



Evaluating the Use of Metaverse Technology as a Tourist Promotion Tool Applied to the National Museum of Egyptian Civilization

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ABSTRACT

The rapid integration of immersive technologies has positioned Metaverse as a promising driver of innovation in cultural tourism. This study aims to evaluate the use of Metaverse technology at the National Museum of Egyptian Civilization (NMEC) and assess its effectiveness in promoting Egypt's cultural heritage. A quantitative research design was applied, and data were collected through a structured questionnaire distributed via Google Forms to a sample of 172 employees, drawn from a total workforce of 300 based on Steven Thompson's formula. The instrument, developed based on existing literature, encompassed five main dimensions: demographic information, knowledge and awareness, perceived advantages, perceived impact on tourism promotion, and challenges of using Metaverse technology. Reliability testing using Cronbach's alpha confirmed high internal consistency across all sections, supporting the credibility of the results. The findings revealed that employees demonstrated strong awareness and positive perceptions of Metaverse, particularly regarding its role in enhancing visitor engagement, preserving artifacts, and improving global accessibility. Gender differences were minimal, although female staff showed greater sensitivity to challenges. Moreover, educational level and professional experience significantly influenced perceptions, with higher education associated with greater awareness and recognition of advantages, while more experienced employees reported higher awareness of operational barriers. Correlation and regression analyses confirmed that awareness and perceived advantages were the strongest predictors of Metaverse's overall impact, whereas challenges had no significant effect on its effectiveness as a promotional tool. The study concludes that Metaverse technology can serve as an innovative and effective mechanism for cultural and tourism development when supported by strong staff awareness, digital readiness, and recognition of its benefits. It recommends continuous staff training, infrastructure enhancement, inclusivity, authenticity in virtual content, and sustainable digital management. This research contributes to the growing body of knowledge on digital transformation in cultural institutions and provides practical insights for leveraging Metaverse to strengthen Egypt's global tourism promotion strategy.

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Metaverse, Cultural Tourism, National Museum of Egyptian Civilization, Digital Transformation.

تقييم استخدام تقنية الميتافيرس كأداة للترويج السياحي: تطبيق على المتحف القومي للحضارة المصرية

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الملخص

في ظل التحول الرقمي العالمي، أصبحت تقنية الميتافيرس إحدى أهم الأدوات الواعدة لتعزيز الابتكار في السياحة الثقافية وتوسيع نطاق التفاعل مع المواقع التراثية. يهدف هذا البحث إلى تقييم فاعلية استخدام تقنية الميتافيرس في المتحف القومي للحضارة المصرية ودورها في الترويج للتراث الثقافي المصري محليًا ودوليًا. تم اعتماد المنهج الكمي من خلال استبيان إلكتروني وزّع على عينة مكونة من 172 موظفًا من إجمالي 300 موظف، وذلك وفق معادلة ستيفن ثامبسون لضمان التمثيل الإحصائي. شمل الاستبيان خمسة محاور رئيسية: البيانات الديموغرافية، المعرفة والوعي، المزايا المتوقعة، التأثير الترويجي، والتحديات المرتبطة بتطبيق الميتافيرس، وقد أثبت اختبار كرونباخ ألفا ارتفاع مستوى الثبات الداخلي لجميع المحاور.

أظهرت النتائج ارتفاع مستوى الوعي والانطباع الإيجابي تجاه الميتافيرس بين العاملين، خاصة فيما يتعلق بقدرته على تعزيز تجربة الزوار والحفاظ على القطع الأثرية وزيادة الانتشار العالمي للمتحف. كما أوضحت أن المستوى التعليمي وسنوات الخبرة لهما تأثير مباشر في إدراك المزايا؛ حيث أظهر الموظفون الحاصلون على دراسات عليا وذوو الخبرة المرتفعة مستوى أعلى من الوعي بالفرص التي يوفرها الميتافيرس، بينما أبدت بعض الفئات حساسية أكبر للتحديات التقنية والبنية التحتية. وأكد التحليل الإحصائي أن كلا من المعرفة والوعي بالمزايا يمثلان أهم العوامل المؤثرة على فاعلية الميتافيرس في الترويج السياحي، في حين لم تظهر التحديات تأثيرًا جوهريًا على النتائج النهائية. وتخلص الدراسة إلى أن الميتافيرس يمثل أداة استراتيجية قادرة على إحداث نقلة نوعية في المتاحف المصرية إذا تم دمجها ضمن رؤية مؤسسية شاملة تعتمد على بناء القدرات البشرية، وتحسين البنية التحتية الرقمية، والحفاظ على أصالة المحتوى الثقافي. وتوصي الدراسة بضرورة الاستثمار في التدريب، وتعزيز الشمولية الرقمية، وبناء شراكات دولية لضمان استدامة التطبيق وتحقيق ميزة تنافسية للمتاحف المصرية في بيئة السياحة العالمية المعاصرة.

الكلمات الدالة

ميتافيرس، السياحة الثقافية، المتحف القومي للحضارة المصرية، التحول الرقمي.

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1. Introduction

In recent years, museums have struggled with declining visitor numbers due to economic instability, global health crises, and shifting cultural consumption patterns. At the same time, the rise of digital innovations has positioned Metaverse as a promising tool to transform cultural tourism and enhance visitor experiences (Buragohain et al., 2024).

Metaverse is a persistent, immersive virtual environment where users engage with digital content and each other in real time. Powered by VR, AR, blockchain, and AI, it represents the next stage of the Internet, delivering multi-sensory experiences that transcend physical boundaries (Kim, 2021; Lee et al., 2021). In the museum context, it presents an opportunity to bridge physical and digital heritage, creating inclusive and global access to culture.

Tourism promotion is a key application of Metaverse, providing virtual tours and “try-before-you-buy” experiences that reduce uncertainty, shape expectations, and strengthen destination branding. Through immersive storytelling, gamification, and real-time interaction, it transforms tourists into active participants, boosting engagement and loyalty (Kontis and Ioannidis, 2025; Sánchez-Amboage et al., 2024).

At the same time, research demonstrates that metaverse technologies can significantly improve the visitor experience. Meta-analytic studies confirm that VR and AR applications in museums foster immersion, cognitive engagement, and educational benefits (Zhou et al., 2022). Similarly, digital exhibitions expand access to hidden collections, support inclusivity for diverse audiences, and appeal strongly to younger, digitally native generations. This suggests that Metaverse has the potential to complement traditional museum visits by enhancing learning, accessibility, and cultural value creation (University of Glasgow, 2025; Avlonitou and Papadaki, 2024). Despite its benefits, Metaverse faces challenges such as technical and financial constraints, authenticity and preservation concerns, intellectual property issues, and limited platform interoperability. Ethical issues like inclusiveness, privacy, and potential declines in physical visits also demand attention. Recognizing these opportunities and constraints is essential for assessing its role in promoting cultural tourism, especially at institutions like the National Museum of Egyptian Civilization (Al-kfairy et al., 2024; Buragohain et al., 2024).

Research Problem

In recent years, museums have faced growing challenges, including declining visitor numbers due to economic and health crises as well as shifts in how people engage with culture and entertainment. At the same time, rapid technological advancements have introduced Metaverse as a promising tool capable of creating immersive experiences that simulate physical visits and expand cultural access. For museums, this raises a critical question: can Metaverse technologies effectively enhance tourism promotion, attract wider audiences, and respond to the expectations of new generations? The National Museum of Egyptian Civilization, which plays a central role in showcasing Egypt’s ancient heritage, provides an ideal case study to explore this issue. The core research problem, therefore, lies in assessing the effectiveness of

using Metaverse as a promotional tool for cultural tourism, while also identifying the opportunities it offers and the challenges that may hinder its successful integration.

Research Aim

To evaluate the effectiveness of employing Metaverse technologies as a tool for tourism promotion, applied to the National Museum of Egyptian Civilization, while identifying the opportunities and challenges involved in enhancing visitor experience and cultural marketing.

Sub-Objectives

1. To assess the impact of Metaverse technology on promoting the National Museum of Egyptian Civilization as a leading cultural tourism destination.
2. To examine how Metaverse technology enhances visitor engagement and improves both virtual and physical museum experiences.
3. To explore the perceived advantages of Metaverse technology in preserving cultural heritage and increasing global accessibility to museum content.
4. To analyze the influence of employees' knowledge, educational level, and professional experience on their perceptions of Metaverse adoption within the museum.
5. To identify the key challenges associated with the implementation of Metaverse technology and evaluate their implications for its effectiveness as a promotional tool.

Research questions

1. To what extent does Metaverse technology enhance the promotion of the National Museum of Egyptian Civilization as a cultural tourism destination?
2. How does Metaverse technology influence visitor engagement and the overall museum experience in both virtual and physical environments?
3. What are the perceived advantages of using Metaverse technology in preserving cultural heritage and increasing global accessibility to the museum?
4. How do knowledge, educational level, and professional experience affect employees' perceptions toward the adoption of Metaverse technology?
5. What challenges may hinder the effective implementation of Metaverse applications at the museum, and how do they influence its promotional impact?

2. Literature review

2.1 Metaverse Concept

Etymologically, the term metaverse derives from the Greek prefix Meta (“beyond” or “after”) and universe, denoting a “beyond-reality universe.” It is conceptualized as a continuous, persistent, and multi-user environment in which physical reality and digital virtuality coalesce, supported by emerging technologies such as 5G networks, artificial intelligence, and immersive VR/AR systems (Huynh-The, 2023).

The concept of metaverse refers to a parallel and persistent virtual universe that integrates with the physical world through advanced technologies such as artificial intelligence, virtual and augmented reality, blockchain, and digital avatars (Buhalis, 2020; Lee et al., 2021). It has been widely conceptualized as the next evolution of the Internet—an embodied, immersive, three-dimensional environment in which users are

not merely observers but active participants interacting synchronously through their avatars (Kim, 2021; George et al., 2021).

Scholars define metaverse as a mediating layer between individuals and reality, enabling a wide range of activities—including work, learning, entertainment, shopping, and social interaction—within shared virtual spaces that simulate and extend real-life experiences (Allam et al., 2022; Damar, 2021; Sekalala, 2020). Fundamentally, it represents the convergence of digital and physical elements, facilitated by the integration of Internet and Web technologies, extended reality (XR), and artificial intelligence (Cheng et al., 2022; Mystakidis, 2022; Gaffar, 2021).

Metaverse is further described as a virtual environment parallel to the physical world, accessible through devices such as virtual reality headsets, augmented reality glasses, smartphones, personal computers, and gaming consoles. Within these spaces, users can create, explore, and collaborate with others without the constraints of physical co-location (Dhelim et al., 2022). Mark Zuckerberg characterized it as the "next generation of the Internet," or an "embodied Internet," where digital interactions become immersive shared experiences that seamlessly blend social, professional, and recreational dimensions (Dwivedi et al., 2022).

2.2 Metaverse Components

Metaverse represents a shared and persistent virtual environment where individuals interact with each other and with digital objects in real time. While virtual reality (VR) is the most recognizable entry point, its realization depends on the convergence of multiple advanced technologies. Lee et al. (2021) identify eight fundamental components that collectively constitute the technological foundation of Metaverse: Extended Reality (XR), Blockchain, Non-Fungible Tokens (NFTs), Edge and Cloud Computing, Artificial Intelligence (AI), the Internet of Things (IoT), Digital Twins (DTs), and Network Infrastructure.

1. Extended Reality (XR)

XR is the primary gateway to metaverse, encompassing VR, Augmented Reality (AR), and Mixed Reality (MR).

- VR creates fully immersive computer-generated environments, enabling users to interact with digital surroundings through headsets, haptic devices, and motion systems (Slater and Sanchez-Vives, 2016).
- AR overlays digital information onto the physical environment, enriching real-world spaces with interactive elements through smartphones, smart glasses, and other wearable devices (Rauschnabel, 2021).
- MR integrates both, allowing real and virtual objects to interact dynamically. This has practical applications in cultural heritage, tourism, and education (Buhalis and Karatay, 2022).

Together, these technologies enable seamless interaction between the physical and digital worlds, making XR a fundamental enabler of metaverse experiences.

2. Block chain

Blockchain provides a secure, decentralized ledger system that underpins transactions and ownership verification in metaverse. Its distributed and immutable structure protects data from manipulation, supports trustless peer-to-peer exchanges, and ensures transparency. Beyond cryptocurrencies, blockchain facilitates secure digital

asset management, privacy protection, and authenticity verification—functions critical for virtual economies (Gadekallu et al., 2021; Cai et al., 2018).

3. Non-Fungible Tokens (NFTs)

NFTs are unique digital tokens stored on blockchain that represent ownership of specific virtual assets. Unlike fungible cryptocurrencies, NFTs are indivisible and non-replicable, making them suitable for verifying authenticity and scarcity. Within metaverse, NFTs serve as proof of ownership for digital land, avatars, in-game items, and creative works, thereby establishing the foundation of virtual economies and new business models (Nadini et al., 2021).

4. Edge and Cloud Computing

Metaverse applications demand high computational power and minimal latency. Cloud computing offers scalable infrastructure for rendering complex environments, while edge computing processes data closer to the user, reducing delays. The integration of these two models, particularly with the deployment of 5G and beyond, is essential for real-time, multi-user metaverse experiences (Gadekallu et al., 2021; Dwivedi et al., 2022).

5. Artificial Intelligence (AI)

AI contributes to metaverse on both functional and experiential levels. It enhances user interaction through natural language processing, motion capture, and emotional recognition, allowing avatars to mirror users' expressions and behaviors. On the systemic side, AI supports scalability through intelligent automation, network optimization, and fraud detection, while also enabling adaptive and personalized environments (Cheng et al., 2022).

6. Internet of Things (IoT)

The IoT connects physical devices to the digital system, enabling real-time synchronization between the virtual and real worlds. Through IoT integration, environmental data such as temperature or location can be mirrored in the metaverse, creating context-aware and interactive experiences. This enhances immersion and enables seamless transitions between digital and physical realities (Buhalis, 2020; Patel et al., 2016).

7. Digital Twins (DTs)

Digital Twins are high-fidelity virtual replicas of physical entities, processes, or environments. They not only mirror real-world objects but also simulate and predict their behaviors. DTs have significant applications in manufacturing, healthcare, urban planning, and tourism, where they allow for real-time monitoring, predictive modeling, and immersive exploration of cultural heritage (Park and Kim, 2022; Mohammadi and Taylor, 2017).

8. Network Infrastructure

Finally, Metaverse relies on robust network infrastructure capable of delivering ultra-high bandwidth and ultra-low latency. Emerging 5G and 6G networks provide the necessary connectivity, enabling large-scale, real-time, multi-user interactions. Features such as network slicing and AI-based optimization ensure reliable performance, making advanced network systems indispensable for the full realization of metaverse (Zawish et al., 2022).

In summary, metaverse is a persistent virtual environment enabled by eight core technologies. XR (VR, AR, MR) offers immersive access; blockchain and NFTs

secure ownership and transactions; cloud and edge computing ensure scalability and low latency; and AI supports personalization and automation. Meanwhile, the IoT connects physical and digital worlds, digital twins replicate real entities for simulation, and advanced 5G/6G networks provide the high-speed infrastructure for real-time multi-user interaction. Together, these components form the foundation of metaverse ecosystem.

2.3 Advantages of Using Metaverse in Museums

Museums have long served as spaces for cultural preservation, education, and public engagement. However, with the rapid advancement of immersive technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (XR), the concept of metaverse has emerged as a transformative tool for museums. Metaverse offers a three-dimensional, interactive, and immersive environment that enhances visitor experiences beyond the constraints of physical museums (Glasgow University, 2025). The research can summarize the advantages of using Metaverse in museums as follows:

1. Immersive Learning and Cognitive Engagement

Immersive technologies like VR and AR within Metaverse significantly deepen the sense of presence for users, improving perceived value and emotional engagement during virtual tourism experiences. These experiences can be deployed at different trip stages—previewing destinations, enhancing on-site visits, or reliving experiences—leading to higher satisfaction and even substitution of real travel in some contexts (Fan et al., 2022). The integration of Virtual Reality (VR) and Augmented Reality (AR) into museum experiences has demonstrated significant positive impacts on learning outcomes and cognitive engagement. A meta-analytic review of 17 empirical studies found that AR and VR enhance academic achievement and improve visitors' perceptions in museum learning contexts (Zhou et al., 2022). Another study using the experience economic framework highlighted that dimensions like education, entertainment, aesthetics, and escapism contribute to immersion and enrich the overall VR museum experience, reinforcing visitors' intentions to later visit museums physically (Lee et al., 2020).

2. Accessibility, Inclusivity, and Multimodal Storytelling

Extended Reality (XR) technologies - encompassing VR, AR, 360° VR, and Mixed Reality (MR) - enable immersive experiences that enhance accessibility, particularly for geographically distant audiences and those with diverse sensory or learning needs. Researchers found that these technologies can boost visitor appeal, understanding of complex structures, and increase motivation to visit in person (Życzkowska et al., 2024).

Moreover, digital storytelling through multimodal formats (video, text, narration) supports neurodiversity visitors by providing flexible, personalized, and sensory-friendly access to museum content (Hutson and Hutson, 2023).

3. Expanded Access to Collections and Detailed Examination

The Museums in Metaverse project reveals how immersive tech drastically expands public interaction with often-hidden museum collections. Conducting the largest survey of its kind, the project found that 79% of respondents were interested in exploring collections inaccessible to the public, and 77% were open to using VR for this purpose. It further noted that about 90% of museum collections remain unseen,

VR offers the potential to expose them to a global audience (University of Glasgow, 2025). Additionally, photogrammetry and 3D modeling allow visitors to manipulate and explore intricate artifacts, fostering detailed and immersive connections that physical display may hinder.

4. Novel Engagement for Digital-Native Audiences

XR features - such as 3D avatars, gamification, interactive AI, and digital storytelling - resonate strongly with younger, digitally native audiences (Gen Z). They enhance engagement, escapism, curiosity, and visit duration, while combining entertainment and learning (Avlonitou and Papadaki, 2024).

5. Metaverse as a Vehicle for Cultural Heritage Engagement and Value Creation

Metaverse serves as a transformative platform for preserving and promoting cultural heritage. It not only safeguards historical identity but also enhances visitor engagement and decision-making through digital tools (Sepe et al., 2025). The immersive environment of the metaverse may shift users' perception of time and presence, fostering deeper engagement. Further, it enables pre-visit access, post-visit reflection, social sharing, and co-creation of value, which bolster long-term connections to cultural heritage sites (Zhang et al., 2025).

2.4 Metaverse as a Tool for Tourism Promotion

Metaverse has emerged as an innovative platform for tourism promotion, providing stakeholders with new opportunities for branding, immersive engagement, and direct interaction with global audiences. By allowing prospective travelers to virtually explore destinations, hotels, and cultural attractions, it offers a “try-before-you-buy” experience that reduces uncertainty and shapes expectations before actual visits (Kontis et al., 2025).

Within this context, tourism marketing in the metaverse is built on three core pillars: the digital representation of tourism products, the use of Metaverse as both a branding and distribution channel, and the positioning of the tourist as an active participant. These strategies are supported by immersive technologies, real-time interactions, and gamification, which together enhance the effectiveness of promotional efforts. Nevertheless, several challenges remain, particularly regarding technical interoperability, regulatory frameworks, equitable access, and environmental sustainability (Sánchez-Amboage et al., 2024).

Empirical evidence further shows that Metaverse experiences—through immersion, escapism, and enjoyment—strengthen tourist engagement and contribute to higher levels of satisfaction, loyalty, and positive behavioral intentions. This highlights the potential of Metaverse not only as a complementary tool for tourism promotion but also as a distinct and viable form of travel that extends beyond the limitations of traditional tourism (Lee et al., 2021).

2.5 Challenges of Using Metaverse in Museums

In museums, Metaverse is understood as a three-dimensional virtual environment that uses technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) to recreate or enhance exhibitions with interactive layers. The promise of Metaverse in this context is to expand public access, enrich storytelling, and enable digital preservation of cultural heritage (Buragohain et al., 2024). Challenges of its use can be summarized as follows:

1. **Technical and Financial Constraints:** Developing and maintaining metaverse applications require advanced infrastructure, high-performance hardware, and specialized expertise. These financial and technical barriers can prevent small and medium-sized museums from adopting such technologies sustainably (Buragohain et al., 2024).
2. **User Experience and Accessibility:** Visitors often face challenges such as onboarding difficulties, motion sickness, and cognitive overload when engaging in immersive environments. If the design is not intuitive, users may perceive the technology as distracting or as a novelty without educational benefit (Marques and Costello, 2018).
3. **Authenticity and Digital Preservation:** Virtual reconstructions can sometimes distort the historical or cultural meaning of artifacts, raising questions of authenticity and archival accuracy. Concerns also exist about the long-term preservation of digital assets and metadata in the metaverse (Buragohain et al., 2024).
4. **Intellectual Property and Legal Concerns:** Metaverse projects often involve copyrighted images, 3D models, and branded content. The cross-platform and decentralized nature of Metaverse makes it difficult to enforce intellectual property rights, requiring new forms of legal and governance frameworks (Foerg, 2022).
5. **Ethical and Social Dimensions:** Ethical issues include cultural misrepresentation, lack of inclusivity, and the exclusion of local communities from decision-making in the digitization of heritage. Privacy risks also emerge as immersive platforms increasingly collect visitor data (Buragohain et al., 2024).
6. **Interoperability and Standards:** The absence of unified standards for 3D formats, metadata, and platform interoperability limits the ability to transfer museum content between metaverse environments. This threatens long-term sustainability and reusability (Al-kfairy et al., 2024).
7. **Economic and Audience Impacts:** Although Metaverse may extend access to new audiences, there are concerns that virtual experiences could reduce physical attendance and revenue. Evidence suggests that hybrid approaches, combining physical and virtual exhibitions, yield the most balanced outcomes (Lee et al., 2024).

3. Research Methodology

3.1 Research Design

This study adopts a quantitative research design to examine employees' awareness, perceived advantages, challenges, and overall impact of using Metaverse technology at the National Museum of Egyptian Civilization (NMEC). The museum represents one of Egypt's flagship cultural institutions, which has begun exploring digital transformation initiatives, including immersive technologies such as Metaverse. Given the growing importance of digital innovation in enhancing cultural heritage experiences, it is critical to investigate how staff perceive this transformation and its potential role in promoting Egypt as a global tourism destination.

To collect data, a structured questionnaire was designed and distributed to employees of the NMEC. This instrument was tailored to measure staff perceptions regarding the knowledge, benefits, challenges, and implications of adopting Metaverse technologies within the museum context. The quantitative approach allowed for the generation of objective, comparable, and statistically analyzable data, ensuring that findings provide

meaningful insights into how staff readiness and perceptions may influence the successful implementation of immersive technologies in cultural institutions.

3.2 Sampling Method

The target population of this study consists of all employees of the National Museum of Egyptian Civilization (NMEC). According to the statement of the museum's Chief Executive Officer, the total workforce comprises approximately 300 staff members, including curatorial, administrative, and support employees. Within this population, a specialized Metaverse unit of six employees was identified, representing the core team directly involved with the new technology.

To determine the appropriate sample size, Steven Thompson's formula was applied, which is suitable for finite populations. At a 95% confidence level and a 5% margin of error, the required sample size was calculated to be approximately 169 participants.

$$n = \frac{N \times p(1-p)}{\left[\frac{N-1}{d^2} \times z^2 \right] + p(1-p)}$$

Source: (Thompson, 2012)

Where:

- n = sample size (169)
- N = population size (300)
- Z = confidence level at 95% (1.96)
- d = margin of error (0.05)
- p = estimated proportion of the population (0.50)

A purposive non-probability sampling method was adopted to ensure that the sample included both staff members directly engaged-in Metaverse-related tasks and those indirectly affected by its application in the museum's broader operations. This method was chosen to balance statistical rigor with the practical constraints of accessing the entire workforce.

3.3 Questionnaire Design

The questionnaire was developed following an extensive review of literature on digital transformation, immersive technologies, and Metaverse applications in museums and cultural tourism. It was structured into five main sections to provide comprehensive coverage of the research objectives:

Section One: Demographic data, including gender, age, educational level, and years of work experience. These factors were included to analyze differences in perceptions across groups.

Section Two: Knowledge and awareness of Metaverse technology, with items measuring staff familiarity with the concept, applications, tools, and potential role in enhancing visitor engagement. This section was developed based on studies that conceptualized the Metaverse as a multidimensional digital environment integrating physical and virtual experiences. Lee et al. (2021) and Dwivedi et al. (2022) defined the Metaverse as a socio-technical ecosystem that merges immersive, networked, and intelligent systems. Cheng et al. (2022) and Mystakidis (2022) explored its emerging opportunities and barriers, emphasizing user awareness and readiness for virtual engagement. Huynh-The et al. (2023) highlighted the contribution of artificial

intelligence in shaping the interactive and personalized nature of Metaverse environments, while Kontis and Ioannidis (2025) investigated early adopters' perceptions and motivations within Metaverse tourism. Collectively, these studies informed the development of items assessing participants' awareness, familiarity, and confidence in using Metaverse technology in the museum context.

Section Three: Perceived advantages of Metaverse technology, focusing on its role in enhancing visitor experience, ensuring artifact preservation, supporting education and research, and expanding accessibility to global audiences. This section was informed by literature emphasizing the transformative role of immersive and extended reality technologies in museums. Lee et al. (2020) and Avlonitou and Papadaki (2024) demonstrated how immersive digital environments enhance learning, interaction, and visitor engagement. Buhalis and Karatay (2022) and Buragohain et al. (2024) identified the Metaverse as a tool for digital preservation and interactive cultural representation. Moreover, Sepe et al. (2025) and Życzkowska et al. (2024) illustrated its potential in education and creativity stimulation, while Sánchez-Amboage et al. (2024) discussed how Metaverse-based experiences contribute to tourism marketing and audience development. These works supported the formulation of items addressing educational, experiential, and promotional advantages of adopting Metaverse technologies in the National Museum of Egyptian Civilization.

Section Four: The impact of Metaverse technology on promoting Egyptian tourism, examining how staff perceives its role in destination marketing, cultural communication, and global outreach. This section focused on the Metaverse's contribution to destination marketing and the promotion of cultural heritage tourism. Allam et al. (2022) discussed the Metaverse as a virtual extension of smart and sustainable cities that enhance cultural accessibility. Buhalis (2020) and George et al. (2021) examined how digital transformation and immersive experiences can foster new forms of e-tourism and smart tourism. Sánchez-Amboage et al. (2024) emphasized the marketing potential of Metaverse experiences, while Zhang et al. (2025) highlighted how digital engagement improves visitor satisfaction and loyalty in heritage contexts. Additionally, the University of Glasgow (2025) report provided real-world evidence on how global museums use immersive technologies to expand audience reach. These sources collectively guided the design of items related to the Metaverse's role in enhancing Egypt's image as a leading cultural tourism destination.

Section Five: Challenges of adopting Metaverse technology, including issues of technical infrastructure, accessibility, costs, usability, and content adaptation. This section addressed the technical, operational, and ethical challenges of Metaverse adoption in museum environments. Dhelim et al. (2022) and Cai et al. (2018) examined the dependence of Metaverse systems on high-speed connectivity, edge computing, and blockchain infrastructure. Gadekallu et al. (2021) and Patel and Patel (2016) discussed the implications of the Internet of Things (IoT) for system interoperability and scalability. Foerg (2022) raised concerns regarding intellectual property and content ownership, while Rauschnabel (2021) and Zawish et al. (2024) noted challenges of usability, cost, and technological obsolescence. Furthermore, Sekalala et al. (2020) analyzed privacy and human rights risks associated with immersive surveillance technologies. These studies provided the foundation for items

evaluating technical limitations, accessibility issues, and ethical considerations in Metaverse implementation at the National Museum of Egyptian Civilization.

All items were assessed using a five-point Likert scale, ranging from “Strongly Disagree” (1) to “Strongly Agree” (5), enabling respondents to express nuanced opinions. This structure ensured that data could be analyzed statistically to reveal patterns, relationships, and group differences in perceptions regarding the adoption of Metaverse technology at the NMEC.

3.4 Data Collection

The questionnaire was designed and administered using Google Forms to facilitate efficient and accessible data collection. The survey link was shared directly with employees of the National Museum of Egyptian Civilization through internal communication channels, email groups, and professional networks. At the beginning of the questionnaire, a concise introduction explained the objectives of the study and obtained participants’ informed consent. Respondents were assured that their participation was voluntary and that their responses would remain confidential and anonymous. The online format was chosen to ensure ease of distribution, reduce administrative effort, and provide respondents with flexibility in completing the survey at their convenience.

3.5 Data Validity and Reliability

Cronbach’s alpha was used to test the reliability of the questionnaire. As shown in Table (1), all dimensions achieved high reliability coefficients, confirming strong internal consistency. These results demonstrate the tool’s suitability for the current study and support the credibility of its findings.

Table (1) Cronbach’s Alpha Value

Section	No. of items	Cronbach’s Alpha	Validity Coefficient*
First Section: Knowledge and awareness about Metaverse technology.	10	0.953	0.976
Second Section: The advantages of using Metaverse technology at the National Museum of Egyptian Civilization.	15	0.971	0.985
Third Section: The impact of using Metaverse technology at the National Museum of Egyptian Civilization the promotion of Egyptian tourism destination.	10	0.950	0.975
Fourth Section: The challenges of using Metaverse technology during your visit to the National Museum of Egyptian Civilization.	13	0.925	0.962
Total	48	0.869	0.931

* **Validity coefficient** = $\sqrt{\text{Reliability coefficient}}$

The reliability and validity assessment of the questionnaire revealed highly satisfactory results. Cronbach’s Alpha coefficients for the four main sections ranged from **0.925 to 0.971**, with an overall coefficient of **0.869** for the entire 48-item instrument, indicating high internal consistency. According to George and Mallery (2003) and Nunnally (1978), values exceeding **0.70** are considered acceptable, those above **0.80** are good, and values above **0.90** indicate excellent reliability. Furthermore, the calculated validity coefficients (ranging from **0.931 to 0.985**) demonstrate strong construct validity across all dimensions. These findings confirm that the instrument is

both **reliable and valid**, making it suitable for measuring knowledge, advantages, impacts, and challenges associated with the use of Metaverse technology in the National Museum of Egyptian Civilization.

3.6 Data analysis

Data analysis was conducted using IBM SPSS Statistics (Version 24). Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to profile respondents' demographics and summarize perceptions across the main questionnaire dimensions: knowledge and awareness, perceived advantages, impact, and challenges of Metaverse technology.

Inferential analyses included Independent Samples t-tests to examine gender-based differences and One-Way ANOVA with Tukey post hoc tests to explore variations by education and years of experience. Pearson correlation was applied to assess relationships between study variables, while multiple regression analysis was used to determine the predictive power of knowledge, advantages, and challenges in explaining the perceived impact of Metaverse technology.

4. Results and Discussion

4.1 Descriptive Analysis of Research Variables

Section one: Demographic characteristics of respondents

Figure (1) analysis of the gender composition indicates that female staff members represented 31% of the surveyed population, while the remaining 69% were male employees. Although females form nearly one-third of the respondents, the data reflect a workforce in which male participation remains more prevalent within the National Museum of Egyptian Civilization.

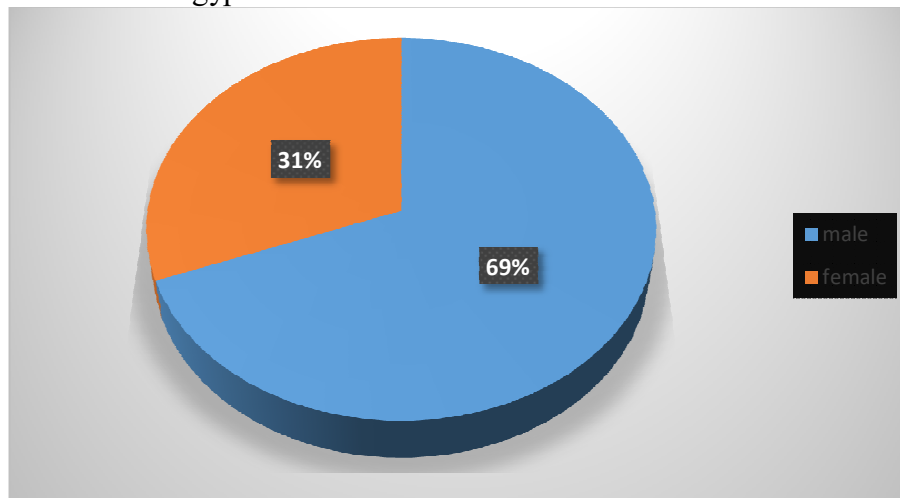


Figure 1: Gender distribution in the sample (%).

In figure (2) the age profile of the participants shows that the largest segment (80 respondents) fell within the 31–40 years category, followed by 41–50 years (65 respondents). In contrast, younger employees aged 21–30 years accounted for only 13 respondents, while those aged 51–60 years represented 14 respondents.

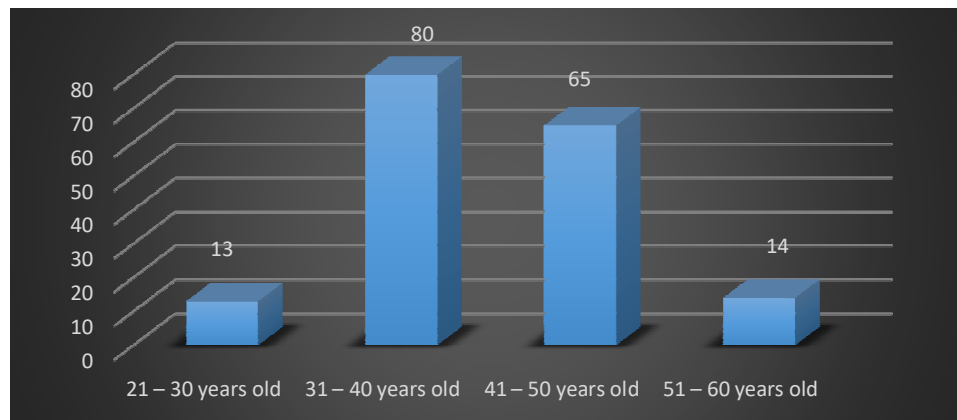


Figure (2): Age group distribution in the sample

Figure (3) shows that most respondents hold a Bachelor's degree (78%), while smaller proportions also hold a Master's degree (41%), a Ph.D. (40%), or only Secondary/Intermediate Education (13%). This indicates that the sample is highly educated, with the majority concentrated at the bachelor's level.

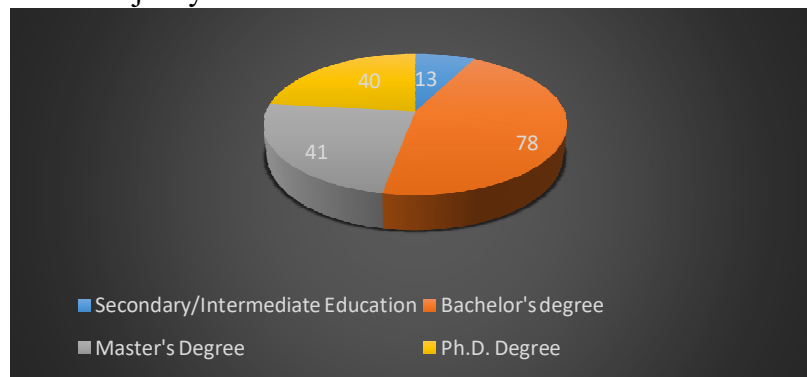


Figure (3): Educational qualifications distribution in the sample

Figure (4) shows that the largest group of respondents has more than 10 years of experience (79), followed by those with 3–5 years (53). The smallest group is those with 6–10 years of experience (40), indicating that long-term experience dominates the sample.

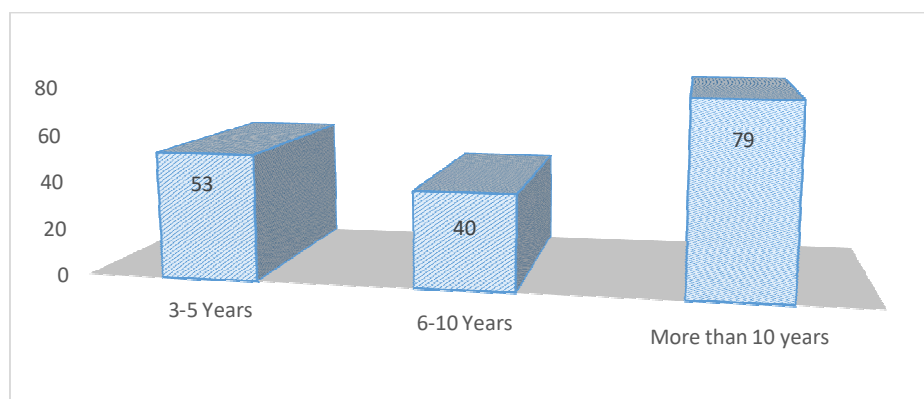


Figure (4): Years of experience distribution in the sample

Table (2) the importance of using metaverse

Variables	Mean	SD	Attitude
The importance of using a metaverse technology at the National Museum of Egyptian Civilization	4.47	.745	Very Important

The findings show a strongly positive perception of the importance of Metaverse technology at the National Museum of Egyptian Civilization ($M = 4.47$, $SD = 0.75$), reflecting a clear recognition of its role in enhancing museum functions and visitor engagement.

Second Section: Knowledge and Awareness about Metaverse Technology

Table (3): Respondents' Perceptions of Knowledge and Awareness Regarding Metaverse Technology at the National Museum of Egyptian Civilization

Variables	Mean	SD	Rank	Attitude
You are aware of the concept of Metaverse technology and its applications in tourism industry.	4.23	.797	5	Strongly Agree
You have a basic understanding of how Metaverse is used in museums and exhibitions.	3.93	.828	8	Agree
You are familiar with the benefits of using Metaverse technology in cultural tourism.	4.24	1.046	3	Strongly Agree
You know how Metaverse technology can enhance the visitor experience at National Museum of Egyptian Civilization.	4.16	.863	5	Agree
You are aware of the tools and resources needed to use Metaverse at National Museum of Egyptian Civilization.	4.38	.926	1	Strongly Agree
You know how to access and interact with Metaverse during a National Museum of Egyptian Civilization visit.	3.91	.732	9	Agree
You are aware of the historical and cultural content that Metaverse can showcase.	4.30	.817	2	Strongly Agree
You feel confident in ability to use Metaverse technology for exploring National Museum of Egyptian Civilization exhibits.	4.01	.784	7	Agree
You understand how Metaverse can recreate historical events and environments virtually.	4.16	.861	6	Agree
You are familiar with other museums or cultural institutions that use Metaverse technology.	3.62	.736	10	Agree
Total	4.09	.708		Agree

The results for the knowledge and awareness section indicated a generally high level of awareness among the respondents ($M = 4.09$, $SD = 0.71$). The highest-rated statement was related to awareness of the tools and resources needed to use Metaverse ($M = 4.38$), followed by awareness of the historical and cultural content that can be showcased through this technology ($M = 4.30$). This reflects the museum's ongoing efforts, as mentioned in the literature review, to integrate digital tools for heritage presentation and visitor engagement. However, lower scores were observed in familiarity with other museums using Metaverse ($M = 3.62$) and in knowing how to

access and interact with it during visits ($M = 3.91$), suggesting that while conceptual awareness is strong, practical exposure and benchmarking remain areas for improvement.

Third Section: The Advantages of Using Metaverse Technology at the National Museum of Egyptian

Table (4): Respondents' Perceptions of the Advantages of Metaverse Technology at the National Museum of Egyptian Civilization

Variables	Mean	SD	Rank	Attitude
Enhanced Visitor Experience				
Metaverse technology offers immersive 3D virtual experiences in ancient Egypt, allowing visitors to explore sites, interact with artifacts, and engage in historical reenactments.	4.38	.624	1	Strongly Agree
Visitors can explore historical artifacts through interactive digital models, such as zooming in on statues to understand their details and manufacturing processes.	4.09	.830	7	Agree
Global Access				
Metaverse enables remote access to the NMEC's treasures, allowing visitors to explore exhibits from their homes, despite geographical, financial, or other barriers.	3.93	.915	13	Agree
Metaverse's virtual tours and exhibits could provide multilingual support, attract a global audience and fostering cross-cultural engagement.	3.93	.730	12	Agree
Preservation of Artifacts				
Digital Archiving in Metaverse could preserve museum's rare artifacts through high-definition scans and 3D models, ensuring their preservation for future generations.	4.30	.817	3	Strongly Agree
Metaverse allows for the digital reconstruction of damaged or fragmented artifacts, allowing them to be displayed as they once were, providing a glimpse into their original form.	4.08	.827	4	Agree
Interactive Education and Research				
Metaverse can be utilized by teachers and students to enhance their understanding of ancient Egyptian history through interactive virtual classrooms and guided tours.	4.31	.908	2	Strongly Agree
Metaverse can offer visitors a virtual excavation experience, allowing them to learn about discovery and contextualize museum treasures.	3.78	.801	14	Agree
Metaverse could facilitate collaboration among researchers on Egyptian artifact and history studies, enabling the sharing of data, models, and discoveries in a virtual environment.	4.01	.875	9	Agree
Innovative Marketing and Engagement				
The museum could enhance its online presence by	4.16	.768	4	Agree

hosting virtual exhibits and events in Metaverse, attracting a larger online audience and generating buzz about its activities.				
Metaverse technology enables the creation of interactive games and scavenger hunts based on Egyptian history, potentially appealing to younger visitors or those not interested in traditional museum displays.	3.55	1.010	15	Agree
Accessibility and Inclusivity				
Metaverse can enhance museum accessibility for disabled individuals, enabling visually impaired visitors to navigate virtual exhibits with audio descriptions and those with mobility issues to experience the museum virtually.	4.16	1.096	6	Agree
Metaverse allows users to customize their experience by adjusting settings for language, audio descriptions, and difficulty levels in interactive exhibits.	4.01	.787	11	Agree
Future Growth and Innovation				
Metaverse platform allows for continuous updates and new exhibits, ensuring a dynamic and fresh virtual space for repeat visitors at the NMEC.	4.16	.768	5	Agree
The museum plans to integrate advanced technologies like AR, AI, and MR into its virtual space, enhancing visitor engagement with exhibits.	4.01	.879	10	Agree
Total	4.06	.713	Agree	

The descriptive analysis revealed a high overall agreement ($M = 4.06$, $SD = 0.71$) on the perceived advantages of integrating Metaverse technology at the National Museum of Egyptian Civilization (NMEC). Respondents strongly agreed that immersive 3D environments ($M = 4.38$), interactive educational tools ($M = 4.31$), and digital archiving for artifact preservation ($M = 4.30$) are among the most significant benefits. These findings are consistent with the studies previously discussed in the literature review, such as those by Cheng et al. (2022) and Allam et al. (2022), which highlighted Metaverse's role in enhancing cultural engagement through immersive virtual environments. Additionally, Park and Kim (2022) emphasized the importance of digital preservation, supporting the positive perception of the Metaverse as a tool for safeguarding cultural heritage.

Furthermore, the high ratings related to accessibility and inclusivity ($M = 4.16$) and innovative marketing approaches ($M = 4.16$) align with the conceptual perspectives outlined earlier, where researchers argued that Metaverse technologies enable cultural institutions to transcend geographical boundaries and reach global audiences. This directly supports the museum's strategic objectives, as highlighted in the literature review, to utilize digital transformation to enhance cultural diplomacy and promote heritage internationally.

In contrast, features such as gamification ($M = 3.55$) and virtual excavation activities ($M = 3.78$) received relatively lower mean scores, indicating that staff members prioritize educational and preservation-focused applications over entertainment-driven

elements. This aligns with the findings of Mystakidis (2022), who noted that the primary value of the Metaverse in cultural contexts lies in educational enrichment rather than recreational use.

Overall, these findings reflect strong institutional readiness to adopt Metaverse technology as a transformative tool for enhancing visitor engagement, supporting heritage preservation, and promoting innovative learning experiences, while also identifying areas where further development, employee training, and awareness initiatives may be required to maximize its potential.

Fourth Section: Impact of Metaverse Technology on Promoting the National Museum of Egyptian Civilization as a Tourism Destination

Table (5): Respondents' Perceptions of the Impact of Metaverse Technology on Promoting the National Museum of Egyptian Civilization as a Tourism Destination

Variables	Mean	SD	Rank	Attitude
You believe that Metaverse is an effective tool for attracting tourists to visit the Egyptian Museum of Civilization.	4.31	.819	5	Strongly Agree
Metaverse offers a rich and engaging experience for tourists interested in Egyptian history and culture.	4.01	.680	9	Agree
You believe Metaverse promotes cultural tourism in a new and innovative way.	4.31	.816	4	Strongly Agree
Metaverse contributes to enhancing the museum's international reputation as an advanced tourist destination.	4.38	.486	2	Strongly Agree
You think Metaverse enhances interaction and communication between visitors and the museum, encouraging physical visits.	4.16	.861	7	Agree
You believe Metaverse can attract a wide range of digital tourists and virtual visitors from around the world.	4.01	.784	10	Agree
Metaverse provides a unique promotional experience that cannot be achieved through traditional promotional methods.	4.46	.634	1	Strongly Agree
You believe that using Metaverse can increase repeat visits to the museum.	4.23	.420	6	Strongly Agree
Metaverse offers tourists an interactive experience that encourages them to share their experiences on social media.	4.16	0.768	8	Agree
You believe Metaverse can contribute to increasing global awareness of the importance of the Egyptian Museum of Civilization.	4.31	.605	3	Strongly Agree
Total	4.21	.584	Strongly Agree	

The results for the impact of Metaverse technology on promoting the National Museum of Egyptian Civilization as a tourism destination indicated a very high overall agreement ($M = 4.21$, $SD = 0.58$). Respondents particularly emphasized its role in creating a unique promotional experience beyond traditional methods ($M =$

4.46) and in enhancing the museum's international reputation ($M = 4.38$). High ratings were also observed for its ability to increase global awareness ($M = 4.31$) and encourage repeat visitation ($M = 4.23$). These findings align with previous studies highlighted in the literature review, which underline Metaverse as a powerful tool for destination marketing, cultural branding, and global outreach.

While all indicators scored positively, slightly lower means were reported for aspects related to social media engagement ($M = 4.16$) and the attraction of digital tourists ($M = 4.01$), suggesting that while Metaverse is widely perceived as a promotional asset, its potential as a driver of online virality and purely digital tourism remains less prominent. This insight indicates a need for integrated marketing strategies combining Metaverse initiatives with targeted digital campaigns to fully leverage its promotional capacity.

Fifth Section: The Challenges of Using Metaverse Technology during Visit to the National Museum of Egyptian Civilization

Table (6): Respondents' Perceptions of the Challenges Associated with Using Metaverse Technology at the National Museum of Egyptian Civilization

Variables	Mean	SD	Rank	Attitude
Technical Limitations				
High-speed internet is crucial for a seamless Metaverse experience, but museums, especially in historic areas, may face connectivity challenges.	3.92	.911	2	Agree
Visitors may face limitations in accessing advanced hardware like VR headsets or the museum's equipment may not be user-friendly or well-maintained.	3.85	.765	3	Agree
Accessibility and Usability				
Metaverse platforms may be unfamiliar to some visitors due to their complexity, which may cause them to feel alienated.	3.40	1.142	11	Neutral
The prolonged use of VR or AR devices can potentially cause discomfort, motion sickness, or fatigue, particularly for older or differently-abled visitors.	3.53	.945	9	Agree
Content Adaptation				
Translating the museum's exhibits into a virtual format requires precise replication of artifacts, cultural context, and storytelling to avoid misrepresentation.	3.61	1.006	7	Agree
Content must be available in multiple languages to cater to the museum's international audience.	3.98	1.057	1	Agree
Creating high-quality 3D models and interactive experiences requires significant time and financial investment.	3.83	1.180	4	Agree
Preserving the Authentic Experience				
Overemphasis on Metaverse experiences might detract from the authenticity of viewing original artifacts.	3.15	1.355	13	Neutral

Virtual adaptations must respect the cultural and historical significance of the exhibits without trivializing them.	3.83	1.114	5	Agree
Cost and Infrastructure				
Setting up and maintaining Metaverse experiences can be expensive for the museum.	3.61	1.069	8	Agree
Ensuring long-term viability of the technology amidst rapid advancements and potential obsolescence is a challenge.	3.69	.994	6	Agree
Privacy and Security				
While Metaverse can enhance storytelling, too much interactivity or information can overwhelm visitors, detracting from the experience.	3.53	1.011	10	Agree
Virtual platforms can be susceptible to hacking or other security breaches.	3.38	.926	12	Neutral
Total	3.63	.753	Agree	

The analysis of challenges associated with the use of Metaverse technology at the National Museum of Egyptian Civilization revealed an overall high agreement level ($M = 3.63$, $SD = 0.75$), indicating a clear awareness among respondents of key obstacles that may affect successful implementation. The most prominent concerns were related to multilingual content availability ($M = 3.98$) and internet connectivity limitations ($M = 3.92$), which align with issues highlighted in the literature review by Cheng et al. (2022) and Mystakidis (2022), who emphasized that equitable access and robust digital infrastructure are fundamental requirements for effective implementation of Metaverse applications in cultural institutions.

Furthermore, concerns regarding the need for advanced hardware, usability challenges ($M = 3.85$), financial investment ($M = 3.83$), and the risk of cultural misrepresentation ($M = 3.83$) are consistent with the theoretical perspectives of Allam et al. (2022) and Park and Kim (2022), who noted that Metaverse deployment requires significant funding, specialized technical expertise, and strict cultural authenticity standards to accurately represent heritage assets.

In contrast, issues related to privacy and security ($M = 3.38$), platform complexity ($M = 3.40$), and loss of authenticity ($M = 3.15$) were rated comparatively lower, reflecting the findings of previous studies that acknowledged these as secondary challenges when strong institutional strategies are in place. Overall, these results confirm the literature's assertion that while the Metaverse holds significant potential for museums, its successful adoption depends on overcoming operational, technical, and cultural barriers through strategic planning, infrastructure enhancement, and continuous staff training.

4.2 T-Test

Table (7): Independent Samples T-Test of Gender Differences in Knowledge and Awareness of Metaverse Technology

Gender	N	Mean	SD	t	df	Sig. (2-tailed)	Mean Difference
Male	119	4.05	0.83				
Female	53	4.20	0.26				
Total	172			-1.887	157.52	0.061	-0.158

The Independent Samples T-Test showed that female staff ($M = 4.20$) reported slightly higher awareness of Metaverse technology than male staff ($M = 4.05$). However, this difference was not statistically significant ($p = 0.061$), indicating that both groups share a similarly high level of knowledge and awareness, consistent with the museum's emphasis on collective digital capacity-building.

Table (8): Independent Samples T-Test of Gender Differences in Perceptions of Challenges of Using Metaverse Technology

Gender	N	Mean	SD	t	df	Sig. (2-tailed)	Mean Difference
Male	119	3.45	0.75				
Female	53	4.03	0.59				
Total	172			-5.46	125.29	0.000*	-0.58

The T-Test revealed a statistically significant gender difference in perceptions of challenges related to Metaverse technology ($p < 0.001$). Female staff ($M = 4.03$) reported higher agreement with the presence of challenges compared to male staff ($M = 3.45$). This indicates that women were more likely to perceive technical, accessibility, and implementation barriers, a finding consistent with literature noting diverse user sensitivities in adopting immersive technologies.

4.3 ANOVA Test

Table (9): One-Way ANOVA of Knowledge and Awareness of Metaverse Technology by Educational Level

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	58.41	3	19.47	119.33	0.000*
Within Groups	27.41	168	0.16		
Total	85.81	171			

* $p < 0.001$, indicating significant differences between groups.

Table (10): Post Hoc Tukey HSD Comparisons of Knowledge and Awareness by Educational Level

Educational Level	Mean	Subset 1	Subset 2	Subset 3
Secondary / Intermediate Education	2.10	2.10		
Bachelor's Degree	4.17		4.17	
Ph.D. Degree	4.22		4.22	4.22
Master's Degree	4.47			4.47

Note: Different subsets indicate statistically significant differences at $\alpha = 0.05$.

The One-Way ANOVA revealed significant differences in knowledge and awareness of Metaverse technology across educational levels, $F(3,168) = 119.33$, $p < 0.001$. Post Hoc comparisons using Tukey HSD indicated that employees with secondary/intermediate education ($M = 2.10$) had significantly lower awareness than all other groups. In contrast, those with a master's degree ($M = 4.47$) reported the highest awareness, followed by Ph.D. holders ($M = 4.22$) and bachelor's degree holders ($M = 4.17$). These results suggest that higher educational attainment is strongly associated with greater awareness and understanding of Metaverse technology, supporting prior literature that links advanced education with digital readiness and openness to adopting emerging technologies in cultural institutions.

Table (11): One-Way ANOVA of Perceived Advantages of Using Metaverse Technology by Educational Level

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	70.25	3	23.42	236.37	0.000*
Within Groups	16.64	168	0.10		
Total	86.89	171			

Table (12): Post Hoc Tukey HSD Comparisons of Advantages by Educational Level

Educational Level	Mean	Subset 1	Subset 2	Subset 3	Subset 4
Secondary / Intermediate Education	2.00	2.00			
Bachelor's Degree	3.98		3.98		
Ph.D. Degree	4.33			4.33	
Master's Degree	4.60				4.60

The One-Way ANOVA indicated significant differences in perceptions of the advantages of Metaverse technology across educational levels, $F(3,168) = 236.37$, $p < 0.001$. Post Hoc analysis revealed that staff with secondary/intermediate education ($M = 2.00$) perceived significantly fewer advantages compared to all other groups. Conversely, employees with a master's degree ($M = 4.60$) reported the highest perception of advantages, followed by Ph.D. holders ($M = 4.33$) and bachelor's degree holders ($M = 3.98$).

These results suggest a clear positive association between higher educational attainment and the recognition of Metaverse's benefits. Respondents with postgraduate qualifications demonstrated greater appreciation for the role of immersive technologies in enhancing visitor engagement, artifact preservation, and museum promotion. This aligns with prior research emphasizing that advanced education often fosters greater digital literacy and openness to innovation, positioning more educated employees as key enablers in the adoption of transformative technologies in cultural institutions.

Table (13): One-Way ANOVA of Perceived Challenges of Using Metaverse Technology by Years of Experience

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	31.82	2	15.91	41.32	0.000*
Within Groups	65.07	169	0.39		
Total	96.89	171			

Table (14): Post Hoc Tukey HSD Comparisons of Challenges by Years of Experience

Years of Experience	Mean	Subset 1	Subset 2
3–5 years	2.98	2.98	
More than 10 years	3.88		3.88
6–10 years	3.97		3.97

The One-Way ANOVA revealed significant differences in perceived challenges of using Metaverse technology across groups with different years of experience, $F(2,169) = 41.32$, $p < 0.001$. Post Hoc comparisons showed that employees with 3–5 years of experience ($M = 2.98$) reported significantly lower perceptions of challenges

compared to those with more than 10 years ($M = 3.88$) and 6–10 years ($M = 3.97$). No significant difference was found between the latter two groups.

This pattern suggests that less experienced staff perceive fewer challenges, possibly due to their greater adaptability and digital fluency, while more experienced employees may be more cautious and aware of the technical, financial, and operational constraints of implementing Metaverse technologies. These findings are consistent with literature noting that professional tenure influences attitudes toward digital transformation, where younger or less tenured employees often show higher openness to emerging technologies compared to their senior counterparts.

4.4 Correlations

Table (15): Pearson Correlation between Knowledge and Awareness of Metaverse Technology and Its Impact on Egyptian Tourism Promotion

Variables	Knowledge & Awareness	Impact of Metaverse
Knowledge & Awareness about Metaverse Technology	1.000	0.860
Impact of Using Metaverse Technology	0.860	1.000

The Pearson correlation analysis revealed a strong positive and statistically significant relationship between knowledge and awareness of Metaverse technology and perceptions of its impact on tourism promotion ($r = 0.860$, $p < 0.01$). This indicates that employees who reported higher levels of awareness and understanding of Metaverse technology were also more likely to recognize its positive impact on enhancing the visibility and attractiveness of the National Museum of Egyptian Civilization.

This finding aligns with previous studies that emphasize the role of digital literacy and awareness as key drivers in the adoption and effectiveness of immersive technologies within cultural institutions. It also highlights the importance of training and capacity-building programs to strengthen staff awareness, which can directly enhance their ability to perceive and leverage Metaverse as a strategic tool for tourism development.

Table (16): Pearson Correlation between the Perceived Impact and Challenges of Using Metaverse Technology

Variables	Impact of Metaverse	Challenges of Metaverse
Impact of Using Metaverse Technology	1.000	0.394
Challenges of Using Metaverse Technology	0.394	1.000

The Pearson correlation analysis showed a moderate positive and statistically significant relationship between the perceived impact of Metaverse technology and the challenges associated with its use ($r = 0.394$, $p < 0.01$). This suggests that employees who acknowledged stronger positive impacts of Metaverse technology on tourism promotion also tended to report greater awareness of the challenges related to its implementation.

This finding indicates that perceiving benefits does not exclude recognizing barriers; rather, staff who are more engaged with the Metaverse concept are likely to have a more balanced perspective, appreciating both its opportunities and its limitations. This

is consistent with prior literature, which highlights that early adopters of immersive technologies in cultural institutions often report both enthusiasm for innovation and concerns about technical, financial, and accessibility constraints.

4.5 Regression

Table (17): Multiple Regression Analysis Predicting the Impact of Metaverse Technology

Model	R	R ²	Adjusted R ²	Std. Error	F	Sig.
1	0.881	0.776	0.772	0.279	193.96	0.000*

Table (18): Regression Coefficients of Predictors of the Impact of Metaverse Technology

Predictor Variable	B	Std. Error	Beta	t	Sig.
(Constant)	1.159	0.140	—	8.281	0.000*
Knowledge & Awareness of Metaverse	0.346	0.081	0.420	4.274	0.000*
Advantages of Using Metaverse	0.380	0.084	0.463	4.499	0.000*
Challenges of Using Metaverse	0.026	0.032	0.033	0.794	0.428

The multiple regression model was statistically significant, $F(3,168) = 193.96$, $p < 0.001$, explaining 77.6% of the variance in the perceived impact of Metaverse technology ($R^2 = 0.776$). Among the predictors, both knowledge and awareness ($\beta = 0.420$, $p < 0.001$) and perceived advantages ($\beta = 0.463$, $p < 0.001$) made strong and significant contributions. In contrast, perceived challenges ($\beta = 0.033$, $p = 0.428$) did not significantly influence the dependent variable.

These findings highlight that employees' awareness and recognition of advantages are the primary drivers shaping their perceptions of Metaverse's impact on tourism promotion. Challenges, while acknowledged in descriptive and ANOVA results, do not diminish the overall positive perception of Metaverse's potential. This aligns with prior research, which stresses that awareness and perceived benefits are crucial determinants of successful adoption of immersive technologies in cultural and tourism institutions.

5 Conclusion

This study set out to evaluate the use of Metaverse technology as a tool for promoting cultural tourism, with a particular focus on the National Museum of Egyptian Civilization (NMEC). Drawing on a quantitative design and data from a structured questionnaire administered to a statistically determined sample of 172 employees (based on Steven Thompson's formula from a total workforce of 300), the research examined five main dimensions: demographic profiles, knowledge and awareness of Metaverse, perceived advantages, perceived impact on tourism promotion, and perceived challenges. Reliability testing using Cronbach's alpha confirmed high internal consistency across all sections of the instrument, ensuring the credibility of the findings.

The results demonstrate that NMEC staff generally possess high levels of awareness of Metaverse technology and recognize its substantial advantages for enhancing museum experiences, preserving cultural heritage, enriching educational outcomes, and improving global accessibility. Importantly, regression analysis confirmed that awareness and perceived advantages are the strongest predictors of Metaverse's

promotional impact, while perceived challenges—although acknowledged—do not significantly diminish its effectiveness as a tourism-promotion mechanism. These findings align with international literature on immersive technologies, which emphasizes the role of staff readiness and perceived benefits in the success of digital transformation initiatives.

Group comparisons provided further insights into patterns of perception. Employees with higher educational qualifications reported greater awareness and stronger recognition of Metaverse's benefits, suggesting that advanced education fosters digital readiness and openness to innovation. Conversely, staff with longer years of experience expressed more concern about operational and technical challenges, indicating that senior employees may be more attuned to potential implementation barriers. Gender differences were minimal but noteworthy, with female respondents showing greater sensitivity to obstacles. Correlation analysis confirmed strong positive relationships between awareness, advantages, and promotional impact, reinforcing the conclusion that strengthening staff knowledge and skills is essential to maximize the technology's potential.

Overall, the study concludes that Metaverse can serve as an effective and innovative instrument for transforming how museums engage with visitors both locally and globally. By offering immersive and interactive experiences, it can help institutions like NMEC increase visibility, strengthen destination branding, and stimulate interest in Egypt's cultural heritage. However, successful implementation will require more than just awareness of the technology's benefits. It will depend on systematic capacity-building for staff, investment in robust digital infrastructure, careful attention to inclusivity and accessibility, and strategies to ensure authenticity in virtual representations and long-term sustainability.

By addressing these areas, the National Museum of Egyptian Civilization can leverage Metaverse to enhance its international profile, attract new audiences, and position Egypt as a regional leader in digital heritage promotion. Beyond its immediate context, the research contributes to the growing body of knowledge on the integration of immersive technologies in cultural institutions and offers practical guidance for museums worldwide seeking to harness Metaverse to enrich visitor engagement, preserve heritage, and advance cultural tourism strategies.

6 Recommendations

Drawing on the overall findings of this study, the following recommendations are proposed to support the effective adoption and sustainable use of Metaverse technology at the National Museum of Egyptian Civilization (NMEC):

Enhance Staff Awareness and Digital Readiness: Implement structured training programs to strengthen employees' knowledge and skills in using Metaverse applications, ensuring all staff can engage with the technology effectively.

Address Educational Gaps: Provide tailored training for employees with lower educational levels, as results showed significant differences in awareness and understanding between staff groups.

Support Experienced Staff in Adoption: Develop targeted capacity-building initiatives for senior employees, who were found to perceive greater challenges, to overcome resistance and build confidence in digital transformation.

Upgrade Technical Infrastructure: Invest in robust digital infrastructure, including reliable internet connectivity, updated servers, and VR/AR equipment, to support seamless and user-friendly Metaverse experiences.

Promote Inclusive Access: Ensure the Metaverse applications are designed with multilingual, accessible, and user-friendly features to accommodate diverse staff and visitor needs, including those with disabilities.

Balance Technology with Authentic Heritage: Maintain cultural and historical accuracy in all virtual representations, ensuring that Metaverse experiences complement rather than replace the authenticity of original artifacts.

Encourage Cross-Sector Collaboration: Establish partnerships with universities, research centers, and technology firms to develop innovative applications and share expertise in immersive technologies.

Monitor and Evaluate Implementation: Conduct regular assessments of the Metaverse's performance, tracking staff perceptions, visitor feedback, and technical challenges to guide continuous improvement.

Ensure Long-Term Sustainability: Develop financial and operational strategies to manage the costs of Metaverse adoption, ensuring that resources are used efficiently and the technology remains viable over time.

7 Further researches

Future research on the use of Metaverse technology in cultural institutions should broaden the scope beyond employees to include visitors' perspectives, providing insights into how immersive experiences influence satisfaction, engagement, and repeat visits. Comparative studies across other Egyptian and international museums would be valuable in identifying shared challenges and best practices, while longitudinal research could track how perceptions evolve as the technology matures. Further exploration of integrating the Metaverse with other emerging tools such as Augmented Reality, Virtual Reality, and Artificial Intelligence could also reveal new opportunities for enhancing cultural experiences. Finally, examining the economic implications of Metaverse adoption, including cost-benefit considerations and its role in sustainable tourism development, would contribute to a more comprehensive understanding of its long-term potential.

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