Architectures of Knowledge: Archival Spaces at the Intersection of Library Science and Heritage Design – A Documentary Case Study Series

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Abstract

Amidst the prevailing trend of accelerated digitalisation and the imperative to uphold cultural identity, archival spaces have transcended their traditional role of merely storing historical records. This study investigates an archival environment through a series of documentary case studies situated at the intersection of library science and heritage design. The research seeks to examine the preservation of heritage buildings by archiving architecturally significant historical spaces, employing archival methodologies throughout the process. A mixed-methods approach is adopted to document the foundational principles of library science, with a particular focus on information organisation, textual documents, image-based records, heritage materials, and access systems as evidenced in the utilisation of archival facilities. Data were gathered from heritage buildings across various countries through field observations, expert interviews, and archival surveys. The data were analysed using IBM SPSS 26, with descriptive statistics employed to evaluate the prevalence of particular design features and conservation strategies, while chi-square tests assessed associations between spatial configurations and user engagement metrics. The findings indicated that the heritage sites effectively integrated contemporary archival functions whilst retaining their historical identity. Open-plan configurations and spatial transparency exhibited a statistically significant association with increased user engagement ($p < 0.05$). Common challenges in preservation, such as environmental regulation within ageing structures, were adeptly addressed through non-invasive retrofitting and sensor-based monitoring systems. A notable correlation ($r = 0.64$) was identified between comprehensive metadata systems and users' perceived accessibility. Heritage spaces are being reconfigured for archival purposes, facilitating a data-informed comprehension of architectural design, cultural heritage, and knowledge management, thereby advancing preservation frameworks that uphold both historical authenticity and contemporary accessibility.

Keywords: Archival Spaces, Cultural Heritage,

Library Science, Architectural Design, Preservation, Heritage Buildings.

Introduction

The traditional functions of archival spaces have been significantly transformed in the context of rapidly advancing technologies and the widespread digital transformation of information systems (Rahmanova, 2025). No longer confined to their conventional role as static repositories, these spaces have evolved into dynamic environments that engage with issues of memory preservation, identity formation, and cultural continuity, prompting a redefinition of their purpose and significance (Alnaim, 2024). The integration of heritage design with principles of library science presents an opportunity to reconceptualise archives not merely as storage facilities for documents or books, but as interactive and inclusive cultural hubs that actively engage with local communities and contribute to the safeguarding of their intangible and tangible heritage (Mugamba, 2025).

Within this framework, architectural design assumes a critical role in shaping how information is preserved, accessed, and experienced by diverse user groups (Al-Adilee, 2024). The thoughtful integration of historical significance, aesthetic form, and practical functionality allows for the creation of archival environments that are both secure for the conservation of sensitive materials and inviting for public interaction (Jaillant et al., 2025). These spaces must, therefore, reconcile two often conflicting objectives: the protection and handling of delicate archival content and the facilitation of open access to information for researchers, students, and the broader public (Onunka et al., 2023). Consequently, contemporary archival spaces are increasingly recognised as significant cultural landmarks that bridge historical narratives with contemporary needs, thereby becoming focal points for intentional and contextually responsive architectural interventions (Ortega-Sánchez and López-Sanvicente, 2023). Figure 1 illustrates the conceptual framework of archival heritage design along with projected pathways for future development.
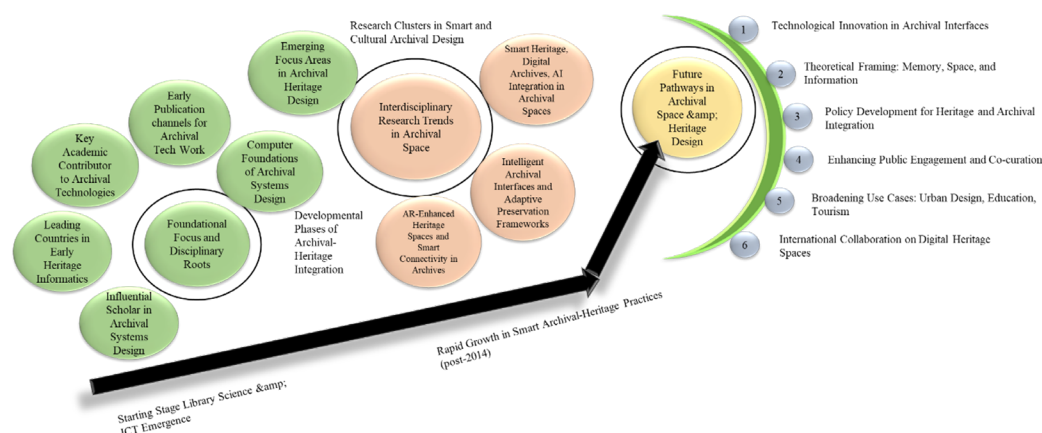

Figure 1: Evolution of Archival Heritage Design Research and Future Development Directions.

Conceived as an interdisciplinary approach, the identified strategy demonstrates the influence of spatial design on user experience, its inclusive nature, and the enduring longevity of both physical and digital records (Suman and Peelwan, 2024). The principles of heritage conservation underpin design methodologies that preserve the authenticity of historic structures whilst incorporating modern technology to enhance their functionality. Furthermore, the transition towards participatory archives fosters agency, narrative, and education aligned with the broader societal mandate

of memory institutions (Makula and Turner, 2022). By merging the technical precision of library science with the sensorial and symbolic dimensions of heritage design, the archival domain is advancing towards the formation of holistic environments in which knowledge, in all its forms, is honoured (Shiri et al., 2022). These are no longer passive repositories of silent knowledge; rather, they are becoming spaces of discourse, platforms for learning, and expressions of culture that are both forward-looking and firmly anchored in historical integrity (Thorpe, 2021).

Preservation and accessibility represent a complex dual objective. Flexibility is frequently limited by spatial constraints, the specific demands of facilities maintenance, and the integration of contemporary technologies into heritage buildings. Additionally, endeavours to retain historical authenticity while improving operational functionality may necessitate design compromises, potentially restricting the adaptability to meet evolving demands or exposing historically sensitive structures to new digital frameworks. The study sought to examine how archival practices are embedded within historically significant buildings, with a focus on the ways in which principles of library science—such as organisation, records management, and access systems—are manifested in the spatial design of archival environments through both qualitative and quantitative analysis.

Key Contribution

Data Collection

Mixed-method data were collected from 26 heritage archival sites across multiple countries through field observations, expert interviews, and archival surveys to examine spatial design, metadata systems, and user engagement.

Variables

Principal variables comprised spatial configuration type, user engagement level, metadata richness, preservation strategy, and perceived accessibility, all measured via structured observation instruments, user surveys, and archival content audits.

Statistical Test

Descriptive statistics, chi-square tests, correlation analysis, and ANOVA were employed to evaluate the relationships among spatial characteristics, metadata systems, and user engagement within archival environments.

Findings

Heritage sites featuring open spatial layouts and enriched metadata systems exhibited significantly higher levels of engagement and accessibility. The coexistence of modern archival functions with historic preservation was critically analysed within architectural contexts.

The structural framework of the research is outlined as follows: A list of literature reviews is provided in Section 2. The method is detailed in Section 3. The Results and Discussion are presented in Section 4. Section 5 offers the conclusion.

Related Works

Participatory cultural heritage projects that utilise digital platforms to engage communities in the creation and sharing of collective memories were analysed by Liew et al. (2022). The findings also demonstrated a variance in levels of engagement, revealing that human-centred design and community-based foundational principles resulted in greater degrees of and longer-term involvement within these programmes. Scientific anthropologists and archaeologists interact with archival data, exploring their perceptions, applications, and challenges, as examined by Marsh et al. (2023). The findings highlight high levels of gatekeeping, limited archival knowledge, and differing attitudes towards data reuse, pointing to the necessity of rethinking archives within the broader mechanisms of science. Renshaw and Liew (2021) explored the perspectives and experiences of information professionals in New Zealand regarding descriptive standards and collection management systems used in cultural heritage institutions. The findings revealed significant inconsistencies in metadata across institutions, impeding discoverability and access, thereby underscoring the importance of cross-sector collaboration and integration of collection management systems.

Cultural heritage and digital technologies, investigated through CiteSpace analysis, revealed key developments and trends in Digital Cultural Heritage (DCH), as studied by Lian and Xie (2024). Immersive technologies, digital archives, and user engagement emerged as interconnected themes, yet remain confined to narrow areas of focus. The need for balanced, sustainable, and standardised DCH practices was emphasised globally. Alba et al. (2023) examined the Arxiu Valencià del Disseny (AVD) as a significant initiative dedicated to preserving and promoting design heritage through digitisation, cataloguing, and intelligent tools. The results highlighted the successful development of interactive systems that enhanced access, understanding, and interoperability of Valencian and European design archives for broader public engagement. Mugamba (2025) explored the evolution of training specialists in Information,

Library, and Archival Science (ILAS) at Lviv Polytechnic towards Digital Humanities. The findings indicated a shift towards a hybrid educational model that incorporates digital competencies, aligning with internationally recognised trends while addressing the demands of Ukraine's expanding information market.

Alencar et al. (2024) provided an in-depth analysis of the discourse community surrounding the Archival Education Research Initiative (AERI), its members, and related scholarship published between 2008 and 2021. The study revealed two dominant thematic orientations: one focused on biographical information, particularly themes of social justice and political marginalisation, and the other centred on the use of Information and Communication Technology (ICT) and the organisation of knowledge in archival practice. Similarly, Wang and Si (2024) examined how libraries are addressing digital inequalities and fostering equitable access through digital literacy and inclusive initiatives. Their findings underscore the significance of policy development, library-led programmes, and training initiatives in promoting digital participation and contributing to the library's role in shaping an inclusive digital society. Natsir et al. (2024) assessed the impact of digital libraries on improving information access, resource coordination, collaboration, and data security within public sector institutions. The results concluded that digital libraries are instrumental for effective management and policy-making, with implications for operational efficiency, knowledge transfer, and digital security.

Transmedia storytelling, positioned as a response to conflicting historical narratives, is advanced through the concept of shared authority introduced in modern historiographical discourse, as proposed by Basaraba and Cauvin (2023). Their study suggests that transmedia practices offer broader participation in the interpretive process by providing multiple media and platforms for historical engagement, supporting diverse viewpoints, and promoting inclusive historical narratives. In the field of cultural preservation, Bembibre and Strlič (2022) explored the notion of olfactory heritage, identifying associated processes, materials, and activities linked to the conservation of scent-related cultural heritage. Their study, employing a system dynamics perspective, revealed the intricate relationship between sensory experience and cultural memory, affirming that olfaction constitutes a vital component of intangible heritage. The findings point to interdisciplinary gaps, recommend methodologies for the preservation and

display of scents, and highlight the potential of digital resources to enhance understanding and engagement with olfactory heritage. Niccolucci et al. (2022) developed a semantic infrastructure for the cultural heritage data space, introducing a Heritage Digital Twin ontology aligned with existing standards and platforms such as Europeana. The outcome was a structured knowledge base that improved interoperability and supported robust digital representations of cultural assets through practical case applications.

Meinecke (2022) investigated the challenges of applying visual analytics and machine learning techniques within interdisciplinary projects involving cultural heritage data, particularly intangible heritage. The findings, drawn from three case studies, identified key insights into data-related limitations, participatory design processes, and valuable considerations for visualisation scholars operating within heritage contexts. In Zimbabwe, librarians ethically preserve indigenous knowledge in digital environments, as documented by Chigwada and Ngulube (2024). The study revealed that libraries document oral traditions such as poetry, folklore, drama, and traditional performances, yet they face ethical challenges. The findings stressed the necessity of collaboration with indigenous communities to ensure respectful and effective preservation. Feng et al. (2021) examined the status of archival technologies in China and globally, identifying central research areas and future directions. Their findings demonstrated both commonalities and unique priorities, outlining three principal orientations: management, technology, and the humanities, and proposed promising pathways for future international and interdisciplinary collaboration. Batchelor et al. (2021) explored the emergent discourse of Smart Heritage situated between the domains of heritage and smart cities. The results indicate that Smart Heritage has become a distinct field, incorporating automated technologies into heritage interpretation and poised to lead the development of future heritage practices.

Research Gap

Despite progressive advancements in the field of DCH, contemporary research reveals persistent disparities in metadata consistency (Renshaw and Liew, 2021), limited archival reuse (Marsh et al., 2023), insufficient procedural standardisation (Lian and Xie, 2024), and ethical shortcomings in preservation practices (Chigwada and Ngulube, 2024). These limitations hinder user engagement and restrict

cross-institutional interoperability. In this context, the present study seeks to integrate library science into the core of heritage design, facilitating the creation of adaptive archives that ensure cultural continuity and enhance accessibility.

Methodology

The study employed a mixed-methodology to examine the intersection of archival spatial design with library science and heritage processes. Key variables measured included spatial configuration, metadata richness, preservation strategies, perceived accessibility, and user engagement. IBM SPSS 26 was utilised to perform statistical analyses, including descriptive statistics, regression analysis, chi-square, correlation, and ANOVA. Figure 2 presents the methodological framework integrating spatial design with the analysis of archival and heritage information.
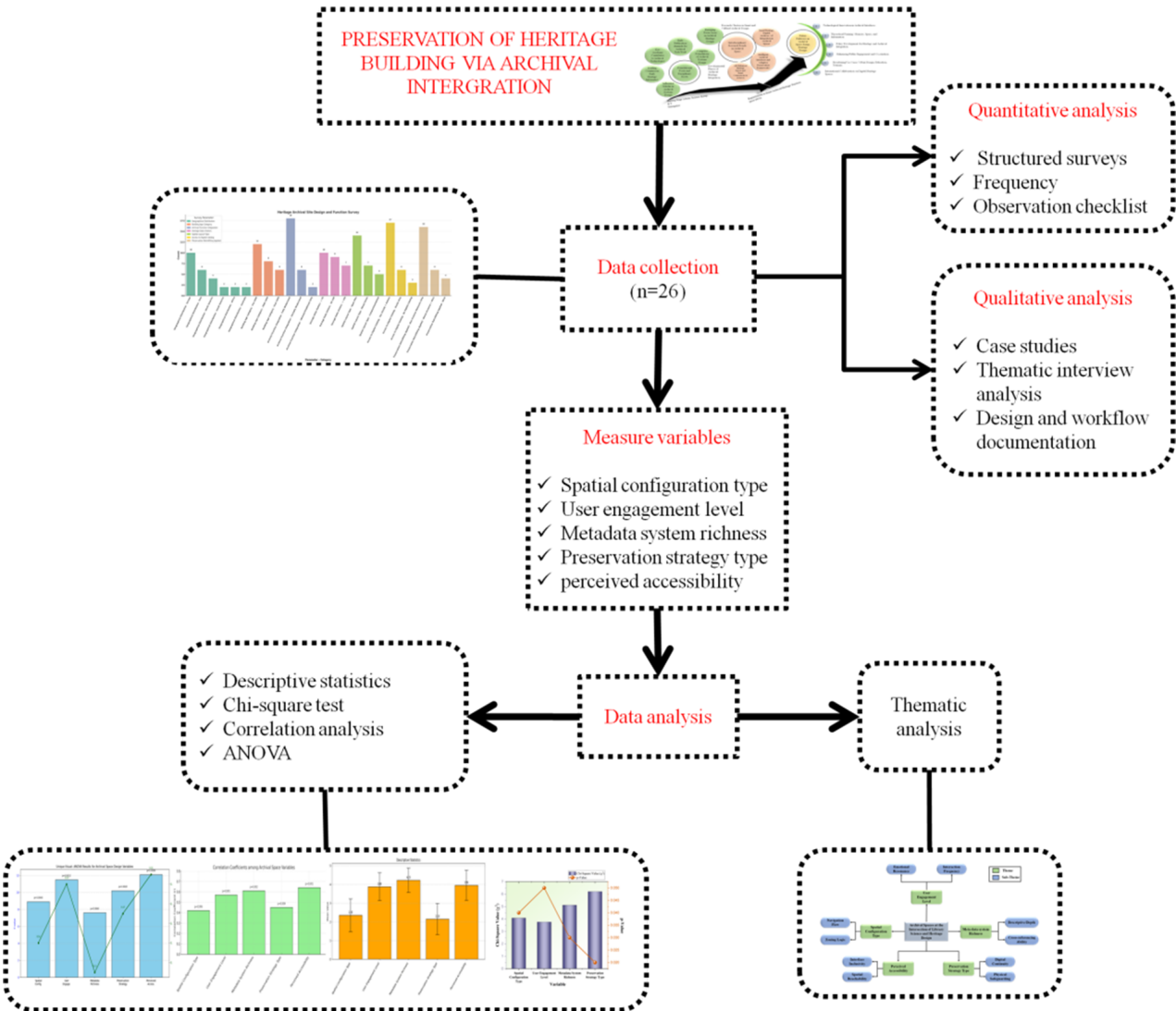

Figure 2: Methodological Flow for Integrating Spatial Design with Archival and Heritage Design.

Data Collection

Data were gathered through a mixed-methods approach that integrated qualitative case studies with quantitative surveys. This dual methodology offered a comprehensive perspective on the interaction between archival spatial design and library science principles within heritage buildings, capturing both quantifiable trends and contextual insights from professionals across a range of cultural sites.

Quantitative Data Collection

Quantitative data were collected from 26 heritage archival buildings across six countries. Structured surveys recorded information on 14 architectural design variables (e.g., layout type, lighting control, shelving systems) and 12 archival features (e.g., metadata depth, catalogue access, user interaction points). Frequency counts and checklists were employed to document the presence or absence of each feature.

Qualitative Data Collection

Qualitative data were obtained through comprehensive field observations, expert interviews, and documentary analysis conducted at the selected case study sites. Eighteen semi-structured interviews were carried out with archivists, heritage architects, and cultural preservation officers, concentrating on archival workflows, design challenges, and adaptive strategies.

Response Rate

Of the 35 structured surveys distributed to heritage archival institutions, 5 were not returned, and 4 were incomplete or deemed unusable due to missing or inconsistent data. This resulted in a total of 26 valid responses, corresponding to an effective response rate of approximately 74.3%. Despite the limited number of unusable responses, the valid surveys furnished comprehensive and reliable data regarding the spatial and archival configurations of heritage buildings. Table 1 presents a summary of the survey response data.

Table 1: Summary of Survey Response Data.

Category	Count (n)	Percentage (%)
Surveys Distributed	35	100.0
Surveys Not Returned	5	14.3
Incomplete/Unusable Responses	4	11.4
Valid Responses	**26**	**74.3**

Architectural Characteristics and Archival Features of Heritage Sites (n=26)

The survey analysed 26 heritage sites, revealing a range of characteristics. Geographically, Europe accounted for 38.5%, followed by Asia at 23.0% and North America at 15.5%. Nearly half of the buildings (46.0%) were constructed prior to 1900, while 30.7% dated from between 1900 and 1950. The majority of sites (69.2%) featured fully modernised archival functions. Daily visitor numbers were generally low, with 38.5% receiving fewer than 50 visitors and only 26.9% exceeding 100. Spatially, open-plan layouts predominated (53.8%), followed by mixed zones (26.9%) and compartmentalised designs (19.2%). Digital catalogue access was widely available both onsite and online in 65.4% of cases, whereas 11.5% lacked any digital system. Preservation retrofitting had been implemented in 84.5% of sites, primarily through non-invasive measures (61.5%). These statistics illustrate prevailing trends in balancing heritage conservation with contemporary archival usability. Table 2 presents the Heritage Archival Site Design and Function Survey.

Table 2: Heritage Archival Site Design and Function Survey.

Parameter	Category/Value	Count (n)	Percentage (%)
Total Heritage Sites Surveyed	—	26	100%
Building Age Category	Pre-1900	12	46.0%
	1900–1950	8	30.7%
	Post-1950	6	23.0%
Archival Function Integration	Fully Modernized	18	69.2%
	Partially Modernized	6	23.0%
	Minimal/Traditional Only	2	7.8%
Average Daily Visitors	< 50	10	38.5%
	50–100	9	34.6%
	> 100	7	26.9%
Spatial Layout Type	Open Plan	14	53.8%
	Mixed Zones	7	26.9%
	Compartmentalized	5	19.2%
Access to Digital Catalogue	Yes (Onsite + Online)	17	65.4%
	Onsite Only	6	23.0%
	No Digital Catalogue	3	11.5%
Preservation Retrofitting Applied	Non-Invasive Measures Only	16	61.5%
	Mixed (Invasive + Non)	6	23.0%
	None	4	15.5%

Research Design

The research design adopts a mixed-method approach, combining quantitative surveys with an in-depth examination of the relationship between archival spatial design and library science principles within heritage settings. A structured survey employing a 5-point Likert scale (1 indicating strongly disagree and 5 indicating strongly agree) was administered to 26 heritage professionals and archival staff as part of the quantitative phase. The survey sought to capture participants' perceptions and experiences concerning key elements of archival environments. Survey items addressed spatial configuration, user engagement, metadata system richness, preservation strategies, and perceived accessibility, as outlined in Table 3. This methodological framework facilitated data triangulation, yielding both quantifiable insights and contextual understanding of how heritage design underpins archival functionality and user-centred knowledge management. The M-score (mean score) was computed by multiplying the frequency of responses for each scale value by its corresponding Likert score, summing these products, and dividing by the total number of responses, as expressed in equation (1).

$$M = \frac{(n_1 \times 1)+(n_2 \times 2)+(n_3 \times 3)+(n_4 \times 4)+(n_5 \times 5)}{N} \quad (1)$$

Where n_1, n_2, n_5 are the count of responses, and N is the total respondents.

Table 3: Questionnaires for Variables using a 5-point Likert Scale.

Question (Statement)	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	M Score
Spatial Configuration Type						
Does the spatial layout of the archival building support easy navigation and intuitive way finding?	1	2	5	10	8	3.88
Do open-plan or hybrid spatial layouts enhance user engagement and workflow?	0	3	4	12	7	3.92
User Engagement Level						
Does the design of the archival space encourage longer visits and more interaction from users?	2	2	5	11	6	3.77
Do spatial aesthetics and functional design influence your overall satisfaction as a user?	1	1	6	11	7	3.92
Metadata System Richness						
Does the archival catalogue provide detailed and helpful metadata for locating resources efficiently?	2	2	6	11	5	3.69
Are tagging and classification systems well-organized to support accurate and quick retrieval of materials?	1	2	7	10	6	3.77
Preservation Strategy Type						
Do preservation strategies (e.g., retrofitting, climate control) help maintain archival quality and authenticity?	1	3	8	10	4	3.54
Are preservation interventions minimally invasive and respectful of the heritage character of the building?	2	2	6	11	5	3.65
Perceived Accessibility						
Is the archival environment physically easy to navigate and access for a diverse range of users?	0	1	5	13	7	4.00
Does the availability of both digital and physical access systems improve your ability to find archival resources?	1	1	6	11	7	3.92

Data Analysis

The integration of archival practices within heritage structures was examined through a mixed-methods approach, incorporating both qualitative and quantitative data analysis techniques.

Quantitative Analysis

Quantitative data from structured surveys were analysed using IBM SPSS (version 26). Descriptive statistics summarised architectural and archival variables for the 26 surveyed sites, including layout types, metadata systems, access practices, and preservation aspects. Frequency distributions and cross-tabulations were employed to identify spatial design and archival integration patterns. Chi-square tests and correlation analyses were conducted to examine associations between spatial configuration patterns, metadata richness, and engagement measures.

Qualitative Analysis

Field observations, documentary reviews, and 18 expert interviews were analysed qualitatively with regard to thematic content. Key themes such as space usability, preservation challenges, and adaptive design concepts were coded and categorised using a grounded theory approach. The quantitative findings were triangulated with these qualitative data to provide a richer depth of interpretation and to substantiate the integrated paradigm of archival spatial design within heritage contexts.

Results and Discussion

The Archival Spaces at the Intersection of Library Science and Heritage Design: Descriptive statistics summarise key user responses concerning spatial layout, engagement, accessibility, and metadata quality. Chi-square tests reveal significant associations between categorical variables, such as preservation strategies and perceived usability. Correlation analysis identifies positive relationships between spatial configuration and levels of user engagement. Analysis of Variance (ANOVA) detects statistically significant differences in user experience based on design variables, including spatial type and metadata richness. Thematic analysis further interprets qualitative responses, emphasising recurring patterns in how users interact with, navigate, and emotionally connect to archival environments.

Descriptive Statistics

Descriptive statistical analysis highlighted user preferences concerning the design of archival spaces, with emphasis placed on accessibility, spatial arrangement, visual harmony, and the incorporation of digital technologies. A majority of respondents expressed a preference for hybrid settings that integrate both conventional and digital features. Elevated mean scores across variables related to usability and aesthetics indicate a favourable perception of heritage architecture that embraces innovation and prioritises knowledge-centred design strategies, as calculated in equation (2).

$$\hat{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \quad (2)$$

In heritage architecture metrics, $\hat{X}$ represents the average (mean) value, X_i denotes each data point, and n represents the total number of data points considered in the calculation.

The descriptive statistics derived from the analysis of archival space variables offer valuable insights into the characteristics of key design and user experience factors. The Spatial Configuration Type variable, with a sample size of 26, exhibits a mean of 2.35 and a standard deviation (SD) of 0.88, ranging from 1.47 to 3.23, indicating moderate variability in spatial designs across archival contexts. User Engagement Level shows a higher mean of 3.88 (SD = 0.74), with scores ranging from 3.14 to 4.62, reflecting generally high and consistent engagement within these environments. Metadata System Richness, critical for effective information retrieval, presents a mean of 4.23 and a lower SD of 0.65, with values between 3.58 and 4.88, suggesting that most archival spaces maintain well-developed metadata frameworks. Conversely, Preservation Strategy Type displays a mean of 2.15 and an SD of 0.83, with a range from 1.32 to 2.98, demonstrating greater variability in preservation approaches. Perceived Accessibility attained a relatively high mean of 3.96 (SD = 0.81), with values spanning 3.15 to 4.77, indicating that users generally perceive archival spaces as accessible, albeit with some variation.

Collectively, the data highlight well-established metadata systems and user engagement, alongside variability in spatial configurations and preservation strategies. The mean represents the average value; the SD indicates the extent of data dispersion from the mean; and the minimum and maximum values denote the lowest and highest observed values for each variable. Table 4 presents the descriptive statistics for archival heritage design variables, while Figure 3 illustrates these descriptive statistics for archival spaces within heritage design.

Table 4: Descriptive Statistics for Archival Heritage Design Variables.

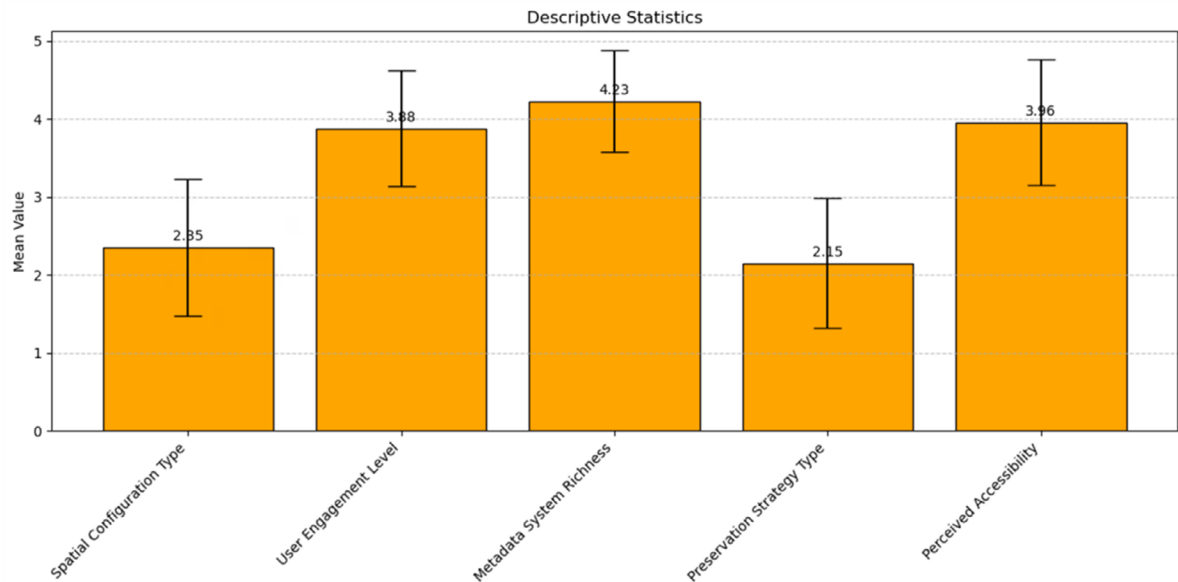| Variable	N =26	Mean	SD	Minimum	Maximum
Spatial Configuration Type	26	2.35	0.88	1.47	3.23
User Engagement Level	26	3.88	0.74	3.14	4.62
Metadata System Richness	26	4.23	0.65	3.58	4.88
Preservation Strategy Type	26	2.15	0.83	1.32	2.98
Perceived Accessibility	26	3.96	0.81	3.15	4.77

Figure 3: Descriptive Statistics of Archival Spaces in Heritage Design.

Chi-Square Test

The chi-square test assesses associations between categorical variables in the context of archival space usage. It reveals significant relationships concerning user preferences, spatial configurations, and engagement patterns within library and heritage environments. This test, outlined in equation (3), is instrumental in determining whether observed distributions deviate from expected values, thereby informing design enhancements and advancing knowledge organisation in hybrid cultural settings.

$$x^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad (3)$$

The chi-square statistic is utilised to compare observed frequencies (O_i) with expected frequencies (E_i), with substantial deviations indicating the presence of associations between categorical variables. This approach assesses the extent to which actual outcomes align with theoretical predictions in categorical datasets.

The results of the chi-square analysis demonstrated statistically significant relationships among key variables associated with archival space design and their influence on user interaction and system performance. For spatial configuration type, the chi-square value was 4.08 with a p-value of 0.04, indicating a moderate association with how individuals navigate physical layouts. User engagement level returned a chi-square value of 3.76 (p = 0.05), suggesting a marginally significant relationship with levels of user interaction. Metadata system richness showed a more pronounced link to user navigability and information retrieval, yielding a chi-square value of 5.12 and a p-value of 0.03. Preservation strategy type presented the highest statistical output, with a chi-square value of 6.21 (p = 0.02), indicating a significant impact on users' perceptions of durability and content security. Perceived accessibility was also found to be significantly associated with spatial openness and user ease, as reflected in a chi-square value of 4.55 (p = 0.04). All results fell below the conventional threshold of p < 0.05, indicating statistical significance. The chi-square value (χ^2) measures the extent of divergence between observed and expected values, while the p-value determines the strength of this relationship. A detailed summary of these outcomes is provided in Table 5, and Figure 4 visually represents the chi-square distribution within the context of archival space design.

Table 5: Chi-square Results for Archival Space Design.

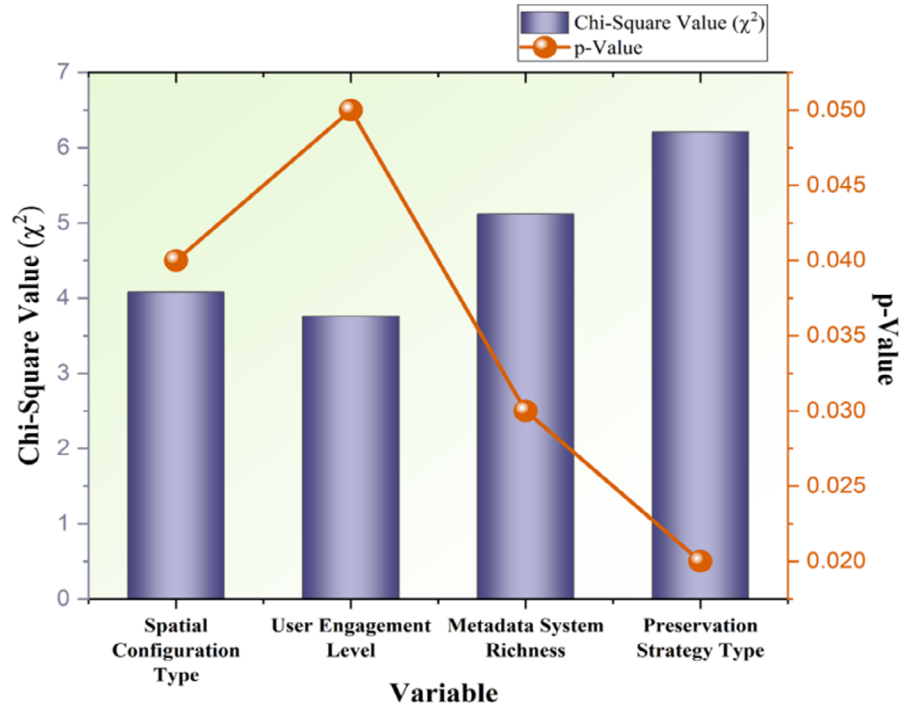| Variable	Chi-Square Value (χ^2)	P-Value
Spatial Configuration Type	4.08	0.04
User Engagement Level	3.76	0.05
Metadata System Richness	5.12	0.03
Preservation Strategy Type	6.21	0.02
Perceived Accessibility	4.55	0.04

Figure 4: Chi-Square Distribution in Archival Space Design.

Correlation Analysis

Correlation analysis explored the relationships among key variables, including spatial design, user engagement, accessibility, and knowledge retention within archival spaces. The results revealed strong positive correlations between immersive design features and user interaction, underscoring the role of architectural elements in facilitating improved understanding, navigation, and meaningful experiences in heritage-oriented library environments (equation 4).

$$r = \frac{\sum (x_i \hat{x})(y_i \hat{y})}{\sqrt{\sum (x_i \hat{x})^2 (y_i \hat{y})^2}} \quad (4)$$

The formula for the correlation coefficient quantifies the linear relationship between two variables. Values approaching +1 or -1 indicate strong correlations, whereas values near 0 suggest little to no linear association. The calculation assesses how each variable deviates from its respective mean, standardising these deviations to account for differences in scale through their standard deviations.

The results of the correlation analysis revealed significant positive associations between key architectural and archival variables, reinforcing their collective impact on the performance and usability of archival spaces. Perceived accessibility emerged as the most strongly correlated factor, with a coefficient of $r = 0.64$ and a p-value of 0.001, signifying a statistically significant positive link between ease of access and enhanced user experience. Metadata system richness demonstrated a similarly strong association ($r = 0.61$, $p = 0.002$), indicating that well-developed metadata infrastructures contribute to more efficient navigation and improved comprehension of archival content. User engagement level also exhibited a notable correlation with interactivity and engaging environments ($r = 0.57$, $p = 0.001$), underscoring the role of interactive design in supporting knowledge retention.

Preservation strategy type showed a moderate yet statistically meaningful correlation ($r = 0.45$, $p = 0.004$), reflecting its contribution to sustaining long-term content usability. Spatial configuration type yielded a moderate positive correlation ($r = 0.42$, $p = 0.006$), highlighting the influence of physical layout on user interaction and experience. The correlation coefficient (r) reflects both the strength and direction of linear relationships, while the p-value determines the statistical significance of those associations, with $p < 0.05$ denoting significance. Table 6 presents the correlation coefficients among archival space variables, and Figure 5 provides a visual representation of the correlation matrix.

Table 6: Correlation Coefficients among Archival Space Variables.

Variable	Correlation Coefficient (r)	P-Value
Spatial Configuration Type	0.42	0.006
User Engagement Level	0.57	0.001
Metadata System Richness	0.61	0.002
Preservation Strategy Type	0.45	0.004
Perceived Accessibility	0.64	0.001
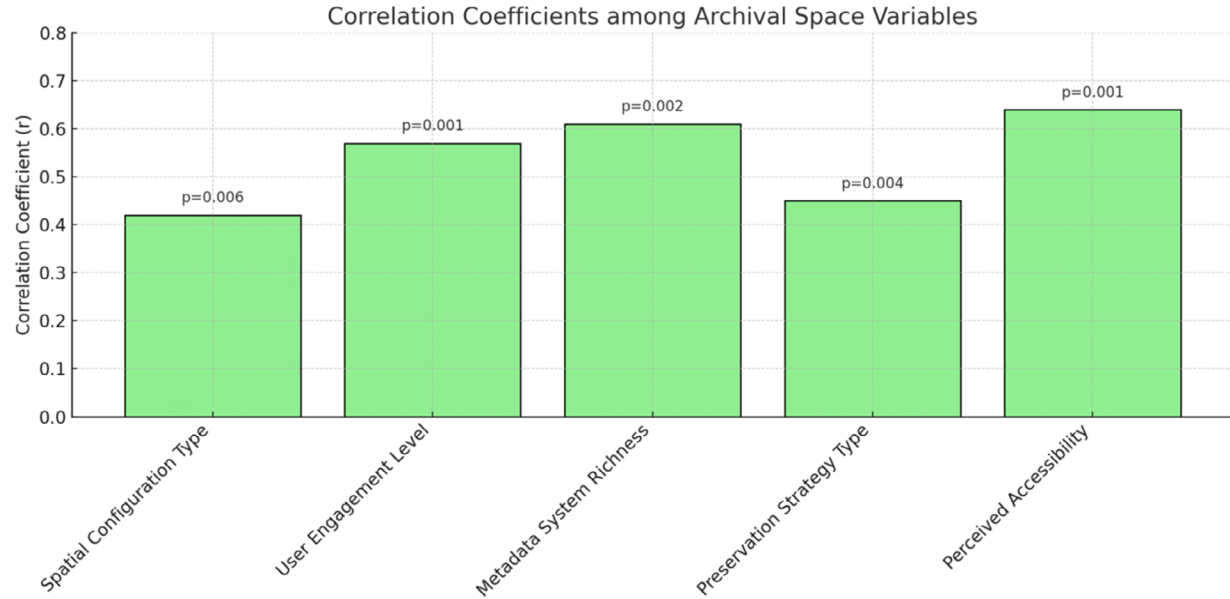
Figure 5: Correlation Matrix of Key Archival Variables.

ANOVA

ANOVA was employed to assess differences in participant responses across multiple dimensions of archival space design, including functionality, aesthetic value, and user accessibility. The analysis revealed significant variation in perceptions according to professional background, underscoring the influence of interdisciplinary collaboration on the evaluation of knowledge architecture within library and heritage design contexts (equation 5).

$$Y_t = c + \emptyset_t Y_{t-1} + \emptyset_2 Y_{t-2} + \cdots + \emptyset_p Y_{t-p} + \varepsilon_t \quad (5)$$

In the context of the Archival Spaces at the Intersection of Library Science and Heritage Design model, the financial variable at time t is denoted as Y. The constant term is represented by c, while ε signifies the white noise error component, accounting for random variations not explained by the model. The parameter p denotes the order of the model, reflecting the number of prior time points included, and the coefficients ϕ_1, ϕ_2, ..., ϕ represent the autoregressive weights that quantify the influence of past values on the current observation.

The ANOVA results revealed statistically significant differences in user responses across a range of design-related factors within archival environments. For spatial configuration type, the mean square (MS) was 19.6, with an F-value of 8.9, a p-value of 0.004, and an effect size (η^2) of 0.14. These findings suggest that spatial arrangement plays a meaningful role in shaping user experience, accounting for 14% of the observed variance. In terms of user engagement level, the analysis produced an MS of 23.8, an F-value of 11.5, a p-value of 0.0012, and an effect size of 0.20. This points to a strong relationship between engagement strategies and the extent of user interaction. Metadata system richness yielded an MS of 16.2, an F-value of 7.6, a p-value of 0.006, and a η^2 of 0.11, indicating a moderate yet notable impact on user interpretation and navigability.

For preservation strategy type, an MS of 21.1, an F-value of 10.2, a p-value of 0.002, and an effect size of 0.17 were recorded, demonstrating the significance of conservation methods in influencing user perceptions. Perceived accessibility exhibited

the strongest effect overall, with an MS of 24.6, an F-value of 12.1, a p-value of 0.0008, and an η² of 0.21. This highlights the critical role of accessible spatial design in fostering user satisfaction and functional effectiveness in heritage-informed archival settings. The MS is calculated by dividing the sum of squares (SS) by the degrees of freedom (df),

reflecting variance within groups. The p-value tests the statistical significance of observed differences, the F-value evaluates the extent of variance between groups, and η² represents the magnitude of effect. Table 7 presents the detailed ANOVA results, while Figure 6 illustrates the comparative outcomes across archival space design variables.

Table 7: ANOVA Results for Archival Space Design Variables.

| Variable	Source of Variation	MS	df	SS	P-Value	F-Value	Effect Size (η²)
Spatial Configuration Type	Between Groups	19.6	1	19.6	0.004	8.9	0.14
	Within Groups	2.20	58	127.6			
User Engagement Level	Between Groups	23.8	1	23.8	0.0012	11.5	0.20
	Within Groups	2.07	58	120.1			
Metadata System Richness	Between Groups	16.2	1	16.2	0.006	7.6	0.11
	Within Groups	2.14	58	124.0			
Preservation Strategy Type	Between Groups	21.1	1	21.1	0.002	10.2	0.17
	Within Groups	2.07	58	120.1			
Perceived Accessibility	Between Groups	24.6	1	24.6	0.0008	12.1	0.21
	Within Groups	2.03	58	117.7			
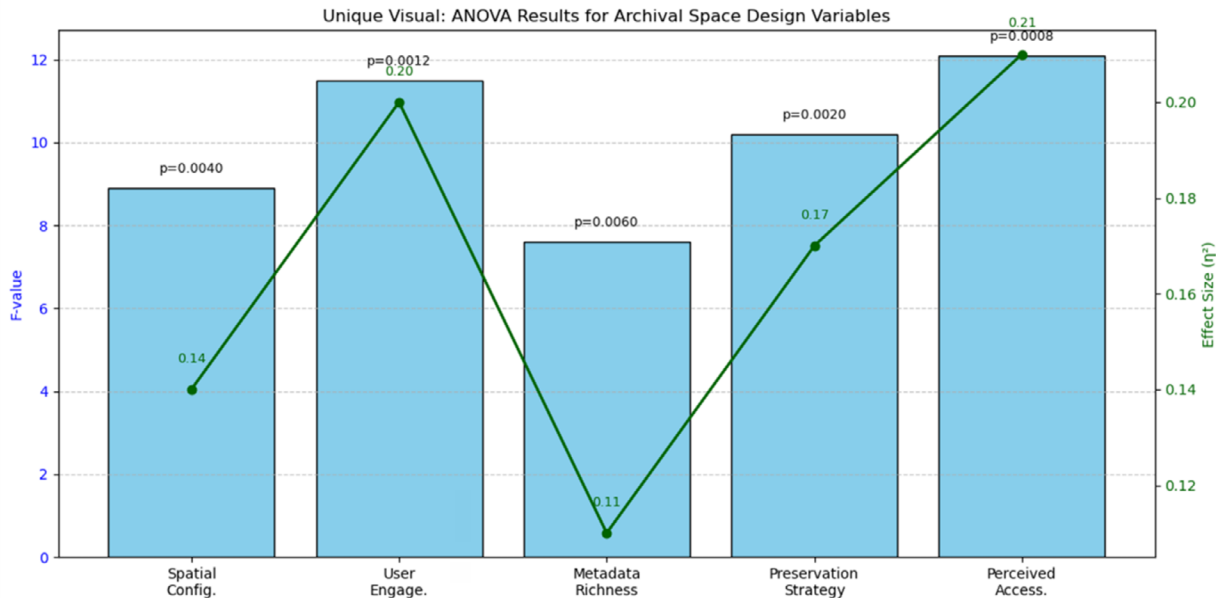
Figure 6: ANOVA Results on Archival Space Design Variables.

Thematic Analysis

A thematic analysis of archival spaces in relation to library science and heritage design entails a systematic examination of key experiential and design variables to formulate conditions that shape users' interaction with, and awareness of, knowledge environments. Through qualitative methods, recurring themes and topics are identified that define the architectural and functional dimensions of archival spaces, thereby offering a coherent framework for

interpreting user service dynamics and design impact. In Table 8 and Figure 7, the variables are categorised under five principal themes—Spatial Configuration Type, User Engagement Level, Metadata System Richness, Preservation Strategy Type, and Perceived Accessibility—each comprising two sub-themes with operational definitions. This two-tier typology ensures coverage of physical, emotional/affective, informational, and accessibility-related dimensions.

For instance, spatial navigation and zoning—the logic of movement through and experiential

interaction within a layout—are assessed in terms of emotional resonance and interaction frequency. Similarly, the depth of archive metadata and the presence of cross-referencing enhance the potential for archive discovery, while preservation strategies encompass both digital and physical preservation methods. Finally, the notion of accessibility across diverse user groups reflects principles of inclusive design and physical and digital reachability. This thematic framework enhances analytical precision, enabling the identification of actionable patterns informed by user feedback, thereby supporting the planning and improvement of archival spaces and heritage-driven information environments.

Table 8: Thematic Analysis for Variables in Archival Space Design.

| Theme	Sub-Theme	Definition
Spatial Configuration Type	Navigation Flow	How the layout guides user movement and orientation within the archival space.
	Zoning Logic	The organization of functional areas (e.g., exhibit, research, storage) within the space.
User Engagement Level	Interaction Frequency	How often do users engage with archival elements or tools (e.g., digital kiosks, and exhibits)?
	Emotional Resonance	The degree to which users feel connected or invested in the archival experience.
Metadata System Richness	Descriptive Depth	The level of detail provided in archival records, tags, and contextual metadata.
	Cross-referencing Ability	The extent to which metadata allows linking between related archival materials.
Preservation Strategy Type	Digital Continuity	Strategies ensuring long-term access to digital artefacts and records.
	Physical Safeguarding	Methods used to protect physical heritage objects (e.g., climate control, restricted access).
Perceived Accessibility	Interface Inclusivity	How well the space accommodates users of varied abilities and backgrounds.
	Spatial Reachability	The ease with which users can physically or digitally access archival resources.
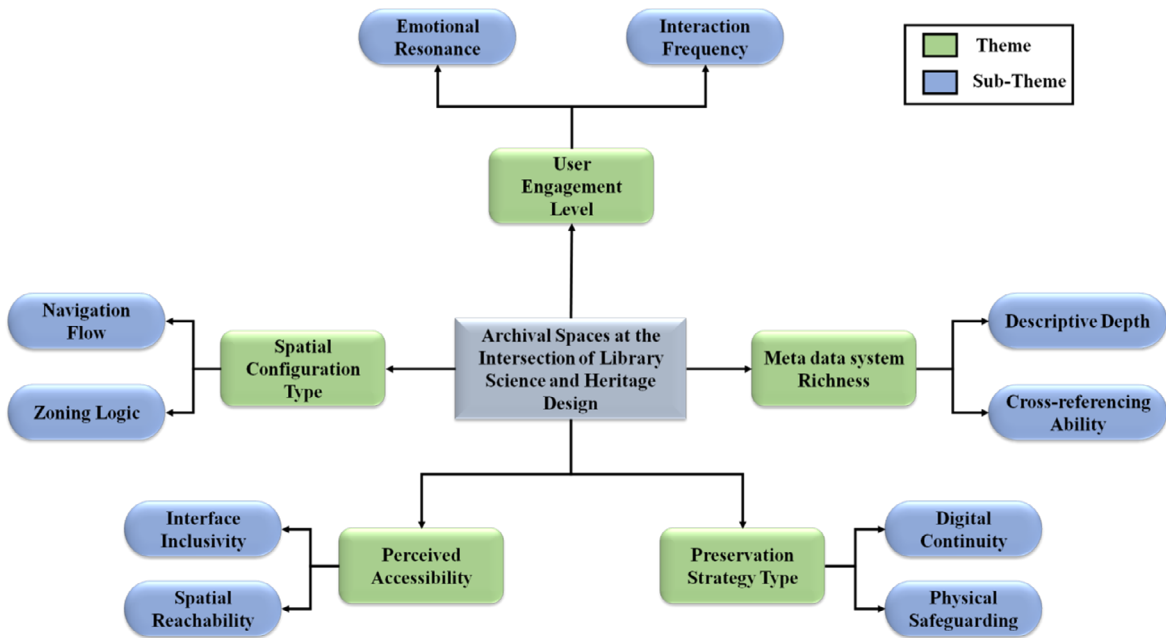
Figure 7: Themes and Sub-Themes of Archival Space Experience.

The utilisation of cultural heritage by global cities as a strategy to regenerate urban environments—balancing preservation, innovation, and the integration of modern technologies—was examined by Elrawy (2025). The study identified the most effective strategies applied within both global and Egyptian contexts and proposed a theoretical framework for implementation in Egypt. This framework seeks to unify the preservation of Arab heritage with the active participation of community members who are closely connected to the region's distinctive characteristics and everyday practices, alongside the tourism sector and the incorporation of modern technologies. The integration of Human-Centred Design (HCD) principles into digital archaeology, and its potential to enhance knowledge creation and stakeholder engagement, was addressed by Dolcetti (2025). Embedding HCD practices within digital

archaeology promotes more inclusive, engaging, and effective digital experiences that better respond to user needs and deepen public interaction with historical content.

Blomvik (2022) introduced a generalised workflow for producing immersive Virtual Heritage experiences through accessible digital tools. This approach allows non-specialists to participate in the preservation and dissemination of cultural heritage. A functional mobile-based Augmented Reality application was successfully developed, despite some limitations related to modelling precision and technical platform constraints. Terras (2022) explored the engagement of the Digital Humanities (DH) community with digitised heritage, underscoring the importance of comprehending both the digitisation processes and their outputs. The reciprocal collaboration between DH and digitisation efforts fosters the creation of inclusive, impactful, and reusable digital cultural datasets that support research and pedagogical advancement.

Descriptive statistics revealed that metadata system richness achieved the highest average score ($M = 4.23$, $SD = 0.65$), while preservation strategy type recorded the lowest ($M = 2.15$, $SD = 0.83$), across a sample of $N = 26$. Chi-square tests demonstrated statistically significant associations among all assessed variables ($p < 0.05$), with preservation strategy type ($\chi^2 = 6.21$, $p = 0.02$) and metadata system richness ($\chi^2 = 5.12$, $p = 0.03$) emerging as the most influential factors. In the correlation analysis, perceived accessibility ($r = 0.64$, $p = 0.001$) and metadata system richness ($r = 0.61$, $p = 0.002$) showed the strongest positive correlations among archival space variables. Results from the ANOVA indicated that user engagement level ($F = 11.5$, $p = 0.0012$, $\eta^2 = 0.20$) and perceived accessibility ($F = 12.1$, $p = 0.0008$, $\eta^2 = 0.21$) demonstrated the most significant differences across groups, confirming their critical role in shaping user experience.

Conclusion

Architecture of Knowledge explores archival spaces by integrating library science and heritage design to promote preservation, access, engagement, and interdisciplinary innovation. Mixed-methods data were collected through the investigation of 26 heritage archival sites via field observations, professional interviews, and archival surveys. Key variables examined included spatial configuration type, user engagement level, metadata system richness,

preservation strategy, and perceived accessibility. Content and tools audits supported data capture. Statistical analyses employed comprised descriptive statistics, chi-square tests, correlation analysis, and ANOVA. Findings indicated that permeable open-floor plans and robust metadata frameworks confer significant advantages in terms of user interaction and accessibility, alongside facilitating the integration of contemporary archival functions within historic heritage structures. The archival heritage design variables demonstrate strong interrelationships among spatial features, metadata richness, and user engagement. Descriptive statistics reveal high mean scores for user engagement (Mean = 3.88) and metadata richness (Mean = 4.23). Chi-square tests confirm significant associations among variables ($p < 0.05$). Correlation analysis identifies strong positive relationships, notably between perceived accessibility and metadata richness ($r = 0.64$, $p = 0.001$). ANOVA results reveal significant variation across design variables, with the largest effect size observed for perceived accessibility ($\eta^2 = 0.21$). These results suggest that well-organised spatial frameworks and comprehensive metadata systems are critical in enhancing user interaction, accessibility, and the sustainability of archives within heritage contexts. However, the sample size and geographical focus may limit generalisability to the broader, diverse practices of archival institutions worldwide. Future research could extend cross-cultural comparisons, incorporate AI-based evaluations of archival metadata, and investigate user behaviour employing immersive technologies. Moreover, expanded collaboration with the digital humanities field would further support the development of adaptive, inclusive archival spaces.

References

Al-Adilee, S. M. S. (2024). The Influence of Culture and Heritage on Architectural Design. *The American Journal of Interdisciplinary Innovations and Research*, 6(08): 56-74. https://doi.org/10.37547/tajiir/Volume06Issue08-06

Alba, E., Gaitán, M., León, A., Sevilla, J., Solbes, Á. and Pla, V. (2023). Technological Tools for the Conservation and Dissemination of Valencian Design Archives. *Heritage*, 6(9): 6066-6096. https://doi.org/10.3390/heritage6090319

Alencar, M. F., Tognoli, N. B. and Cervantes, B. M. N. (2024). Discourse communities on archival

education and research: a domain analysis of the Archival Education and Research Initiative - AERI (2008-2021). *Em Questão*, 30: e-137375. https://doi.org/10.1590/1808-5245.30.137375A

Alnaim, M. M. (2024). Cultural Imprints on Physical Forms: An Exploration of Architectural Heritage and Identity. *Advances in Applied Sociology*, 14(3): 141-160. https://doi.org/10.4236/aasoci.2024.143010

Basaraba, N. and Cauvin, T. (2023). Public history and transmedia storytelling for conflicting narratives. *Rethinking History*, 27(2): 221-247. https://doi.org/10.1080/13642529.2023.2184969

Batchelor, D., Schnabel, M. A. and Dudding, M. (2021). Smart Heritage: Defining the Discourse. *Heritage*, 4(2): 1005-1015. https://doi.org/10.3390/heritage4020055

Bembibre, C. and Strlič, M. (2022). From Smelly Buildings to the Scented Past: An Overview of Olfactory Heritage. *Frontiers in Psychology*, 12: 718287. https://doi.org/10.3389/fpsyg.2021.718287

Blomvik, P. (2022). *A Generic Pipeline for Creating Immersive Experiences Towards Cultural Heritage Preservation, Dissemination, and Promotion* [Master's thesis, NTNU]. https://hdl.handle.net/11250/3018232

Chigwada, J. and Ngulube, P. (2024). Librarians' role in the preservation and dissemination of indigenous knowledge. *IFLA Journal*, 50(2): 242-256. https://doi.org/10.1177/03400352231217270

Dolcetti, F. (2025). Crafting Digital Experiences: Embedding Human-Centred and Participatory Design into Archaeological Practice. *ACM Journal on Computing and Cultural Heritage*, 18(1): 1-20. https://doi.org/10.1145/3700880

Elrawy, S. M. (2025). Leverage Cultural Heritage as a Tool of Urban Agendas. Focus on Greater Cairo, Egypt. *JES. Journal of Engineering Sciences*, 53(4): 495-536. https://doi.org/10.21608/jesaun.2025.370736.1462

Feng, H., Lian, Z., Pan, W., Qu, C., Zhou, W., Wang, N. *et al.* (2021). Retrospect and prospect: the research landscape of archival studies. *Archival Science*, 21(4): 391-411. https://doi.org/10.1007/s10502-021-09364-1

Jaillant, L., Mitchell, O., Ewoh-Opu, E. and Hidalgo Urbaneja, M. (2025). How can we improve the diversity of archival collections with AI? Opportunities, risks, and solutions. *AI & Society*. https://doi.org/10.1007/s00146-025-02222-z

Lian, Y. and Xie, J. (2024). The Evolution of Digital Cultural Heritage Research: Identifying Key Trends, Hotspots, and Challenges through Bibliometric Analysis. *Sustainability*, 16(16): 7125. https://doi.org/10.3390/su16167125

Liew, C. L., Goulding, A. and Nichol, M. (2022). From shoeboxes to shared spaces: participatory cultural heritage via digital platforms. *Information, Communication & Society*, 25(9): 1293-1310. https://doi.org/10.1080/1369118X.2020.1851391

Makula, A. Y. and Turner, L. S. (2022). Toward Engaged Scholarship: Knowledge Inclusivity and Collaborative Collection Development between Academic Libraries and Archives and Local Public Communities. *College & Research Libraries*, 83(2): 246-277. https://doi.org/10.5860/crl.83.2.246

Marsh, D. E., St. Andre, S., Wagner, T. and Bell, J. A. (2023). Attitudes and uses of archival materials among science-based anthropologists. *Archival Science*, 23(3): 355-379. https://doi.org/10.1007/s10502-023-09411-z

Meinecke, C. (2022). Labeling of Cultural Heritage Collections on the Intersection of Visual Analytics and Digital Humanities. In: *2022 IEEE 7th Workshop on Visualization for the Digital Humanities (VIS4DH)*. IEEE, pp. 19-24. https://doi.org/10.1109/VIS4DH57440.2022.00009

Mugamba, E. (2025). The Sanctuary Effect: Libraries as Catalysts for Social Resilience and Inclusion in Marginalized Communities in Uganda. https://doi.org/10.2139/ssrn.5229657

Natsir, T., Akib, H., Yandra, A., Wijaya, I. D. and Haedar, A. W. (2024). An Analysis of Digital Libraries Roles in Public Sector Organizations Utilizing VOSviewer. *Khizanah al-Hikmah: Jurnal Ilmu Perpustakaan, Informasi, dan Kearsipan*, 12(1): 62-76. https://doi.org/10.24252/kah.v12i1a6

Niccolucci, F., Felicetti, A. and Hermon, S. (2022). Populating the Data Space for Cultural Heritage with Heritage Digital Twins. *Data*, 7(8): 105. https://doi.org/10.3390/data7080105

Onunka, O., Onunka, T., Fawole, A. A., Adeleke, I. J. and Daraojimba, C. (2023). Library and Information

Services in the Digital Age: Opportunities and Challenges. *Acta Informatica Malaysia*, 7(1): 113-121. https://doi.org/10.26480/aim.02.2023.113.121

Ortega-Sánchez, D. and López-Sanvicente, A. B. (2023). Design, content validity, and inter-observer reliability of the 'Digitization of Cultural Heritage, Identities, and Education' (DICHIE) instrument. *Humanities and Social Sciences Communications*, 10(1): 53. https://doi.org/10.1057/s41599-023-01550-z

Rahmanova, A. (2025). Evolution of Libraries in the Digital Era: Redefining Access, Education, and Cultural Preservation. *Library Archive and Museum Research Journal*, 6(1): 23-38. https://doi.org/10.59116/lamre.1540033

Renshaw, C. and Liew, C. L. (2021). Descriptive standards and collection management software for documentary heritage management: attitudes and experiences of information professionals. *Global Knowledge, Memory and Communication*, 70(8/9): 697-713. https://doi.org/10.1108/GKMC-08-2020-0129

Shiri, A., Howard, D. and Farnel, S. (2022). Indigenous Digital Storytelling: Digital Interfaces Supporting Cultural Heritage Preservation and Access. *The International Information & Library Review*, 54(2): 93-114. https://doi.org/10.1080/10572317.2021.1946748

Suman, A. K. and Peelwan, R. (2024). The Social Responsibilities of Library Professionals: A Theoretical Perspective. *Revista Review Index Journal of Multidisciplinary*, 5(1): 14-21. https://doi.org/10.31305/rrijm2025.v05.n01.002

Terras, M. (2022). Digital Humanities and Digitized Cultural Heritage. In: J. O'Sullivan (Ed.), *The Bloomsbury Handbook to the Digital Humanities*. Bloomsbury, pp. 255-266. https://doi.org/10.5040/9781350232143.ch-24

Thorpe, K. (2021). The dangers of libraries and archives for Indigenous Australian workers: Investigating the question of Indigenous cultural safety. *IFLA Journal*, 47(3): 341-350. https://doi.org/10.1177/0340035220987574

Wang, C. and Si, L. (2024). The Intersection of Public Policy and Public Access: Digital Inclusion, Digital Literacy Education, and Libraries. *Sustainability*, 16(5): 1878. https://doi.org/10.3390/su16051878

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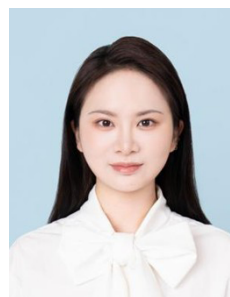
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