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A COMPREHENSIVE REVIEW OF INTERACTIVE DIGITAL EXHIBITION DESIGN BASED ON VISITOR EXPERIENCE

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*Abstract**. Purpose.** This paper provides a comprehensive review of interactive digital exhibition design, focusing on audience experience. It aims to map the evolution of these exhibitions, assess the impact of design elements, and explore future implications.*

***Methodology.** The review employs a chronological approach, analyzing academic articles and conference proceedings. It integrates interdisciplinary aspects like design, technology, and psychology, identifying research gaps and future directions.*

***Results.** Key observations include the evolution from technology-centric to user-centric design, and the growing integration of psychology into design. It underscores the importance of a unified theoretical framework and diverse visitor needs in future research.*

***Scientific novelty** lies in its comprehensive, chronological approach and the integration of various disciplines, providing a new perspective on the evolution and future of interactive digital exhibition design.*

***Practical significance.** This review serves as a resource for researchers, designers, and museum professionals, guiding the design of interactive digital exhibitions to enhance audience engagement and experience.*

Keywords: *interactive digital exhibition design, audience experience, future exhibition design, digital technologies, audience engagement.*

INTRODUCTION

The digital era has led to remarkable changes in various fields, and the world of exhibitions is no exception. With the proliferation of new technologies such as Augmented Reality (AR), Virtual Reality (VR), and interactive digital interfaces, the conventional approach to exhibition design is transforming. This shift allows exhibitions to offer a more engaging and personalized experience to the audience, fostering a deeper connection between them and the exhibited objects. The topic of interactive digital exhibition design based on audience experience has, therefore, garnered considerable attention in the scholarly community.

This paper presents a comprehensive review of the existing literature related to interactive digital exhibition design, with a specific focus on how these designs are influenced by and affect the audience experience. It aims to elucidate the evolution of interactive digital exhibitions, examine the impacts of various

design elements on audience interaction and engagement, and explore the implications of these findings for future exhibition design.

The review encompasses a variety of sources, including academic articles and conference proceedings, and it is organized chronologically to present a clear picture of how the field has developed and where it is headed. With an interdisciplinary approach, the paper intertwines aspects of design, technology, and user psychology, highlighting the significance of considering the audience experience in interactive digital exhibition design.

By mapping the trajectory of this research area, identifying existing gaps, and suggesting potential areas for future investigation, this comprehensive review serves as a valuable resource for researchers, designers, and museum professionals who aim to leverage interactive digital technologies to enrich audience experience and engagement in exhibitions.

ANALYSIS OF PREVIOUS RESEARCH

A substantial amount of relevant literature, mainly composed of journal articles and conference papers, can be retrieved pertaining to the topic of "Interactive Digital Exhibition Design Based on Visitor Experience". After excluding resources for which the full text is inaccessible, a set of representative articles has been selected for this literature review. Depending upon the publication time and their core research content, the evolution of research in this field can be divided into three major stages (fig. 1).

The picture presents an overview of the seminal works in interactive digital exhibition design, focusing on how these designs influence and are influenced by visitor experience. The evolution of this field is characterized by three major stages, reflecting a transition from technology-centric to user-centric design approaches.

Initially, research primarily emphasized the technological aspects within physical exhibition spaces. Early studies, such as Hatala's et al. [6] exploration of immersive museum experiences and Rauschenbach's et al. [15] work on service scalability, laid the groundwork for integrating digital technology in exhibition design.

The next phase saw a shift towards enhancing visitor experience through virtual spaces. Innovative methodologies in spatial analysis began to emerge, indicating a maturing field. Researchers like Chen-Burger and Tate [2] and Vosinakis and Tsakonas [21] explored virtual reality applications and their impact on visitor engagement.

Recently, the integration of psychological theories into design processes marks a sophisticated, user-centric focus. Studies by Tian et al. [19] and Zhang [23], for example, delve into how interactive technologies can be optimized for enriching visitor experiences, suggesting a need for a unified theoretical framework to guide future research.

This brief overview sets the stage for the detailed exploration of the current state and future directions of interactive digital exhibition design, discussed comprehensively in the Result section.

PURPOSE

A comprehensive review of interactive digital exhibition design, focusing on audience experience, is needed. The study aims to map the evolution of these exhibitions, assess the impact of design elements, and explore future implications.

RESULTS AND DISCUSSION

Stage of Digital Technology Development. During the inception phase spanning 2004 to 2014, the advancement of digital technology resulted in the deployment of an assortment of digital media technologies within the realm of exhibition design. Significantly, these applications were predominantly within physical spaces. However, the dissemination of related research was sporadic during this phase, suggesting an early stage of exploration and adaptation.

Hatala et al. [6] developed the ec(h) o system to create an immersive museum experience, shedding light on an area that requires further investigation for quantifiable evaluations and integration of more sensory modalities and personalization. Subsequently, a discourse on service scalability and personalization is offered by Rauschenbach et al. [15] providing cues for the study, especially concerning user interface design and content adaptability. Adding to this, Walker and Winters [22] introduce innovative technologies for visitor interaction and personalized experiences, opening a potential exploration of the absence of a comprehensive theoretical framework for non-interactive computing and the utilization of Mayer's cognitive theory of multimedia learning.

Furthermore, Hinrichs et al. [7] introduced the EMDialog system which fosters visitor-exhibit interaction, paving the way for in-depth exploration of visitor experiences, offering best practices for designing interactive exhibits, and studying varying visitor needs. Cultraro et al. [3]

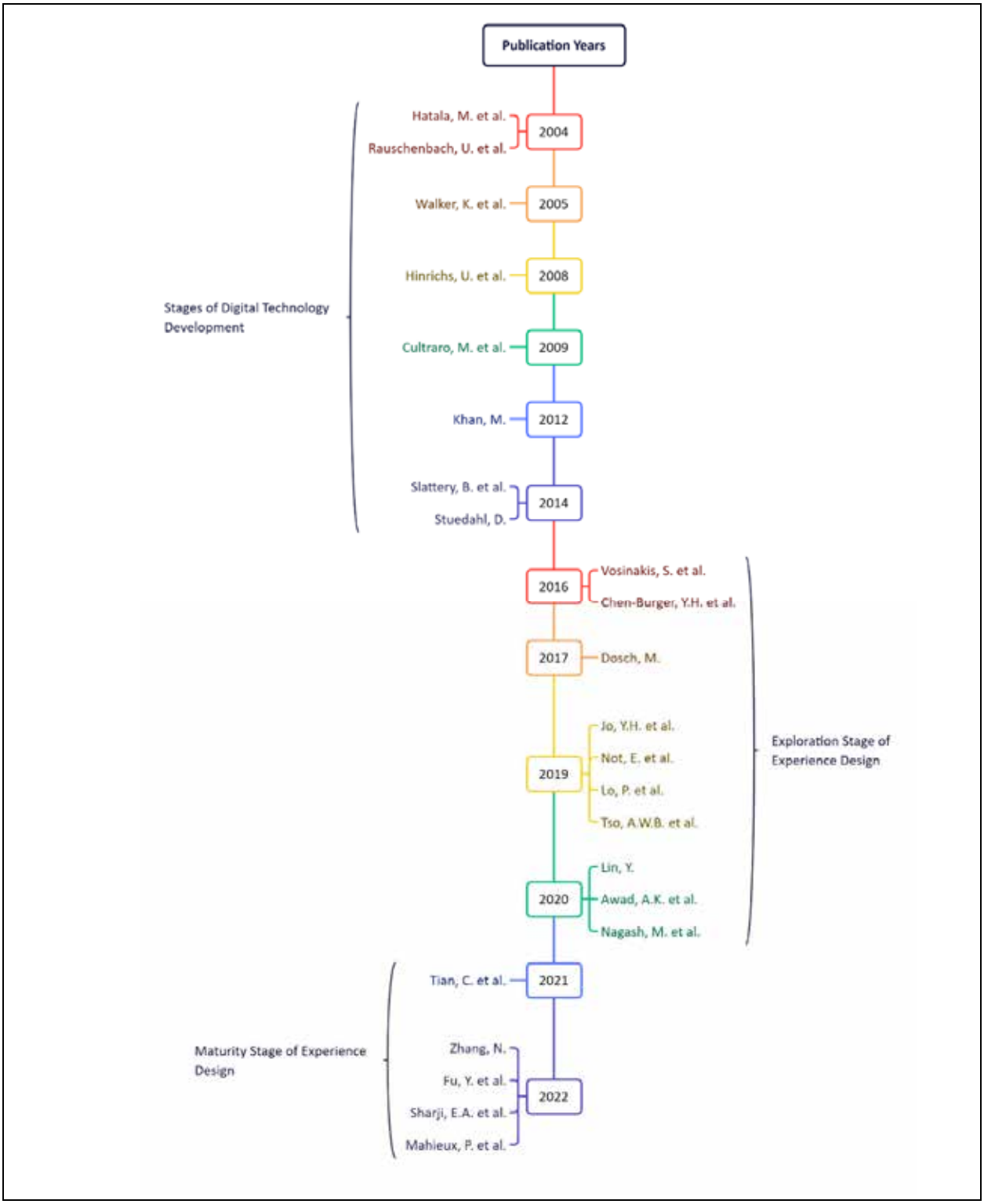

Fig. 1. Timeline And Stages of Literature Publication (He, 2023)

explicate augmented backdrops through virtual technology, highlighting a gap to explore, including the need for ground truth validation of satellite images, balancing content simplification, and integration of techno-scientific methods. Correspondingly, Khan [9] demonstrates motion-detecting technologies for heritage preservation, enabling further investigation into the effective integration of these technologies to meet diverse visitor needs and effectively present intangible cultural heritage.

Moreover, Slattery et al. [17] amplified tour guide-visitor interaction through the Tablet Support Tool, prompting research to improve

the design of tools and address attention demands faced by tour guides when using TST. Lastly, Stuedahl [18] deliberates on innovative museum designs, particularly participatory museums, inviting more in-depth exploration of participation forms, creative involvement of visitors, and the concept of the museum as infrastructure.

Exploration Stage of Experience Design. In the subsequent exploratory phase from 2016 to 2020, a shift towards virtual exhibition space design began to take form. This phase witnessed a broadening of research focus that extended beyond mere technological applications. The research landscape began to integrate innovative methodologies in spatial analysis and placed an increased emphasis on visitor experience, indicative of a maturing field and a shift towards more holistic approaches.

Chen-Burger and Tate [2] share an inventive approach through the Fish4Knowledge (F4K) Gallery, a virtual underwater aquarium employing Virtual Reality (VR) technology, yet simultaneously highlighting the challenge of interface complexity, promotion, and age restriction. On the other hand, Vosinakis and Tsakonas [21] contrast the visitor experiences offered by Google Art Project (GAP) and Second Life-based virtual museums, praising both for their unique strengths but also pinpointing certain limitations such as the 2D experience and restricted movement. This paves the way for innovation in creating a shared, immersive, multi-user experience with an artifact representation of high quality. The final piece by Dosch [4] introduces an inventive method of spatial analysis through the lens of Richard Serra's work, Gravity, emphasizing the importance of space for embodied experience and the relevance of surface details. Although, gaps in the potential application of these findings to the design of interactive digital exhibition spaces exist. Therefore, a combination of these insights provides a rich platform for further exploration in the design of interactive digital exhibition spaces, suggesting an amalgamation of technologies, methodologies, and promotional strategies, thereby addressing a wide range of user experiences and ensuring accessibility and appeal to diverse age groups.

In the empirical investigation, Tso [20] highlight how digital devices and multimedia platforms can enhance visitor engagement at exhibitions, while also cautioning that such technology might overshadow the exhibition's core content. Adding to this, Lo et al. [11] reveal the critical role of multimedia technologies in disseminating cultural knowledge. Yet, they identify a research gap in the application of these technologies within Chinese museum exhibitions. Offering a novel solution, Not [14] introduce a tool enabling non-professionals to create interactive experiences, although it may constrain professionals' expressive capabilities. Furthermore, Jo et al. [8] develop an experiential exhibition system of scientific cultural heritage, leaving some potential limitations unaddressed. Turning to the realm of physical design, Awad and Shokry [1] propose a waterfront-based cultural complex in Saudi Arabia, unfortunately overlooking the opportunity to utilize digital technologies to enhance visitor experience. On a similar note, the "Kids Edutainment Center" project by Nagash and Shokry [13] presents a design for an educational and recreational center for children, but does not delve into the design of digital exhibition spaces and visitor experiences. Finally, Lin [10] discusses the innovative application of digital technology in preserving and showcasing cultural heritage, while pointing out several challenges in the field of interactive digital exhibition design.

Maturity Stage of Experience Design. Finally, the recent maturation stage spanning 2021 to 2022 witnessed the development of a structured knowledge system. This phase was marked by the incorporation of psychological theories into the design process, coupled with more refined applications of virtual reality technology. These developments contribute towards enriching the user experience in the design of digital exhibition spaces, reflecting the culmination of previous advancements, and signifying a sophisticated, user-centric focus in the field.

Tian et al. [19] bring an innovative emotional psychology framework to understand how interactive technologies can enhance visitor experiences. Although the paper offers practical suggestions, it does not analyze a variety of digital exhibition spaces nor conduct empirical research on the effects of implementing these suggestions. Further exploration could be done through analyzing different types of digital exhibition spaces and proposing strategies to enhance visitor experiences, while also testing the suggested improvements through field research and user feedback.

Zhang [23] provides innovative methods in the design and implementation of a digital exhibition hall using VR technology. However, there are opportunities for future research in optimizing the design of the exhibition hall based on visitor experiences and combining VR with other emerging technologies. Future studies could also explore how to leverage the advantage

of time and space limitations to attract a wider audience and how digital technology can expand the impact and coverage of exhibitions.

Mahieux et al. [12] present the SABLIER device as an innovative solution for enhancing the visitor experience in digital exhibition spaces. While it provides an immersive experience, there are areas for improvement, such as the size and weight of the device, its stability, and the incorporation of additional interaction methods. The focus could be on optimizing the size, weight, stability, and interaction methods of such devices to enhance visitor experience.

Fu and Zhao [5] focus on VR technology and intelligent interactive lighting systems to improve visitor experiences in digital exhibition spaces. However, there is a lack of personalized design and the optimization of interactive technologies. Future research could concentrate on providing personalized designs and optimizing the interactive technologies. Furthermore, real-time collection and processing of visitor feedback could be a valuable avenue to explore.

Sharji et al. [16] provide insights into the application of experiential design concepts in multimedia galleries. Despite the advances, visitor interactions often fall short of expectations due to limitations imposed on visitor-artwork interactions. Future research could delve into how the experiential design concept can influence visitor behavior and interaction. Moreover, it could provide specific strategies to improve spatial layout designs, content, activities, and tools, with an emphasis on incorporating experiential design elements to enhance interaction and engagement.

From the outlined evolution of interactive digital exhibition design based on audience experience, several key observations and insights have been identified.

Initially, the focus was on the progression of digital technology, primarily within physical exhibition spaces. This phase showed a clear bias towards physical spaces, suggesting an early research gap in exploring digital technology's potential in virtual environments. This highlights the need for future studies to delve into virtual exhibition design. The subsequent exploratory phase witnessed a significant shift towards enhancing visitor experiences in virtual exhibition spaces. This period saw an increased acknowledgment of the visitor's interaction with digital technology. However, the lack of a unified theoretical framework during this phase points to a critical path for future research. In the final stage, the maturation of experience design is evident. This phase is characterized by the integration of psychological theories into digital exhibition space design and the maturation of virtual reality technology. However, the existing structured knowledge system, while a step forward, requires further elaboration.

The current structured knowledge system in digital exhibition design incorporates elements from psychology, user experience design, and technology. It has begun to provide a more holistic approach to creating engaging and meaningful visitor experiences. However, this system still lacks comprehensive theoretical underpinnings that could guide practical applications more effectively.

CONCLUSIONS

In conclusion, the evolution in interactive digital exhibition design underscores a shift from a technology-centric approach to one that prioritizes user experience, leading to the initial formation of a structured knowledge system. This evolution suggests a dual-directional path for future research:

Deepening exploration of Virtual Exhibition Space Design. There is a need to enhance visitor experiences in virtual spaces, considering the diverse and evolving expectations of visitors.

Theoretical advancements. There is an urgent requirement for in-depth theoretical research aimed at constructing a comprehensive framework for experience design. This framework should not only inform practical applications but also adapt to emerging technologies and diverse visitor experiences.

This expanded focus on both the practical and theoretical aspects will significantly contribute to the field of interactive digital exhibition design, ensuring its relevance and effectiveness in the ever-evolving digital landscape.

Future research should focus on:

Developing a unified theoretical framework. There is a need to synthesize existing theories from psychology, design, and technology to create a cohesive framework that can guide the design of digital exhibitions.

Incorporating emerging technologies. As technology evolves, the framework should be flexible enough to incorporate new advancements, such as augmented reality and AI-driven interactive experiences.

Focusing on diverse visitor needs. The system should be adaptable to cater to a diverse range of visitor preferences and needs, ensuring inclusivity in digital exhibition design.

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АНОТАЦІЯ

Хе Цііін, Косенко Д. Комплексний огляд дизайну інтерактивних цифрових експозицій на основі досвіду відвідувачів.

Мета. *Ця стаття містить комплексний огляд дизайну інтерактивних цифрових експозицій, зосереджуючись на досвіді аудиторії. Робота має на меті відобразити еволюцію дизайну експозиції, оцінити вплив елементів дизайну та дослідити майбутні наслідки.*

Методологія*. В роботі використано хронологічний підхід з аналізом наукових статей і матеріалів конференцій. Вона об'єднує міждисциплінарні аспекти, такі як дизайн, технології та психологія, визначаючи прогалини в дослідженнях і майбутні напрямки.*

Результати*. Основні спостереження включають еволюцію від технологічно орієнтованого дизайну до орієнтованого на користувача та зростаючу інтеграцію психології в дизайн. Це підкреслює важливість єдиної теоретичної основи та різноманітних потреб відвідувачів у майбутніх дослідженнях.*

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Наукова новизна *полягає в комплексному, хронологічному підході та інтеграції різних дисциплін, забезпечуючи новий погляд на еволюцію та майбутнє дизайну інтерактивних цифрових експозицій.*

Практичне значення. *Цей огляд слугує ресурсом для дослідників, дизайнерів і музейних професіоналів, керуючи дизайном інтерактивних цифрових експозицій для підвищення залучення аудиторії та досвіду.*

Ключові слова: інтерактивний цифровий дизайн експозицій, досвід аудиторії, перспективний дизайн експозицій, цифрові технології, залучення аудиторії.

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