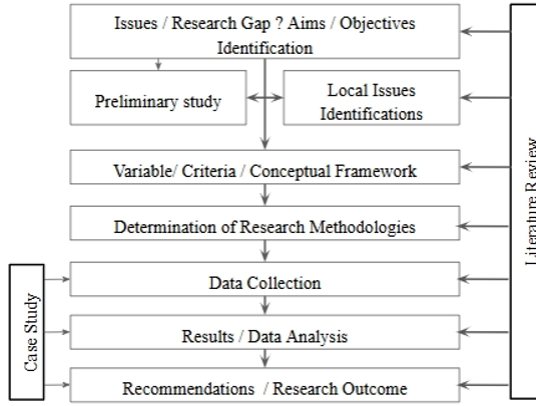

Figure 2. Research Design

Source: Author, (2024)

The integration of cutting-edge display technologies, such as digital displays, AR/VR, projection mapping, and digital storytelling, into textile exhibitions in Malaysia is the subject of this study. To evaluate the effectiveness of such technologies in enhancing visitor engagement, narrative, and cultural preservation, a qualitative study strategy combining case studies and precedent studies was used.

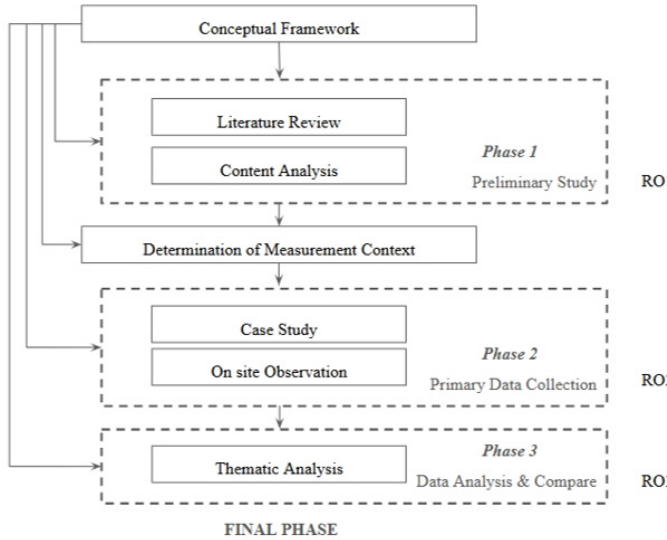

Figure 3. Research Methodology Procedure

Source: Author, (2024)

Preliminary research, primary data collection, and data analysis and comparison are its three stages. To identify gaps and categorize the major technologies pertinent to textile exhibitions, the Preliminary Phase established a conceptual framework and studied the literature. Four main technologies were identified by the literature assessment as being especially well-positioned to revitalize historical exhibits for contemporary, tech-savvy audiences. The Fashion and Textile Museum in London and the Kyoto Costume Institute provided global best practices as part of precedent research, and the State and Textile Museum of Russia and the George Washington University Textile Museum offered innovative ideas. Case studies on the Van Gogh Immersive Exhibition, Hanya Batik at REXKL, and the National Textile Museum in Kuala Lumpur were part of the main data collecting phase. Aspects of visitor experience, technology integration, and spatial design have all been considered during on-site observations in these places. The Van Gogh Exhibition and Hanya Batik's experiences showed how immersive technologies like multimedia storytelling and projection mapping can be genuinely transformative, whereas the National Textile Museum, in its current state, represented the old paradigm. During the Data Analysis Phase, the information from case studies and precedents was subjected to thematic analysis. Thematic analysis is used based on the paper from

Hani et al. (2012), which brought to light the trends and patterns in various situations. The presence, frequency, and effects of the four technologies on enhancing cultural narratives and improving the visitor experience were evaluated using comparative analysis. To make sure that recommendations were focused on local needs, the study considered Malaysia's logistical and cultural environment. To comprehend how such cutting-edge display technologies might be utilized efficiently for the benefit of textile displays, it offers a methodology to close the gap between theory and practice. In addition to identifying the appropriate technologies, the current research study combines local observation with a global perspective to provide actionable recommendations for enhancing Malaysia's textile heritage displays. It acts as a resource for curators, designers, and policymakers while preserving cultures and satisfying the demands of today's audience. As for limitations, although the thematic analysis offers valuable insights, greater empirical depth and analysis transparency could improve it. To develop a conceptual framework, the methodology currently uses a triangulation of literature reviews, precedent studies, and local case studies. However, the breadth of empirical evidence is constrained by the reliance on qualitative methods. The themes would be more strongly validated and quantifiable insights into visitor responses could be obtained by including visitor surveys, interviews, or quantitative engagement data. Such information could improve openness, lessen subjectivity, and strengthen the framework's resilience.

FINDINGS AND DISCUSSION

Innovative Technologies in Textile Exhibitions

This research explored the integration of innovative technologies in textile exhibitions, focusing on their impact on visitor engagement, cultural preservation, and educational value. Through precedent and case studies, the analysis highlighted the transformative role of digital storytelling, projection mapping, augmented and virtual reality (AR/VR), and digital displays in enhancing visitor experiences.

International Precedent Studies

Four global textile institutions which include The Fashion and Textile Museum in London, George Washington Textile Museum in Washington, Kyoto Costume Institute in Japan, and State Textile and Industrial Museum in Russia, illustrate how cutting-edge technologies redefine the exhibition landscape. Each institution integrates modern techniques to enhance visitor engagement while preserving textile heritage.

Fashion and Textile Museum (London): The museum employs projection mapping in figure 4 and digital storytelling in figure 5 to create immersive narratives. For instance, projection mapping animates textile patterns, while storytelling combines audio, visuals, and archival materials to contextualize artifacts, appealing to diverse learning styles and fostering a connection with younger audiences. (Home - Fashion and Textile Museum, 2024).

Figure 4. Projection Mapping in Exhibition

Source: (Home - Fashion and Textile Museum, 2024)

Figure 5. Digital Storytelling in Exhibition

Ssource:(Home - Fashion and Textile Museum, 2024)

George Washington Textile Museum (Washington): Known for its interactive displays, the museum uses touchscreens in figure 6 to immerse visitors in textile production methods. These technologies bridge the gap between tangible artifacts and their historical significance, ensuring a dynamic learning environment. (The George Washington University Museum and The Textile Museum | The George Washington University, n.d.).

Figure 6. Interactive Display

Ssource: (The George Washington University Museum and The Textile Museum | The George Washington University, n.d.)

Kyoto Costume Institute (Japan): With innovative digital display, AR/VR, projection mapping and digital storytelling in Figures 7, 8, 9 and 10. The museum brings historical garments like kimonos to life. Visitors can digitally "wear" kimonos or explore garment production stages. This integration of cultural and technological narratives exemplifies the potential of immersive technology in educational exhibits. (KCI | The Kyoto Costume Institute, n.d.)

Figure 7. Innovative Digital Display

Source, (KCI | The Kyoto Costume Institute, n.d.)

Figure 8. AR and VR
Source: (KCI | The Kyoto Costume Institute, n.d.)

Figure 9. Projection Mapping on Cloth
Source: (KCI | The Kyoto Costume Institute, n.d.)

Figure 10. Digital Storytelling
Source: (KCI | The Kyoto Costume Institute, n.d.)

State Textile and Industrial Museum (Russia): This institution uses Interactive digital display (figure 11), projection mapping (Figure 12), and interactive storytelling (Figure 13) to connect visitors with Russia's industrial textile history. These technologies enhance learning by demonstrating production processes and contextualizing cultural heritage (Tim - State Textile and Industrial Museum – ERIH, n.d.).

Figure 11. Interactive Digital Display

Ssource: (Tim - State Textile and Industrial Museum – ERIH, n.d.)

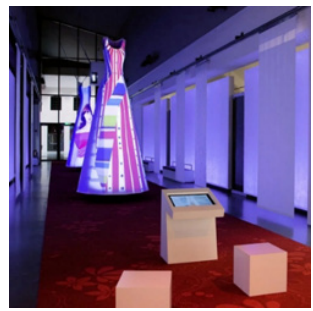

Figure 12. Projection Mapping

Source: (Tim - State Textile and Industrial Museum – ERIH, n.d.)

Figure 13. Digital Display

Source: (Tim - State Textile and Industrial Museum – ERIH, n.d.)

Local Case Studies in Malaysia

Three local exhibitions National Textile Museum, Hanya Batik Exhibition at REXKL, and Vincent van Gogh Immersive Exhibition were analysed to understand Malaysia's approach to textile displays and potential areas for innovation. National Textile Museum (Kuala Lumpur): Despite its rich collection of traditional textiles, the museum relies heavily on static displays and interpretive signage as show in figure 14. While preserving cultural artifacts effectively, the lack of digital technologies limits their appeal to younger, tech-savvy audiences. The inclusion of AR/VR or interactive displays could significantly enhance engagement and accessibility.

Figure 14. Exhibition Space

Source: Author, (2024)

Hanya Batik Exhibition (REXKL): This exhibition integrates projection mapping (figure 15) and audio-visual storytelling (figure 16) to transform batik motifs into dynamic, engaging narratives. By combining traditional art with modern technology, it bridges generational gaps and highlights batik's relevance in contemporary contexts. The sensory engagement and use of space provide a model for future heritage exhibitions.

Figure 15. Projection Mapping Exhibition Space

Source: Author, (2024)

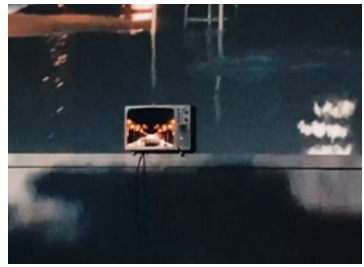

Figure 16. Audio Storytelling

Source: Author, (2024)

Vincent van Gogh Immersive Exhibition (Kuala Lumpur): Although unrelated to textiles, this exhibition showcases the power of digital storytelling (Figure 17) and projection mapping (Figure 18). Visitors engage with Van Gogh's artworks through large-scale projections and interactive displays that create an immersive room exhibition (Figure 19), demonstrating the potential for such technologies in Malaysian textile exhibitions.

Figure 17. Digital Display

Source: Author, (2024)

Figure 18. Projection Mapping on White Cloth

Source: Author, (2024)

Figure 19. Immersive Room Exhibition Space

Source: Author, (2024)

Thematic Analysis

Thematic analysis was used to explore how digital displays, AR/VR, projection mapping, and digital storytelling enhance visitor engagement in cultural heritage textile exhibitions and are used for cultural preservation and education. Key themes to emerge through the analysis include learning experiences, cultural preservation, and visitor engagement, demonstrating how interactive technologies transform passive exhibits into immersive experiences. Digital storytelling elicits emotional responses through multimedia. AR/VR lets visitors study textile-making processes interactively; projection mapping gives life to exhibits that are generally static. All these innovations not only bridge the gap between traditional and modern approaches but also continue to make batik heritage alive, relevant, engaging, accessible, and in-depth for culturally diverse audiences.

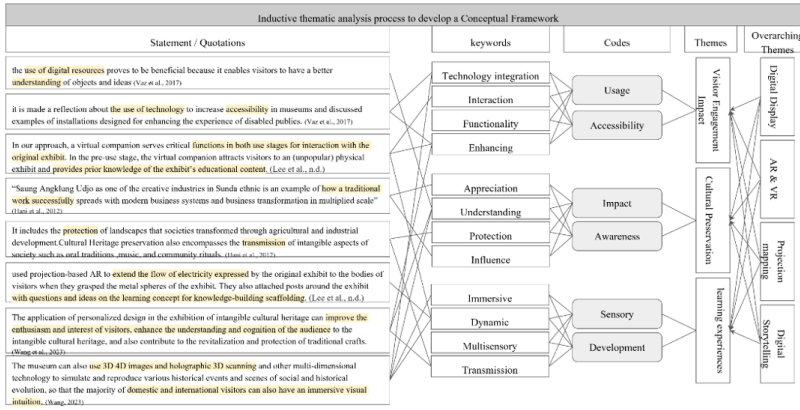

Figure 19: Thematic Analysis

Source: Author, (2024)

Open coding of data from case studies and literature was the first step in the thematic study's inductive thematic analysis. At this point, certain concepts and recurring themes were found, including the use of digital resources, interactive features, visitors' enthusiasm, prior exhibit knowledge, cognitive improvement, and the use of 3D/4D images or holographic scanning. To capture their common meaning, these early codes were subsequently categorized into more general groups. Codes pertaining to digital interaction and learning functions, for instance, were categorized under Usage, whereas codes pertaining to prior knowledge and ease of engagement were categorized under Accessibility. Likewise, codes that described cultural appreciation and learning outcomes were categorized as Impact, whereas codes that described maintaining knowledge and heritage identity were categorized as Awareness. Lastly, sensory development was used to classify immersive components like AR/VR experiences and sensory visuals. Five major themes: Use, Accessibility, Impact, Awareness, and Sensory Development were derived from this classification and collectively comprise the conceptual framework. This methodical procedure ensures transparency in analysis by showing how conclusions were derived methodically from data rather than conjecture. By cross-referencing codes from literature, international case studies, and local exhibitions, triangulation was used to increase rigor, provide validation, and lessen researcher bias. This method reveals the underlying structures that influence visitor engagement and cultural learning in addition to showcasing the potential of cutting-edge display technologies.

KEY FINDINGS AND IMPLICATIONS

The results show that local and international practices in heritage textile exhibitions differ significantly. International case studies that demonstrate the successful integration of AR/VR, projection mapping, and digital storytelling into exhibition spaces include the Fashion and Textile Museum London and the Kyoto Costume Institute. By promoting introspective and immersive experiences, these technologies improve cultural awareness and visitor engagement. On the other hand, static displays are frequently used in Malaysian exhibitions, like the National Textile Museum, which restricts interaction and deeper learning opportunities. Though they are still uncommon and dispersed, exceptions like the Hanya Batik showcase

at REXKL demonstrate the potential of immersive storytelling.

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These difficulties highlight how crucial it is to match the adoption of technology with sustainable practices. Institutions must create long-term frameworks that include staff training, cooperative partnerships with technology providers, and policy-level support rather than considering digital displays as "add-ons." Innovative technologies run the risk of being underutilized or unsustainable if these structural problems are not resolved.

In conclusion, the results demonstrate that although cutting-edge display technologies have the potential to enhance visitor experiences and engage cultural heritage preservation, their effective deployment is contingent upon overcoming institutional, technological, and financial obstacles. To guarantee that these resources are not only embraced but also integrated into the cultural and educational missions of Malaysian heritage institutions, a more methodical and critical approach is needed.

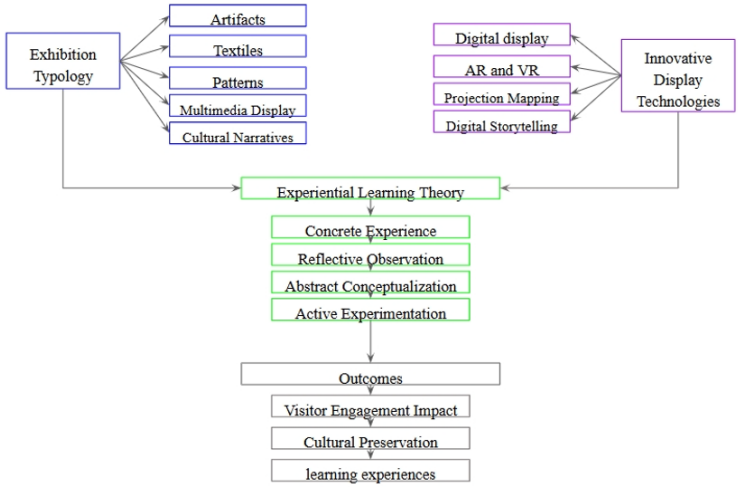

Figure 19. Design Conceptual Framework

Source: Author, (2024)

FINDING SUMMARY

The analysis reveals a stark contrast between international and local practices in integrating innovative display technologies. While institutions abroad set benchmarks for interactive and immersive experiences, Malaysian museums can adapt these strategies to their unique cultural contexts. By incorporating digital storytelling, projection mapping, and AR/VR, Malaysian textile exhibitions can engage broader audiences, preserve heritage, and educate visitors more effectively. These advancements will not only modernize exhibition practices but also ensure the sustainability and global relevance of Malaysia's rich textile traditions.

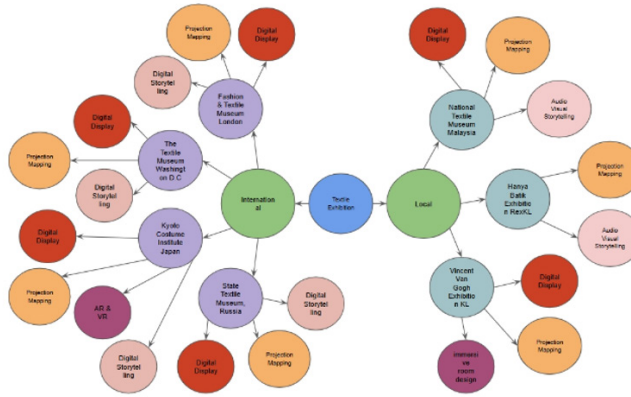

Figure 20. Finding Summary Diagram

Source: Author, (2024)

CONCLUSION

According to this study, contemporary display technologies including augmented reality, virtual reality, projection mapping, and digital storytelling have the potential to revolutionize textile displays in Malaysia. The study examined the difficulties that traditional displays face, namely their inability to maintain visitor engagement, capture the interest of younger, tech-savvy audiences, and meaningfully preserve cultural heritage. Using prior research and local case studies, the study has been able to demonstrate how these new technologies improve the visitor experience through interactivity and dynamism. The Fashion and Textile Museum and the Kyoto Costume Institute are two international examples that show how immersive technologies can serve as a link between historical items and their contemporary significance. The National Textile Museum serves as an example of how Malaysian institutions must change from static, traditional approaches to interactive technological ones, while the Hanya Batik Exhibition locally offers insight into how projection mapping and storytelling can rethink the way batik is presented while maintaining its cultural essence. The objectives of this study are met through a conceptual framework that provides interventions towards cultural relevance, interactivity, and inclusivity to ensure that exhibitions are for diverse audiences while heritage is preserved. It does this by identifying the types of new display technologies that are appropriate for textile exhibitions and assessing their applicability in Malaysia. Therefore,

designers, curators, and legislators can learn a lot from this research about the significance of technology-driven approaches that will guarantee the sustainability and allure of Malaysia's textile legacy. Malaysian exhibitions may stay current, draw in larger audiences, and close the gap between tradition and modernity by incorporating these technologies, guaranteeing that cultural heritage is honoured and conserved in the digital era. To combine qualitative and quantitative methods in the future, such as visitor questionnaires and experiments that gauge engagement and learning results, mixed-methods approaches will be essential. The effects of technology on cultural preservation and tourism throughout time may be evaluated through longitudinal research. Textile shows from both domestic and foreign settings must be included in case studies. It is advised to research the application of AI, virtual museums, and interactive exhibits in visitor engagement. Before implementing AR/VR and projection mapping, museums can begin with cost-effective solutions like digital storytelling, if curators get the appropriate training for curators and work with craftsmen to preserve cultural authenticity.

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DECLARATION OF AI-GENERATED CONTENT

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AUTHOR CONTRIBUTIONS

All authors contributed to the design of the research, the write-up. The on-line survey, data cleaning and tabulation was undertaken by Universiti Teknologi MARA Perak Branch. All authors have read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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