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Case Report

An Integrated PESTEL-AIDAS Framework for Digitizing Nüshu Archives: Toward Technology-Empowered Participation

Shuwen Fan [1,*], Apple Hiu Ching Lam [1] and Yun Liang [1,2]

[1] Faculty of Education, The University of Hong Kong, Pokfulam, Hong Kong
[2] Graduate School, Xinghai Conservatory of Music, Guangzhou 510006, China
* Correspondence: u3631799@connect.hku.hk

How To Cite: Fan, S.; Lam, A.H.C.; Liang, Y. An Integrated PESTEL-AIDAS Framework for Digitizing Nüshu Archives: Toward Technology-Empowered Participation. *Library, Information & Services* **2026**, *1*(1), 4

Received: 30 December 2025
Revised: 20 February 2025
Accepted: 16 March 2026
Published:1 April 2026

Abstract: The digitalization of Nüshu, a distinctive feminine script and intangible cultural heritage, represents a critical undertaking for both its preservation and its integration into contemporary cultural discourse. This process confronts multifaceted challenges spanning strategic planning to public engagement. This conceptual paper proposes an integrated PESTEL-AIDAS framework to guide the digitization of Nüshu, a feminine form of intangible cultural heritage. Drawing on a systematic synthesis of existing literature on Nüshu studies, cultural heritage informatics, and technology applications, the paper first employs the PESTEL model as a diagnostic tool to identify and categorize the macro-environmental challenges hindering Nüshu's digital development. It then applies the AIDAS model prescriptively to design a staged user engagement pathway. The resulting analytical propositions demonstrate how immersive technologies (AR/VR) and AI-generated content (AIGC) can be strategically deployed to guide audiences from initial attention to sustained satisfaction. This framework offers both a theoretical lens and an actionable roadmap for heritage practitioners, advocating a shift away from technology-centric digitization toward a participatory, audience-centered approach.

Keywords: Nüshu; cultural heritage; digitalization; challenges; PESTEL model; AIDAS model

1. Introduction

Jiangyong Nüshu is a unique female script created by and for women and is an intangible cultural heritage. Its protection is not limited to physical archives, but also requires ensuring its vitality in the contemporary world and promoting the activation of Nüshu. Nüshu is a symbolic system born from women's production practices in Hunan Province, and its survival now largely depends on a limited collection of modern texts and documents [1,2]. Further elucidating its transition from static preservation to dynamic digital integration is urgent. Current Nüshu preservation efforts, led by institutions such as the Jiangyong Nüshu Museum and the Yongzhou City Archives [3], focus mainly on physical conservation and philological research. While important, this emphasis has produced digitization projects that are often fragmented and not easily accessible to the public. Early initiatives like the Nüshu Digital Museum offer a static online repository but lack interactive storytelling and user-centered design, limiting engagement to a small circle of scholars and enthusiasts [4,5]. As a result, most potential users—from domestic tourists to international researchers and diaspora communities—still have limited access to Nüshu's cultural richness due to geographic distance, language barriers, and the lack of compelling, curated digital content [6].

In this study, the term "Nüshu" requires clarification, as it encompasses several interrelated dimensions. First, as a script, Nüshu [2,4–6] is a unique phonographic writing system with approximately 1300 distinct characters.

Second, as archival records [3], it denotes tangible artifacts such as handwritten documents, letters, embroidery patterns, and song texts held in institutions including the Jiangyong Nüshu Museum and the Yongzhou City Archives [5–7]. These materials, inscribed on the China National Archives Heritage List in the early 2000s, form the primary corpus whose digitization is the central concern of this paper (see Figure 1 for examples). Third, as a recognized item of China's national intangible cultural heritage, Nüshu also includes the living practices, knowledge systems, and social meanings associated with the script [3,4,8]—its transmission traditions, the women's communities that sustained it, and the cultural identities it articulates. When existing scholarship notes that the script "absorbs culture", it suggests that Nüshu texts—such as songs, autobiographical writings, and personal correspondence [3–5,9]—both reflect and transmit local agricultural practices, gender relations, and folk customs. This study concentrates chiefly on the digitization of Nüshu archival records, with the broader aim of leveraging digital resources to safeguard and transmit Nüshu as intangible cultural heritage, and to render these records accessible, engaging, and meaningful in contemporary society.

Figure 1. Examples of Nüshu archives exhibited at the Hunan Nüshu Ecological Museum.

To understand the current state of Nüshu digitization: foundational steps have been taken. The Nüshu Digital Museum, established in the early 2010s, provides an online repository of scanned documents and basic descriptive metadata [2,4]. However, this and similar efforts remain largely static repositories, designed for scholarly access rather than public engagement. Usage data, where available, suggests that these resources attract limited attention beyond a small circle of researchers and enthusiasts [8]. The problem, therefore, is not an absence of digitization, but a gap between digitization and meaningful public engagement. Digital records exist, but they are not being used in ways that foster cultural understanding, emotional connection, or sustained participation [9].

This study addresses the following research question: How can heritage institutions strategically deploy emerging technologies to transform static digital archives into dynamic, engaging experiences that guide users from initial attention to deep, sustained cultural engagement with Nüshu? To answer this question, the study proposes an integrated framework that combines two complementary analytical tools. The PESTEL framework (Political, Economic, Social, Technological, Environmental, Legal) originates in strategic management as a tool for scanning the macro-environmental factors that affect organizations and projects [10]. When applied to cultural heritage digitization, it provides a structured lens for identifying the multifaceted challenges—from funding constraints to legal ambiguities—that shape the feasibility and sustainability of digital initiatives. The AIDAS

model (Attention, Interest, Desire, Action, Satisfaction) was developed in marketing and communication to map the psychological stages consumers traverse from initial awareness to loyal engagement [11]. Adapted to heritage contexts, it offers a blueprint for designing user journeys that move audiences from superficial awareness to deep, sustained cultural participation. By integrating these two frameworks, this study creates a governance-to-engagement pathway that links macro-level environmental diagnosis with micro-level intervention design.

2. Literature Review

This literature review examines three interconnected bodies of scholarship that inform the research question. At first, it surveys the existing literature on Nüshu itself, tracing the evolution of research from philological studies of the script to contemporary concerns with digital preservation and dissemination. This establishes what is already known about Nüshu and highlights gaps in current digitization efforts. Secondly, it reviews research on immersive technologies (AR, VR) and AI-generated content (AIGC) in cultural heritage contexts, analyzing how these tools have been used to enhance public engagement with archives and heritage materials. This strand provides the technological foundation for the proposed interventions. Finally, it introduces the PESTEL and AIDAS frameworks, outlining their origins, core dimensions and stages, and relevance to heritage digitization. Together, these three strands of literature establish the theoretical and empirical basis for the integrated framework developed in the subsequent sections.

2.1. Nüshu Textual Preservation to Digital Communication Imperative

Academic research on Nüshu has fully confirmed its significant status as intangible cultural heritage. Nüshu archives are original records created by women in various social activities, with Nüshu serving as the writing symbol or carrier. They not only have essential preservation value, but also carry profound traditional cultural heritage [6–8]. Over the long term, Nüshu has continuously absorbed the essence of traditional Chinese farming and reading culture, as well as regional ethnic culture, gradually forming a unique Nüshu culture, and was successfully included in the first batch of national intangible cultural heritage lists in my country [12].

Academic research on Nüshu [6–9,13] begins with the decipherment of its unique philological features and the documentation of its social function as a female-exclusive script. With the deepening of research, scholars gradually expand their horizons, begin to pay attention to the broader cultural value of Nüshu, and at the same time become aware of the endangered predicament it faces. In the field of Nüshu archives and Nüshu culture, many scholars have conducted in-depth exploration from two perspectives: content and form. In July 1983, Nüshu was first introduced to the academic community after the publication of "A Survey Report on a Special Writing System: A Record of Collecting Folklore in the Yao Mountains in Southern Hunan" [5]. Since then, Nüshu has received widespread attention from academic circles.

To date, interdisciplinary research on women's scripts spans more than 40 academic fields. In 1991, Jiangyong, China, successfully held the first National Women's Script Symposium. This event became an important symbol of the first upsurge in the academic research of female scripts in China [6]. In 2002, Jiang Yong Nüshu was included in the "List of Chinese Archives and Documents Heritage", becoming one of the first 48 groups of documents and archives in the list [9].

From the perspective of the evolution of research hotspots, the research on Nüshu has experienced a development process from the basic research on Nüshu characters, to the basic research on Nüshu culture, and then to the protection of Nüshu culture and its modern value application research [1,14]. Some scholars pointed out that Nüshu archives have been passed down from generation to generation among folk women. Yet, due to local customs, after a woman dies, the Nüshu archives cherished during her lifetime are often buried or burned as funerary objects, making it difficult for many Nüshu archives to be preserved over the long term [8]. Additionally, some scholars believe that in the process of developing and utilizing Nüshu archive resources, there are many problems, such as a lack of vitality, scattered resources, compromised authenticity, and low popularity [2].

Although technologies such as AR have been applied at the Jiangyong Nüshu Eco-Museum, this attempt also marks an important step in the digital dissemination of Nüshu. However, the existing relevant research is still mainly descriptive. Most of these studies focus on the presentation of static archives or the application effects of a single technology, but lack in-depth analysis of how to use digital tools through systematic planning to achieve the continuous dissemination of women's books and cultivate audience groups. Therefore, academic circles generally believe that the research paradigm of Nüshu needs to undergo a substantial change, from a previous model centered on heritage digitization to a new model centered on digital means for disseminating heritage.

2.2. Immersive Technologies and AIGC in Cultural Heritage and Archives

Immersive technologies such as AR, VR, MR, and XR are typically associated with the exploration of physical spaces (historic sites, museum galleries) or three-dimensional objects (artifacts, sculptures). Their application to text-based cultural heritage may seem less intuitive [15]. Immersive technologies encompass a range of tools for creating interactive digital experiences. Augmented Reality (AR) overlays digital information onto the user's view of the physical world, typically through a smartphone or tablet screen. Virtual Reality (VR) immerses the user in a completely computer-generated environment, often using head-mounted displays. Mixed Reality (MR) blends physical and digital worlds in ways that allow real-time interaction between them. Extended Reality (XR) is an umbrella term encompassing AR, VR, MR, and related technologies. Among these, Immersive Virtual Reality (IVR) refers to high-fidelity VR systems that create a strong sense of presence and embodiment. These technologies have been increasingly applied in cultural heritage contexts to enhance public access and engagement [15].

However, a growing body of work demonstrates their potential for enhancing engagement with written materials. AR can overlay digital annotations, translations, or contextual information onto physical documents, transforming a static text into a layered learning resource at the Jiangyong Nüshu Eco-Museum, for instance, an AR application has been piloted that allows visitors to scan exhibits with their mobile devices. When a visitor points their phone at a handwritten Nüshu letter displayed in a glass case, the application overlays an animated visualization showing how the characters were written stroke by stroke, along with a translation and audio narration explaining the letter's content and historical context [7]. In another feature, scanning a traditional embroidery pattern triggers a video of contemporary women demonstrating the embroidery techniques and explaining the pattern's cultural significance. While these applications remain experimental and limited in scale, they demonstrate the potential of AR to transform static archival materials—documents and artifacts—into interactive learning experiences that provide contextual information, bridge language barriers, and connect users to living practitioners.

Among all immersive technologies, VR, exceptionally immersive virtual reality (IVR), is outstanding. It allows users to overcome geographical restrictions and freely explore heritage sites or archival resources reconstructed digitally [16]. VR can reconstruct the social and historical contexts in which texts were created—for example, placing a Nüshu letter within a virtual recreation of the village, home, or women's workspace where it was written and read [16]. These technologies do not replace the text itself but enrich the user's encounter with it by providing spatial, social, and emotional context. For a script like Nüshu, whose meaning is deeply intertwined with the lives and communities of its users, such contextualization is particularly valuable. At the same time, AIGC technology has demonstrated transformative potential for protecting and dynamically disseminating archives. For heritage with exceptional cultural value, such as Nüshu, AIGC technology can enable intelligent translation and the generation of new text content, helping to bridge the gap between language and time [7]. Further, AIGC technology can also play an essential role in the digital protection of ancient books and archives, such as extending the preservation cycle of cultural materials and enhancing their use value through applications such as handwriting restoration, text conversion, and the construction of structured knowledge graphs [17]. Studies have shown that combining large language models (LLMs) with archival data has achieved good results in improving information retrieval efficiency, optimizing the effect of situation interpretation, and reducing information inaccuracy [18].

Yet these advanced technologies still face many challenges when they are put into practical use. One of the most critical issues is ensuring the integrity, authenticity, and security of cultural data throughout the entire process of digital processing and generation [17]. Additionally, the application of generative artificial intelligence in cultural contexts raises several key problems. These include protecting historical accuracy, addressing potential biases in training data, and mitigating the risk that generated content could become homogeneous or deviate from authenticity [19,20]. To achieve the practical application of these technologies, therefore, a balanced and rigorous approach is needed. This approach should combine technological innovation with a sound methodological framework and clear ethical guidelines to attract the attention of contemporary audiences.

2.3. PESTEL and AIDAS Frameworks for Archives Digitalization

The process of heritage and archives digitization is both systematic and complex, and it is necessary to achieve the dual goals of controlling the external environment and guiding audience interaction through multidimensional analysis tools. In this article, the PESTEL framework, as a classic analysis tool in the field of strategic management, systematically examines the linkage impact of the six dimensions of Political, Economic, Social, Technological, Environmental, and Legal, and provides a structured perspective on the challenges faced by digitalization [10]. Taking the digital transformation of Nüshu as an example, its application value is reflected in: the political dimension can clarify the institutional support brought about by cultural heritage protection policies, the economic dimension can evaluate the sustainability of digital funds, and the social dimension can

study and judge the public's support for women's written heritage. The technical dimension can align with the digital tools applicable to Nüshu documents, and the legal dimension can define the copyright boundaries for digital resource development, providing a comprehensive reference for project feasibility demonstration and direction calibration.

Unlike the PESTEL model, the AIDAS model provides a comprehensive guidance framework for audience participation, forming a complementary system for theoretical analysis. With the continuous stages of "Attention-Interest-Desire-Action-Satisfaction" at its core, the model provides an operational blueprint for the design of a precise communication strategy [11]. Although it originated in the field of marketing, improving promotional efficiency by guiding consumers through the process of psychological transformation, the cultural heritage field's demand for public attention capture and continuous participation makes its core principles cross-domain adaptable. In the digital communication practice of Nüshu archives, the value of the AIDAS model is particularly significant: using the communication characteristics of social media platforms to attract public Attention (corresponding to the Attention stage), stimulating Interest through the interpretation of Nüshu cultural connotations (corresponding to the Interest stage), relying on digital experience strengthens the willingness to inherit (corresponding to Desire stage), promotes practical participation with interactive projects (corresponding to Action stage), and finally maintains long-term identity through personalized services (corresponding to Satisfaction stage) to build a complete closed loop of audience interaction.

2.4. Integrating Narrative and Technology in Archives Digitalization

In the theoretical context of audience-oriented models such as AIDAS, the construction of digital heritage has gone beyond the basic goal of information storage and transmission and has turned to the systematic design of meaningful experiences. Narrative is not an independent theoretical category in this process, but a core design principle that bridges the connection between user engagement and emotion [21]. According to the theory of classical narratology, narrative texts are composed of dual elements of content and expression [22], while David Herman's "post-classical narratology" further places narrative in specific historical and cultural contexts, emphasizing gender, ideology, and the interaction between text and historical context [21]. Based on this theoretical basis, archival narrative presents the story of archival documents through "discourse" arrangement under specific themes and historical situations, and digital technology provides a pluralistic path for this presentation. Multimedia and cross-media narrative methods can break through the limitations of a single platform, enrich communication forms through multi-channel content organization, and significantly increase public participation [18,23].

The application of digital technology provides crucial support for narrative innovation in intangible cultural heritage archives and promotes an upgrade in audience participation from mere "interest stimulation" to "deep immersion." AR and VR technologies enable immersive narrative experiences through spatial reconstruction. For example, holographic projection technologies used for Jiangyong Nüshu can recreate scenes of Nüshu transmission, allowing audiences to explore its history within a virtual time–space environment. AIGC, relying on advanced data processing and personalized generation, enables adaptive narrative interaction: it can intelligently classify and archive large-scale data such as Nüshu texts and audio, design interactive popular-science content for young audiences, and generate cross-cultural materials for international users. This technology-mediated, multimodal narrative—integrating text, images, and audiovisual materials—has become a core pathway for activating cultural heritage and constructing cultural memory [24,25]. Its value has been found in cases such as "Nanjing Photo Studio"; AI enhancement technology allows archives to be "visualized", greatly enhancing the emotional impact of the narrative.

For Nüshu archives, the integration of narrative and technology must go beyond isolated technical applications and achieve a systematic arrangement. This requires that, under the guidance of the AIDAS framework, the AR immersive experience, AIGC personalized content, and the female narrative characteristics of Nüshu be deeply integrated: strengthen the micro-narrative strategy through technical means, and lower the participation threshold through virtual guides and intelligent writing interactions. At the same time, it relies on a standardized digital database to verify the narrative's authenticity. This integration path can effectively navigate the entire process of the audience from attention capture to continuous participation, and finally solve the core problems, such as insufficient visibility and weak emotional resonance in the digital communication of women's scripts, and promote the digital memory construction of women's written heritage.

The literature reviewed above provides the foundation for this study's analytical work. It offers an understanding of Nüshu's significance and the current state of its digitization, insight into the capabilities and limitations of relevant technologies, and familiarity with the two frameworks that structure the analysis. The

following sections apply these frameworks to the literature in a systematic manner. Section 3 outlines the methodological approach, while Section 4 presents the results of using the PESTEL framework to diagnose key challenges. It is important to note that the analysis in Section 4 does not introduce new empirical data; instead, it synthesizes and reorganizes existing research—the same literature reviewed above—through the structured lens of the PESTEL dimensions. Similarly, Section 5 employs the AIDAS model to organize the technological possibilities identified in the literature into a staged user-engagement pathway.

3. Methodology

This conceptual study draws on a critical synthesis and analytical integration of existing literature. The methodology follows a two-stage design: at first, a diagnostic environmental analysis using the PESTEL framework; then, the development of a prescriptive engagement strategy based on the AIDAS model.

3.1. Literature Search and Selection

A systematic literature search was conducted using three primary academic databases: Web of Science, Scopus, and China's National Knowledge Infrastructure (CNKI). The search strategy combined four groups of keywords: (1) heritage objects ("Nüshu" OR "women's script"), (2) core concepts ("cultural heritage digitization", "digital archives"), (3) technologies ("VR", "AR", "AIGC", "Gen-AI"), and (4) analytical models ("PESTEL analysis", "AIDAS model", "user engagement").

The literature retrieved using Nvshu-related terms mainly spans 2000–2025 and is predominantly written in Chinese, whereas the technical and model-related literature is primarily in English. Given the rapid evolution and applicability of digital technologies, as well as the growing maturity and visibility of AIGC driven by recent Gen-AI developments, the review of technology- and AIGC-related work focuses on publications from approximately the past 5 years.

3.2. Framework Integration

In the second stage, information on the challenges, opportunities, and contextual factors influencing the digitization of women's books was extracted under the guidance of the six dimensions of the PESTEL framework and mapped to political, economic, social, technological, environmental, and legal categories. This mapping process organizes dispersed findings into a structured diagnosis of the macro-environment and leads to the identification of 4 core systemic challenges (see Section 4, Table 1).

Table 1. Core Systemic Challenges in Nüshu Digitization.

Challenge	PESTEL Dimensions	Core Conflict	Evidence
Uncoordinated Strategy and Governance	Political (Inconsistent implementation) Legal (Regulatory ambiguity)	Strong official support does not translate into coordinated action on the ground, due to fragmented management and outdated regulations.	Fragmented departmental responsibilities [4]; Lack of unified technical standards [9].
Unsustainable Funding and Market Model	Economic (High cost) Social (Limited public interest) Technological (Costly tools)	The high expense of quality digitization is not supported by a market that generates sufficient revenue or public value to cover costs.	Reliance on initial project funding vs. long-term sustainability gap [9]; Limited commercial appeal of current products [26].
Technology Fails to Enable Deep Engagement	Technological (Immature and unstable tools) Social (Superficial content)	Digital tools increase visibility but often lack the sophistication or reliability needed to foster a proper understanding of the culture.	OCR limitations requiring manual correction [2]; Superficial public understanding despite increased exposure [26]; VR technical issues undermining experience [16].
Conflict Between Digital and Physical Authenticity	Environmental (Evolving physical referent) Technological (Mediation necessity) Social (Expectation management)	Creating engaging digital versions can unintentionally distort or replace the value of the original, at-risk cultural and physical context.	Physical sites like Pumei village under development pressure [2]; Digital records becoming fixed representations of evolving originals.

For instance, the challenge of "technology fails to achieve deep engagement" emerges from synthesizing evidence from multiple strands of literature: technology studies that underscore OCR limitations [2], social research that documents superficial public understanding [26], and user experience research that reports technical shortcomings in virtual reality applications [16].

Building on this diagnosis, the study then applies the five stages of the AIDAS model (attention, interest, desire, action, satisfaction) as analytical lenses. Literature on technological applications in the cultural heritage domain (AR/VR/AIGC) is revisited to examine how specific interventions can support each stage of the user journey.

Accordingly, the PESTEL–AIDAS integrative framework is not an arbitrary juxtaposition, but the outcome of a systematic procedure that connects macroscopic diagnostic themes with microscopic, user-centred intervention design.

4. Challenges in Nüshu's Digitalization Based on the PESTEL Analysis

As shown in Figure 2, this study uses the PESTEL framework to systematically present the core elements that affect the digital preservation and dissemination of women's books, focusing on the evaluation of 6 dimensions: Political, Economic, Social, Technological, Environmental, and Legal.

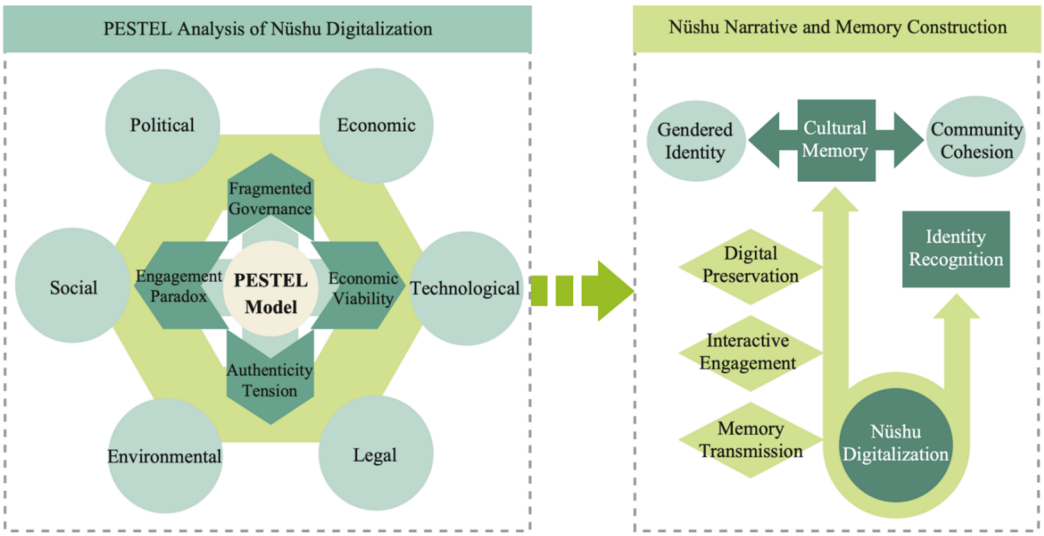

Figure 2. A PESTEL Analysis Framework for Nüshu Digitization and Narrative Construction: This figure visually summarizes the PESTEL analysis presented in Section 4. The six outer boxes (Political, Economic, Social, Technological, Environmental, Legal) represent the six dimensions of the PESTEL framework. Within each box, key challenges identified from the literature are listed. The arrows connecting these boxes illustrate the interrelationships among dimensions—for example, how legal ambiguity (Legal) exacerbates coordination difficulties (Political), and how high costs (Economic) are linked to technological limitations (Technological). At the center, the two overlapping boxes represent the dual focus of Nüshu digitization: "Nüshu Narrative" refers to the stories and meanings constructed around the heritage, while "Memory Construction" refers to the role of archives in preserving and shaping collective memory. The phrases "Engagement Paradox" (referring to the gap between increased visibility and shallow understanding, discussed in Section 4.3) and "Authenticity Tension" (referring to the challenge of maintaining authenticity when physical referents change, discussed in Section 4.5) highlight two cross-cutting challenges that emerge from the interaction of multiple PESTEL dimensions. The figure as a whole conveys that Nüshu digitization is shaped by an interconnected system of environmental factors, and that narrative and memory are at the center of these intersecting forces.

4.1. Political Dimension: Coordination and Strategic Alignment

Political impetus has been crucial to the digitization of Nüshu, with local government support enabling foundational projects such as the Nüshu Digital Museum, an online repository established with institutional backing [9]. This top-down endorsement has supplied key institutional resources. Yet translating strategic commitments into coordinated action remains difficult. Digitization initiatives are frequently fragmented across departments—such as the Jiangyong County Cultural Bureau (responsible for cultural promotion) and the Yongzhou City Archives (responsible for document preservation)—leading to disparate data systems and the absence of unified technical standards [4]. This fragmentation reflects a tension specific to Nüshu: it is claimed simultaneously by local cultural tourism initiatives (which prioritize public engagement) and by archival institutions (which prioritize preservation and scholarly access). These competing mandates create coordination challenges that might not arise for heritage with a single institutional home. At the same time, the rapid evolution of digital tools introduces new complexities. From an archival governance perspective, policymakers must balance

technological innovation with the archival principle of authenticity—ensuring that digital surrogates faithfully represent original materials—while updating regulatory frameworks to keep pace with technological change [17].

4.2. Economic Dimension: Investment and Sustainable Models

Initial funding for digital infrastructure largely came from regional development budgets, supporting the project's first phase [9]. However, from an economic perspective, these initiatives face serious sustainability challenges. The costs of high-quality digitization—including high-resolution scanning, metadata creation, and long-term preservation—are substantial and require ongoing investment. At the market level, digital Nüshu products often lack both commercial viability and broad public acceptance [26]. Many offerings, such as basic e-books or static online galleries, attract attention mainly from academic circles or niche enthusiasts and lack the innovative design and narrative appeal needed for wider dissemination. This imbalance between high capital investment and limited returns undermines the long-term financial health of digital heritage projects, leaving them dependent on public subsidies and vulnerable to shifting funding priorities. Such economic precarity directly affects the archival principle of access, as projects without sustainable funding cannot guarantee continued public availability of digital resources.

4.3. Social Dimension: Engagement Breadth Versus Depth

Digital platforms have successfully increased social awareness of Nüshu. On platforms like Douyin (TikTok), short videos featuring Nüshu calligraphy—often set to music and showcasing the graceful strokes of the script—have attracted millions of views, particularly among younger demographics [9]. However, this visibility comes with a specific limitation for Nüshu. Because the script is visually distinctive and aesthetically pleasing, it circulates easily as image content. Yet the meaning of Nüshu lies not in its visual form alone but in the words written, the women who wrote them, and the social contexts that gave rise to the script. Content optimized for viral dissemination—concise, visual, decontextualized—struggles to convey these deeper layers [2,26]. This creates a participation paradox: while Nüshu's exposure increases, public understanding remains superficial. From an archival perspective, this represents a failure of representation—the digital surrogates circulating online do not adequately represent the cultural richness and complexity of the original archival materials. Changes in intergenerational transmission exacerbate this challenge; as traditional community-based learning models disappear, engaging younger generations with Nüshu's relevance and value has become urgent [27]. New technologies, such as immersive virtual reality, hold promise for creating deeper, more emotionally resonant learning experiences, thereby bridging this gap. However, their effectiveness relative to traditional methods remains unclear, warranting further research [16].

4.4. Technological Dimension: Potential and Persistent Limitations

Technology is a key enabler of digitalization, but a series of contradictions arises in its application. Currently, high-fidelity scanning and digital display tools are relatively mature; however, core technologies for content expansion and interaction are still under development. For example, optical character recognition (OCR) for the unique Nüshu script often fails to achieve ideal recognition rates, requiring extensive and costly manual correction [2]. These technological constraints directly affect the archival principle of appraisal and selection, forcing institutions to make difficult choices about which materials to prioritize for labor-intensive digitization. Advanced applications such as VR may also suffer from user experience issues and technical glitches, undermining their educational potential. Emerging AIGC tools offer possibilities for automatic translation, text generation, and the virtual restoration of damaged manuscripts [7,17]. However, these technologies raise concerns about data quality, algorithmic bias, and the potential homogenization of cultural output [20].

4.5. Environmental Dimension: The Physical Anchor of Digital Narratives

The natural and cultural landscape of Jiangyong County is not merely a backdrop, but a core component of the Nüshu cultural identity. Digital projects fully utilize this environmental advantage, enriching narrative content with imagery and virtual reconstruction technologies [9], thus forming a complex interdependence. Digital narratives rely on the authenticity of the physical environment, which itself is dynamic and fragile [28]. The pressures from tourism development, urban construction, and environmental changes may alter the villages and landscapes that provide the cultural context for Nüshu [2]. This creates a fundamental tension for digital archivists: they must produce faithful digital representations of heritage sites—honoring the archival principle of authenticity—even as the physical referents continually change. The digital archive becomes not only a

preservation tool but also a fixed record of an evolving original, raising questions about which version of a site or practice counts as "authentic" heritage. Digitization is therefore both an act of conservation and a race against potential physical loss, adding urgency and complexity to the archivist's task.

4.6. Legal Dimension: Regulatory Frameworks in a Digital Age

As a legally protected intangible cultural heritage, Nüshu benefits from basic legal safeguards. However, existing legal frameworks are ill-prepared primarily to address the nuances of the digital realm. Ambiguity is particularly acute around intellectual property rights for digital surrogates, blockchain-authenticated collectibles, and AI-generated content that incorporates Nüshu elements [2]. This legal uncertainty stifles innovation, as cultural institutions and potential commercial partners are reluctant to invest when ownership and usage rights remain unclear. From an archival perspective, such ambiguity threatens the principle of provenance: the ability to clearly document the chain of custody and associated rights becomes compromised when legal systems fail to recognize new forms of creation and ownership. Beyond copyright, AI raises deeper questions about data sovereignty, algorithmic transparency, and responsibility for AI-generated cultural content [19,20,28]. Addressing these issues requires continuously evolving legal and ethical frameworks that can support innovative digital transformations while safeguarding the integrity of heritage.

The analysis of these six dimensions shows that the obstacles to Nüshu's digitization are not isolated problems. These obstacles are interconnected, and each obstacle complicates the resolution of the others. The ambiguity of legal provisions exacerbates the political difficulties faced by parties in collaborative action; high economic costs are closely linked to expensive, imperfect technology, which, in turn, affects the depth of social participation. These intertwined issues can ultimately be summarized into the four core systemic challenges listed in Table 1.

As shown in the PESTEL framework, the challenges faced by Nüshu and its digitization are not isolated across different dimensions. Based on this, the next chapter proposes a comprehensive user engagement strategy using the AIDAS model, aiming to transform the widespread visibility achieved through digital means into a sustained, meaningful, and culturally rich connection with Nüshu archives.

5. Proposing Strategies for Nüshu Archives Based on the AIDAS Model

As shown in Figure 3, based on the problems of Nüshu and its digitization, this study uses the PESTEL model to identify the key factors affecting Nüshu's cultural memory construction and identity recognition, and then applies the AIDAS model to focus on deep-seated cultural memory construction and identity recognition, and proposes the following 5 strategies.

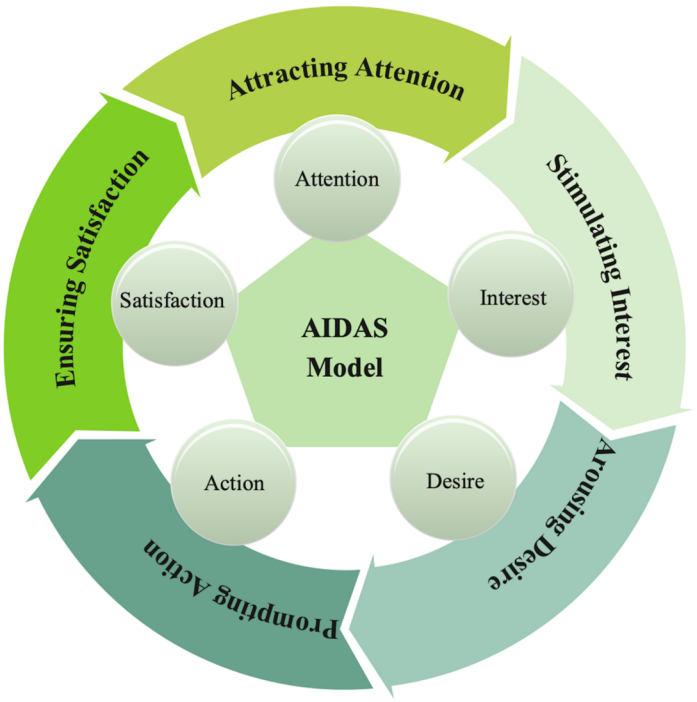

Figure 3. Strategies Based on the AIDAS Model.

5.1. Attention: Attracting Attention

In the initial stage of digital engagement, capturing audience attention is paramount. Social media platforms like TikTok, which feature short, visually impactful videos set against authentic Nüshu cultural backdrops, are especially effective at this stage. The creation of these digital surrogates must be grounded in archival principles of authenticity and representation. Even when designed for virality, such clips must faithfully represent the original cultural context, script, and practices, rather than distorting them for spectacle [17]. This first contact with the content is also the user's first encounter with the archive's governance of its public image, setting the ethical tone for the entire engagement journey. Similarly, AIGC-generated animated posters, while offering stylistic consistency and innovation, must be anchored in verified visual references to ensure that Nüshu's unique aesthetic is represented authentically [20]. Interactive activities—such as Q&A challenges and gamified experiences delivered through mini-programs—can deepen engagement. AIGC can dynamically generate questions about Nüshu's history and cultural background, ensuring that content remains both informative and educational, while digital rewards such as blockchain-certified participation badges help guide users from "complete ignorance" to "initial contact" [19].

From an archival perspective, this attention stage must remain grounded in the principles of authenticity and representation. Visually compelling digital surrogates created for social media should faithfully reflect the original cultural context, script, and practices, rather than distorting them for the sake of virality [17]. This moment also constitutes users' first encounter with the archive's governance of its public image, setting the ethical tone for the entire engagement journey. When AIGC is used to generate visual content, it must be anchored in verified reference materials so that representations of Nüshu's distinctive aesthetic and linguistic features remain authentic, rather than being homogenized by algorithmic patterns derived from other writing systems.

5.2. Interest: Stimulating Interest

After successfully attracting audience attention, the key is to turn passive attention into active interest, and providing a more in-depth and immersive experience is the core path to achieving this. Immersive technologies, such as VR, offer significant advantages at this stage. Constructing richly detailed VR scenes of Nüshu cultural villages, including virtual museums and various interactive elements, can help users overcome geographical and temporal limitations and experience Nüshu culture firsthand [16]. This tangible exploration experience creates a sense of presence that static images and text cannot achieve, allowing users to establish a personalized connection with Nüshu culture. When users can touch simulated Nüshu artifacts, observe writing techniques, and stroll through historical spaces in virtual environments, the multi-sensory stimulation fully arouses curiosity, transforming short-term attention into long-term exploration interest [15]. To maintain and deepen this interest, an intelligent content recommendation system based on AIGC and user data analysis is indispensable. This system analyzes users' browsing history and interaction records across digital platforms to personalize exclusive content for each user. For example, users interested in calligraphy may receive AI-generated Nüshu writing tutorial animations, analyses of classic Nüshu works, or registration notices for related academic seminars. In contrast, users interested in cultural stories will receive content on the female historical narratives behind Nüshu. This personalized recommendation ensures that content closely matches user interests, preventing user churn due to content disconnection and guiding them to explore Nüshu culture actively [18].

This interest stage should be guided by the archival principle of provenance. Immersive experiences and personalized content recommendations must be anchored in the original context of Nüshu materials—their creators, social functions, and historical transmission pathways. For example, a VR reconstruction of a Nüshu learning session should be grounded in documented ethnographic evidence of how knowledge was traditionally passed down among women (provenance of practice), rather than generic templates of "traditional education". Similarly, AIGC-generated content should draw on the archive's provenance metadata—linking each story or tutorial back to specific documents, individuals, or communities—to ensure that the interest being cultivated is rooted in authentic historical and cultural connections, not generic cultural tropes.

5.3. Desire: Arousing Desire

The curiosity cultivated in the interest stage needs to be further transformed into a desire for deep participation or cultural identification, which is the core goal of the desire stage. Developing limited-edition, digitally enhanced cultural and creative products is an effective way to achieve this goal. AIGC can assist designers in achieving creative breakthroughs by combining traditional Nüshu patterns with the aesthetic needs of modern items such as clothing and accessories, creating products that balance cultural connotation and practical value [7]. Subsequently, AR technology can be used to give these physical products dynamic digital attributes—users can

scan the product with their smartphones to watch animated stories about the Nüshu characters or to see virtual writing demonstrations. For audiences who have shown a willingness to "learn Nüshu in depth", providing a structured, high-value learning path is crucial. Developing a comprehensive online curriculum system using AIGC can create scalable and engaging educational resources. This system can cover multiple modules from basic to advanced: the basic module includes AI-generated interactive exercises to help users master Nüshu character recognition; the advanced module uses synthesized video lectures to delve into Nüshu literary analysis and cultural interpretation. Simultaneously, integrating learning progress tracking, milestone reward mechanisms, and blockchain certification upon course completion systematizes and formalizes the fragmented learning process. This design allows learners to have their efforts recognized and reap tangible learning outcomes, thereby strengthening their desire to master Nüshu knowledge and improve their cultural literacy [17].

This stage should be guided by the principle of appraisal and selection. Just as archivists must make deliberate choices about which materials to preserve based on their enduring value, digital heritage practitioners must make curatorial decisions about which aspects of Nüshu culture to highlight in products and courses designed to generate desire. By treating product development and curriculum design as acts of digital appraisal—selecting specific cultural elements to foreground—institutions can ensure that the desire they cultivate is directed toward culturally significant content, not merely commercially appealing novelties. Blockchain certification for course completion can be seen as a digital mechanism for establishing provenance of learning, creating a verifiable record of the learner's engagement with authentically appraised cultural materials.

5.4. Action: Prompting Action

Action Stage-Driving Actual Behavior Conversion: Once the audience develops a desire to participate, it needs to be guided to translate that desire into concrete action. As the primary interaction scenario, the digital platform's design should focus on "lowering the threshold for action". The official website or dedicated app of the Nüshu Museum should feature clear, prominent action buttons that let users quickly find the core interactive entry points. Simultaneously, the user operation process should be optimized, reducing unnecessary clicks and operational obstacles, and paired with mainstream and convenient payment gateways, donating to support the cause, or booking a trip to Nüshu cultural sites, everything should be completed smoothly. Furthermore, promoting audience participation in the dissemination of Nüshu culture is also an important direction for action conversion. Establishing a transparent mechanism for volunteer recruitment and management can effectively mobilize social forces to participate in cultural protection. Promoting volunteer recruitment information through digital channels and social media platforms can attract individuals passionate about Nüshu culture to join. AIGC can support this process by generating customized volunteer training materials, public interaction guides, and easy-to-use content creation tools to lower the barrier to entry for volunteers, allowing even newcomers to the cultural or technical fields to quickly get involved [24].

From an archival perspective, this action stage directly embodies the principle of access. While AIGC tools enable volunteers to create and share content, institutions must establish clear protocols for reviewing user-generated materials to ensure alignment with archival standards of accuracy and authenticity. This constitutes a form of participatory governance in which the archive facilitates public contribution while maintaining oversight to protect the integrity of the cultural record. The action stage thus becomes a key site where access and governance intersect, enabling broad participation while safeguarding against misinformation and cultural misrepresentation.

5.5. Satisfaction: Ensuring Satisfaction

The final stage of the AIDAS model aims to cultivate user loyalty and drive long-term engagement through positive feedback. Building dedicated online community forums or social media groups provides users with a space for exchange and interaction—where they can share their experiences participating in Nüshu cultural activities, showcase their Nüshu-themed works, or offer suggestions on VR experiences and cultural and creative products. Assigning professional community administrators or Nüshu culture experts to promptly and meticulously respond to user feedback is key to maintaining community vitality. This two-way communication not only makes users feel that their opinions are valued but also enables rapid product and service improvements based on feedback, thereby enhancing user trust and overall satisfaction with the Nüshu digitization project [15]. Morever, maintaining long-term satisfaction also relies on the dynamic updating of digital resources, leveraging AIGC and data analysis to regularly launch new VR cultural scenes, AR cultural and creative product lines, in-depth cultural research articles, and advanced Nüshu course modules. For example, themed VR scenes can be released alongside traditional festivals, and course content can be updated in response to users' learning needs. This continuous innovation not only demonstrates the project's vitality and long-term commitment to cultural inheritance but also

provides users with reasons to "participate again", transforming Nüshu digitization participation from a "one-time experience" into a "long-term cultural consumption habit", ensuring that Nüshu culture continues to receive attention and recognition in the digital age [20].

This stage reinforces the principles of provenance and access. On the one hand, dedicated online communities align with an expanded understanding of provenance: the community itself becomes a new context for creating and sharing Nüshu-related content, linking user-generated materials and personal narratives back to the original archival holdings. When users share their creations or discuss their learning experiences, they generate new records that, while not part of the traditional archive, are nonetheless connected to it through their subject matter and inspiration. On the other hand, continuous content updates embody the principle of access, ensuring that resources remain available, relevant, and engaging over time. Responsive community management by experts demonstrates ongoing governance, safeguarding the quality and accuracy of information within these user-driven spaces. Together, these practices sustain trust, deepen engagement, and foster long-term satisfaction by positioning the digital archive as a living, evolving resource rather than a static repository.

6. Discussion

6.1. A Hypothetical Implementation at the Jiangyong Nüshu Museum

To show how the proposed PESTEL-AIDAS framework works in practice, consider its potential application in the main exhibition hall of the Jiangyong Nüshu Museum. The PESTEL analysis highlights several constraints in this setting: the high cost and specialist expertise required for custom VR development (Technological), the tendency for tourist engagement to remain superficial (Social), and the reliance on project-based funding that demands cost-effective solutions (Economic). Together, these constraints indicate that, rather than investing scarce resources in an expensive VR installation for all visitors, the museum could strategically prioritize an AR-enhanced mobile application as a more scalable, affordable, and quickly deployable initial intervention.

Once this technological direction is set, the AIDAS model offers a blueprint for designing the visitor journey. As visitors enter the hall, the application uses image recognition to trigger an AR overlay when their device camera is pointed at key exhibits: a Nüshu character appears to "fly" out of a display case and onto their screen, accompanied by an audio teaser that immediately captures Attention. When visitors point their phones at a handwritten Nüshu letter, the application delivers layered contextual information: an AI-generated voice narrates the emotional story behind the letter, turning a static artifact into a personal narrative that sparks curiosity and deepens Interest. After learning a few basic characters through interactive tutorials, visitors unlock an AIGC-powered personalized feature, "Write Your Name in Nüshu". This cultivates a strong personal connection and a sense of symbolic ownership, generating Desire for deeper cultural engagement.

The application then channels this engagement into concrete Action through prominent buttons linking to the museum's online shop and volunteer registration portal, highlighting AR-enabled cultural products that users can purchase instantly. Finally, after the visit, the application offers personalized recommendations for online courses and community events based on each user's interaction history, while inviting contributions to a "living archive" of user-generated content. This ongoing interaction and sense of community foster long-term Satisfaction, turning a one-time museum visit into an enduring cultural relationship.

This hypothetical example illustrates how the integrated framework converts high-level environmental analysis (PESTEL) into a tangible, phased user experience (AIDAS). The PESTEL diagnosis grounds technological choices in institutional realities, while the AIDAS model ensures that each technological feature supports a specific stage of the visitor journey. The framework thus operates not as an abstract theoretical construct but as a practical planning tool for heritage institutions undergoing digital transformation.

6.2. Theoretical and Practical Implications

Theoretically, this study provides a novel analytical lens that bridges macro-level governance analysis with micro-level user engagement design. While PESTEL has been widely applied in strategic management to identify environmental factors, and AIDAS has served as a foundational model in marketing and communication, their combined application in heritage digitization represents an innovative synthesis. This integrated framework enables a structured transition from diagnostic environmental analysis to prescriptive engagement strategy, addressing a gap in the literature where challenges and solutions are often discussed in isolation [22]. Furthermore, technologies such as AIGC, AR, and VR should not be simply regarded as tools in the process of heritage digitization, but should be fundamentally repositioned as core components of the heritage dissemination ecosystem, constituting a technology-driven cultural digitization framework. Taking AIGC technology as an example, its value far exceeds its basic content

generation function. It can enable large-scale personalized content customization and dynamic creation of educational resources, injecting long-term vitality into heritage dissemination [7,17].

Practically, the framework provides heritage institutions with a structured tool for strategic planning. For institutions like the Jiangyong Nüshu Museum, the framework offers guidance on several fronts. It not only helps justify technology investments by linking them to specific engagement outcomes but also facilitates cross-departmental communication by providing a shared language: technical teams, curators, and community engagement officers can use the AIDAS stages to discuss how their respective contributions fit into an integrated user experience. Additionally, the PESTEL analysis highlights the importance of considering sustainability from multiple dimensions, encouraging institutions to look beyond initial project funding to long-term economic, social, and legal viability. Such experiences can foster a profound emotional resonance and intellectual connection between the audience and the heritage, which is precisely the core element of effective heritage learning, as repeatedly emphasized in existing research [15,16]. This shift in positioning requires emphasizing the role of technology in strengthening cultural memory and emotional connection in the process of cultural digitization.

6.3. Limitations and Future Research

As a conceptual study based on secondary literature review and framework integration, this study has several limitations that point toward productive directions for future investigation.

Firstly, the framework lacks empirical validation. While the strategic propositions are grounded in existing research on cultural heritage technology applications, their actual effectiveness in guiding Nüshu digitization remains untested. The hypothetical museum implementation presented in Section 6.1 illustrates the framework's potential but does not substitute for empirical evidence. Future research should prioritize pilot projects implementing AIDAS-guided strategies in specific settings—such as the Jiangyong Nüshu Museum's exhibition hall or digital portal—to empirically test their impact on user engagement. Key indicators could include dwell time, platform return rate, cultural knowledge acquisition (measured through pre-/post-tests), volunteer sign-up conversion, cultural product purchase rates, and net promoter scores reflecting users' recommendation intentions. Mixed-methods approaches combining usage analytics, satisfaction surveys, and in-depth interviews would provide a comprehensive assessment of both the framework's effectiveness and areas for refinement. Secondly, the economic feasibility and sustainable business models of AIGC-driven or AR-enhanced cultural products require dedicated investigation. As the PESTEL analysis highlighted (Section 4.2), funding remains a core bottleneck for heritage digitization, particularly for niche heritage such as Nüshu. The balance between investment and return, and the construction of sustainable operating models, directly affect project survival [27]. Future research should examine different revenue models—such as freemium digital content, AR product lines, educational course subscriptions, and crowdfunding—to identify sustainable approaches that align with Nüshu's cultural values and audience expectations. Furthermore, the ethical dimensions of generative AI applications in culturally sensitive heritage contexts demand urgent attention. As noted in the legal dimension analysis (Section 4.6), questions of cultural authenticity, potential bias in training data, and the risk of homogenized narratives pose significant challenges [19,20]. Future research should focus on developing and testing specific ethical guidelines and technical safeguards, such as improving the accuracy and cultural adaptability of content generation, to effectively reduce these risks in practice [24,28]. Finally, to enhance the framework's theoretical generalizability, future research should apply the integrated PESTEL–AIDAS framework to other forms of intangible cultural heritage across different cultural contexts and socio-political environments. Such comparative studies would test the framework's universality, identify context-specific adaptations, and refine its constituent variables and internal logic, ultimately contributing to a more robust and widely applicable theoretical model for cultural heritage digitization.

7. Conclusions

As a unique writing system used exclusively by women worldwide, Nüshu plays an irreplaceable role in shaping women's collective memory and strengthening cultural identity. Its cultural value and significance for inheritance deserve more exhaustive exploration, development, and promotion. This study systematically explores the digitization process of Nüshu archives by constructing and applying an integrated PESTEL-AIDAS framework. Unlike previous studies that listed challenges and strategies in isolation, this analysis identifies four interrelated clusters of core challenges: strategic fragmentation, economic sustainability gaps, the paradox of deep participation, and authenticity tensions. Addressing these systemic issues, the study further integrates the characteristics of emerging technologies to formulate targeted strategic advancement paths.

This paper set out to address the strategic and engagement-related challenges of digitizing Nüshu archives. By proposing and elaborating the integrated PESTEL–AIDAS framework, it makes several core contributions to cultural heritage informatics and archival studies.

Firstly, the paper introduces a theoretical lens that systematically links macro-level heritage governance (PESTEL) with micro-level user engagement design (AIDAS). This integrated perspective moves beyond approaches that treat digitization as purely technical or curatorial, offering a holistic tool for diagnosing complex digitization challenges and designing coherent, context-sensitive interventions. Secondly, it presents a methodological template for literature-based, conceptual research in archival digitization. The transparent two-stage process in Section 3—systematic literature search followed by theory-driven thematic mapping to PESTEL dimensions and AIDAS stages—provides a replicable model for future work that seeks to build theory from existing evidence. Thirdly, the study offers a contextualized application of emerging technologies (AR, VR, AIGC) by mapping them onto a structured user journey and grounding them in archival principles. This reframes the discourse beyond technological solutionism, treating these tools not as ends in themselves but as strategic enablers of authenticity, provenance, representation, and access in the digital age.

For heritage institutions such as the Jiangyong Nüshu Museum and other archival bodies, the framework carries two main practical implications. First, it calls for a shift from technology-led projects to audience-centered design. Investments in tools like AR or AIGC should be informed by a clear understanding of which stage of the user journey (e.g., capturing Attention vs. cultivating Desire) they are meant to enhance, so that resources are used effectively and technology choices follow engagement objectives rather than novelty. Second, it underscores the need for cross-departmental collaboration. Effective implementation depends on breaking down silos between technical teams, curators, community engagement officers, and legal advisors, ensuring that interventions align with governance conditions (PESTEL), engagement goals (AIDAS), and archival principles across the user journey.

This conceptual work opens several avenues for empirical research. A first step is to run a pilot study that implements AIDAS-guided strategies in a concrete setting—such as the Jiangyong Nüshu Museum's exhibition hall or digital portal—to evaluate their impact on user engagement. Potential indicators include dwell time, return visits, cultural knowledge gains (via pre-/post-tests), volunteer sign-up rates, and cultural product purchases. Such studies would strengthen the framework's empirical grounding and allow its refinement based on real-world feedback. A second direction is to examine the ethical implications of using generative AIGC with a culturally sensitive heritage like Nüshu. Future work should develop and test protocols for safeguarding cultural authenticity, mitigating algorithmic bias, and establishing governance models for AI-generated cultural content—issues flagged in our PESTEL analysis (Legal dimension) but beyond the scope of this conceptual study. Addressing these challenges will require collaboration among archival scholars, AI ethicists, and Nüshu cultural experts.

Author Contributions

S.F.: conceptualization, methodology, investigation, formal analysis, original draft preparation and editing. A.H.C.L.: supervision, review and editing. Y.L.: validation, review and editing. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data are available from the author on request.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

This paper has been polished for language expression with the assistance of AI tools including DeepSeek and Grammarly.

References

1. Chang, H.; Tian, Y.; Fu, J. Development and application of the curriculum resource library for the study tour of Jiangyong Nüshu culture. *J. Hunan Univ. Sci. Eng.* **2023**, *44*, 35–38.
2. Liu, Y.; Yan, J. From Female Identity Recognition to Cultural Identity: The Value Change and Development and Utilization Strategies of Nüshu Archive Resources. *Arch. Sci. Study* **2023**, *3*, 104–111.
3. Yongzhou Nüshu Archive Literature. *China Archives News*, 4 March 2010, p. 2.
4. Zhou, Y. Thoughts on the Protection Status and Strategies of Nüshu Archives. *Lantai World* **2019**, *8*, 120–122.
5. Gong, Z. A survey report on a special writing system: A record of collecting folklores in the Yao Mountains in southern Hunan. *J. South-Cent. Univ. Natl.* **1983**, *3*, 122–128.
6. He, J. Nüshu Archives: A Wonderful Work in the Memory of the World. *Shanxi Arch.* **2005**, *5*, 46–49.
7. Liu, Y.N.; Dong, S.H. AIGC-enabled communication paths of Jiangyong women's script. *Pap. Mak. Inf.* **2025**, *2*, 110–111.
8. Huang, Y. Unveiling the Mysterious Veil of the Millennium-old Yao Nüshu—Visiting the Yongzhou Yao Nüshu That First Appeared on the "List of Chinese Archival Document Heritage". *China Arch.* **2011**, *12*, 64–65.
9. Li, M. Research on the Protection of Jiangyong Nüshu Archive Resources. *New Legend.* **2024**, *12*, 101–103.
10. Lim, Y.J. The PESTEL model application to Ok Boomer and TikTok from a public relations perspective. *J. Media Res. Rev. Stud. Media* **2020**, *13*, 94–110.
11. Hassan, S.; Nadzim, S.Z.A.; Shiratuddin, N. Strategic use of social media for small business based on the AIDA model. *Procedia-Soc. Behav. Sci.* **2015**, *172*, 262–269.
12. Zhao, L. Legendary Nüshu: Nine Hairpins of the Talented Ladies in the Flowery Path (Revised edition). *Natl. New Books Cat.* **2021**, *5*, 29.
13. Zhang, M. Promoting, Regulating, and Guiding the Subjectivity of the Inheritance of Nüshu Culture-Fieldwork on the Inheritors and the Way of Inheritance. *Trans. Soc.Sci. Educ. Humanit. Res.* **2024**, *5*, 162–168.
14. Dai, Y.; Liu, S. Research on the Exhibition and Broadcasting Service of Intangible Cultural Heritage Archival Resources Under the Framework of Digital Intelligence Driven—Taking "Along the River During the Qingming Festival 3.0" as an Example. *Arch. Constr.* **2024**, *7*, 64–71.
15. Anwar, M.S.; Yang, J.; Frnda, J.; et al. Metaverse and XR for cultural heritage education: Applications, standards, architecture, and technological insights for enhanced immersive experience. *Virtual Real.* **2025**, *29*, 51.
16. Tang, H.; Zhang, C.; Li, Q. Assessing creativity and user experience in immersive virtual reality with cultural heritage learning. *Int. J. Hum. Comput. Interact.* **2025**, *41*, 8136–8152.
17. Ma, G.; Pu, Z. Resurrection and Heritage: Research on the Application of AIGC in the Preservation of Ancient Books in Archives. *Int. J. Adv. AI Appl.* **2025**, *1*, 21–38.
18. Fu, Y.; Song, J.; Zhang, X.; et al. Innovative practice of archival data development workflow in the AGI era: A case study of scientist archives project. *Inf. Res. Int. Electron. J.* **2025**, *30*, 349–360.
19. Natale, S.; Surace, B.; Mensa, E.; et al. ChatGPT for cultural heritage and the customization of generative AI: A talkthrough analysis of the Luigi Einaudi chatbot. *New Media Soc.* 2025, *online first*. https://doi.org/10.1177/14614448251384258.
20. Chen, X. Research on the Digital Application of Museums under AIGC Technology. *J. Theory Pract. Manag. Sci.* **2025**, *5*, 25–29.
21. Lian, Z.; Yu, M. Archival Narrative and Empathy: Theoretical Explanation and Empirical Analysis. *Arch. Sci. Bull.* **2024**, *6*, 13–21.
22. Zhao, X.; Peng, D. Research on the Digital Narrative Mode of Archives in the Environment of Digital Intelligence. *Arch. Sci. Res.* **2022**, *5*, 67–73.
23. Guo, J. Innovative Dissemination of Archival Cultural Memory from the Perspective of Digital Narrative. *Arch. Mem.* **2024**, *9*, 54–56.
24. Fu, Y.; Zhang, Y.; Liu, W.; et al. Digital Narrative as a Digital Humanities Method: Current Situation and Possibilities. *Libr. Inf. Serv.* **2022**, *66*, 10–19.
25. Feng, H. Digital memory from the perspective of digital humanities: Also on the methods and characteristics of digital memory. *Digit. Humanit. Res.* **2020**, *46*, 4–16.
26. Qi, Y.; Cui, S. Construction of Cultural and Tourism Element Extraction Model and Reconstruction of Intangible Cultural Heritage Cultural and Tourism Efficiency Positioning——Taking the Nüshu Intangible Cultural Heritage Project as an Example. *J. Chang. Soc. Work. Coll.* **2024**, *31*, 130–136.
27. Zhang, G.R.; Song, X.X. A study on the cultural and creative development of intangible cultural heritage women's script. *Art Res. Lett.* **2024**, *13*, 158.
28. Liu, Z.; Zhou, Y. Research on the Archive Digital Narrative Model Empowered by AIGC. *Zhejiang Arch.* **2024**, *10*, 18–22.