Towards a Digital Atlas for Cultural Landscape: Framework Design and Mobile Application Development for Documenting Tangible and Intangible Heritage

Ozlem Kevseroglu[1][0000-0003-1828-2256], Rifat Kurban[2][0000-0002-0277-2210]

[1] Department of Architecture, Abdullah Gül University, Sümer Campus, Erkilet Blvd., 38080 Kocasinan, Kayseri, Türkiye
[2] Department of Computer Engineering, Abdullah Gül University, Sümer Campus, Erkilet Blvd., 38080 Kocasinan, Kayseri, Türkiye
ozlem.kevseroglu@agu.edu.tr, rifat.kurban@agu.edu.tr

Abstract. This paper introduces the Kayseri Digital Atlas project, a mobile application built with Flutter and supported by a web interface, created to document both the tangible and intangible cultural heritage of Kayseri's Cumhuriyet Neighbourhood. Through a custom data-entry system, the project has systematically collected more than 2,000 archival and oral history records, establishing a well-structured platform that can serve as a foundation for future efforts such as AI-driven classification and digital reconstruction.

Keywords: Cultural Landscape, Digital Heritage, Mobile Application, Collective Memory, Kayseri.

1 Introduction

Kayseri, a city rich in history in Central Anatolia, has an urban layout that showcases over 6,000 years of continuous human life. Its fortified centre, including the Inner and Outer Fortresses, has long been a hub for politics, trade, and culture, accommodating various civilisations from the Roman province of Cappadocia through the Seljuk, Danishmendid, and Ottoman periods, up to the modern Republic era (Usul, 2023). Among its many layers of history, the Cumhuriyet Neighbourhood, located within the remains of the Outer Fortress walls in the Melikgazi district, stands out as a lively area filled with cultural accumulations. Up until the early twentieth century, it was home to several communities living side by side, leaving behind a variety of physical structures and social traditions that tell of a diverse and interconnected past (Tozoğlu, 2008).

Despite its importance, the cultural values represented by the Cumhuriyet Neighbourhood are rapidly fading. Old documents, photographs, and maps often deteriorate or become inaccessible, which means the loss of valuable pieces of history. Oral history becomes even more vulnerable, particularly as older generations pass away. Meanwhile, younger residents tend to feel less connected to their neighbourhood's heritage, which heightens concerns about the loss of collective memory. Traditional preservation

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methods such as storing items in archives, displaying them in museums, or maintaining paper records have proven insufficient to keep these cultural values alive, accessible, and meaningful to diverse audiences (Eryazıcıoğlu & Cengiz, 2018).

Digitalization is the transformative response to these challenges. It is clear that projects dedicated to the digital documentation of cultural heritage around the world have demonstrated the capacity of information technology to expand access, deepen interpretation, and extend the lifespan of endangered records (Pappa & Makropoulos, 2022; Stoyanova, 2024). The convergence of AI, mobile computing, and open data infrastructure offers the potential to preserve heritage and revitalize it through interactive, user-cantered platforms (Hou et al., 2022).

The selected study area is the walled precinct of Cumhuriyet Neighbourhood, as illustrated in Figure 1. The bold outline delineates the study zone's boundaries. Overlaid on a contemporary aerial photograph, the Gabriel map from 1931 reveals the approximate locations of the Inner and Outer Fortress walls. Geographically, the district is bordered by the remnants of the Outer Fortress, whose bastions and wall fragments are visible in the current streetscape. Historically, this precinct housed various structures such as mosques, baths, inns, madrasahs, and residential mansions, representing architectural periods from Roman, Seljuk, Ottoman, to Republican eras. Although many monumental structures have endured to the present day, a substantial portion of vernacular buildings and most of the Outer Fortress walls were demolished during twentieth-century efforts to widen roads and the construction of an underground bazaar beneath Cumhuriyet Square in 1975 (Çayırdağ, 2001). This blend of preservation and loss renders the neighbourhood both a valuable historical record and an active site of collective memory and ongoing transformation.

Fig. 1. Satellite image showing the Cumhuriyet Neighbourhood within the boundary of the Kayseri Outer Fortress walls.

The present paper reports on the first phase of the Kayseri Digital Atlas project, which addresses precisely this challenge. The project aims to identify, classify, and digitize the cultural landscape elements of Cumhuriyet Neighbourhood through a three-stage

methodology: (1) data collection and archiving, (2) data classification, generation and visualization using AI, and (3) mobile application development. This paper focuses on stages one and three as implemented to date, presenting the design and current state of the Flutter-based data-entry interface and the closed-beta mobile application through which the collected material is made accessible. The research provides a concrete, replicable model for the digital documentation of urban heritage at the neighbourhood scale. The central hypothesis is that a structured integration of qualitative heritage data (oral history, archival records, memory walks) within a relational database, delivered via a cross-platform mobile application, constitutes a scalable and replicable model for neighbourhood-scale cultural landscape documentation. The scientific contribution is twofold: (i) a documented methodology for the simultaneous collection of tangible and intangible heritage data within a unified digital framework, and (ii) an open, replicable technical architecture serving as a foundation for subsequent AI-driven classification.

2 Theoretical Background

2.1 Cultural Landscape and Collective Memory

As defined in the Operational Guidelines of the UNESCO World Heritage Convention, the concept of cultural landscape refers to "the combined works of nature and humankind" that represent the evolutionary interaction between human societies and their natural environments over time (UNESCO, 2008). Carl Sauer's groundbreaking formulation positions culture as the agent, the natural area as the setting, and the cultural landscape as the result. According to Sauer (1925), "The cultural landscape is shaped by a cultural group from the natural landscape." Recent theoretical developments have expanded this definition to include not only the tangible products of human interaction with the environment but also abstract aspects such as beliefs, practices, social memories, and identities tied to specific places (Kevseroğlu & Ayataç, 2023).

The view of memory as social, as well as individually psychological, is rooted in the environment, such as streets, buildings, open spaces, etc., and the demolition of such structures can endanger social memory (Halbwachs, 1980). Nora (1989) suggested that the appreciation of the social collective's identity can be attached to certain locations, and in the recent past, the destruction of the outer walls of the Citadel of Kayseri proved this. Connerton (2019) also focuses on social memory as being concrete in the sense that the communal memory about the memory of everyday life, as well as the religious and seasonal rituals, is transmitted by means of an interactive memory, as opposed to a narrative memory, through an engagement with a particular place and memory (Kevseroğlu et al., 2021). To document such practices, space that is relational and experiential needs to be remembered and methods like oral history, memory walks, and participatory observation (in addition to) conventional archives and cartography.

2.2 Digital Technologies in Heritage Preservation

The opportunity to represent intangible heritage through video ethnography, spatial databases, augmented and virtual reality, participatory apps, etc. has emerged (Hou et al., 2022). Today, artificial intelligence offers us CNNs that can automatically classify heritage images (Kevseroğlu & Kurban, 2024) or text-to-image techniques that can visualise missing heritage through archival records (Qin, 2023). There have been some conceptual discussions on digital cultural landscape systems (Yang et al., 2019) but practical guidelines for its development are still missing. The Kayseri Digital Atlas addressed this issue by providing a scalable digital framework on integrating cultural landscape idea with real heritage management practices (Espina-Romero & Guerrero-Alcedo, 2022). Particularly, a mobile application is a great way to reach out to young and heterogeneous audience for cultural heritage interpretation (Xie, 2021).

Table 1. Comparative overview of nine digital cultural heritage platforms.

Platform	**Developer / Institution**	**Year**	**Geographic Coverage**	**Heritage Data Type**	**Key Technology**	**Oral History Component**
Kayseri Digital Atlas (this study)	*Abdullah Gul University*	*2025 (dev.)*	*Kayseri – Cumhuriyet Mah., Turkey*	*Tangible + Intangible (oral history, archival, memory walks)*	*Flutter / Spring Boot / MySQL / OSM; Phase 2: CNN + LLM (planned)*	*Yes – central; snowball sampling + triangulation*
Ani Mobile App	Anadolu Kultur Foundation	2023	Ani Archaeological Site, Kars, Turkey	Tangible (architectural, archaeological)	GPS-triggered audio guides; 3 languages; quiz modules	No
KarDes	Hrant Dink Foundation	2019–20	Istanbul, Ankara, Izmir, Turkey	Tangible + Intangible (oral history, video)	GPS tours; 2 000+ heritage entries; 100+ oral history videos	Yes – 100+ videos, 70+ audio recordings
Palimpsest Cities	Alanya University (Erasmus+)	2023–24	Alanya, Istanbul (extensible)	Tangible + Intangible (video, timeline)	Gamification; storytelling; education modules	No (video narratives only)
Kultur Yolu Kayseri	UrbanSense AI Lab	2025	Kayseri city centre, Turkey	Tangible (architectural inventory)	Optimised walking route algorithm; UI/UX-first design	No
StoryCorps	StoryCorps, Inc.	2015	USA (global)	Intangible only (oral history)	Mobile recording; Library of Congress archive integration	Yes – exclusive focus; 700 000+ recordings
Clio – Discover Nearby History	Clio Foundation (Marshall Univ.)	2013–14	USA (national)	Tangible (historic sites)	Crowdsourced + expert-reviewed; AR wayfinding; PDF export	No
Google Arts & Culture	Google Cultural Institute	2011/2015	Global (80+ countries)	Tangible (artworks, museum collections)	AI Art Selfie; Gigapixel imaging; VR museum tours	No
InHeritage	Univ. of Zagreb (research prototype)	2024–25	Zagreb, Croatia (pilot)	Tangible (3D models)	Metaverse integration; AR/VR; gamification (SDT-based)	No

2.3 Positioning the Kayseri Digital Atlas: Comparison with Existing Platforms

Kayseri Digital Atlas is situated within the broader landscape of digital cultural heritage platforms, Table 1 provides a structured comparison across eight existing systems representing local initiatives, national crowdsourcing platforms, and globally scaled AI-driven archives. The comparison criteria, developer institution, launch year, geographic coverage, heritage data type, key technology, and oral history component, were selected to highlight the dimensions along which the present study makes a distinct methodological contribution.

As shown in Table 1, the nine platforms can be broadly grouped along two axes: geographic scope (local/national vs. global) and heritage data type (tangible, intangible, or integrated). Local initiatives, Ani, Palimpsest Cities and Kultur Yolu Kayseri, focus primarily on architectural (tangible) documentation and route optimisation; KarDes is the sole precedent that integrates oral history at scale, with more than 100 video narratives linked to GPS-located entries. At a global scale, StoryCorps represents the opposite extreme: an exclusively intangible, citizen-recording model with institutional archiving (Library of Congress). At the same time, Google Arts & Culture deploys AI-driven image recognition and gigapixel visualisation for museum collections. The Kayseri Digital Atlas occupies a distinct position: it is the only platform in this comparison that simultaneously captures tangible heritage (architectural inventory, GPS, photographic documentation) and intangible heritage (structured oral history interviews, memory walks, archival cross-referencing) within a single relational data architecture, at neighbourhood scale, and with an explicit roadmap for AI-driven classification (Phase 2 CNN-based image analysis). This integrated design addresses a gap identified by InHeritage and Clio: structured data entry is a prerequisite for any subsequent machine-learning layer. The comparative analysis, therefore, confirms that the methodology and architecture proposed in this study constitute a replicable model that combines the oral-history depth of KarDes, the open technical stack of Clio, and the AI-readiness of InHeritage within a neighbourhood-scale Anatolian urban context.

3 Methodology: Data Collection and Interface Design

3.1 Overall Research Design

The three-phase process used in the Kayseri Digital Atlas project (shown in Figure 2) involves (a) data collection and preservation through archival research, interviews, and memory walks, (b) data classification and visualization through CNN-based image classification and AI tools to reconstruct the missing elements of the heritage, and (c) development of a mobile application leading to the atlas output. This paper presents the first and third phases that were applied in the early stage of the project. Our method, thus, employs qualitative techniques, such as oral history, ethno-graphic notes from memory walks, and archival records, to capture the complexity and texture of the her-

itage experience. Simultaneously, we employ quantitative data, such as item count, media distribution, and spatial information, to allow for systematic analysis and AI-driven processes in subsequent stages. The integration of the two into a unified relational database is a key innovative element of our method.

3.2 Archival Research and Oral History

A comprehensive review of historical and geographical sources was conducted, covering Ottoman and Republic-era state archives, cadastral records, military maps, municipal heritage inventories, and the collections of the Preservation Board, as well as academic literature on the urban evolution of Kayseri. Long-time residents of Cumhuriyet Neighborhood participated in semi-structured interviews selected using snowball sampling. In accordance with Kümbetoğlu's (2019) qualitative research guidelines, approximately 30 interviews were targeted, with questions focusing on place-related personal memories, local social and cultural traditions, and memories of lost or altered historical features. Additionally, drawing inspiration from Halbwachs' (1992) concept of treating place as a mental framework for memory, "memory walks" interactive interviews conducted during walks through the neighborhood streets are employed. Oral history is an inherently subjective method: the narratives collected reflect the lived experience of individual contributors and are not intended to represent a statistical sample of community opinion (Portelli, 1991). The snowball sampling strategy was selected to access long-time residents with in-depth local knowledge; it is acknowledged that this approach may under-represent more recently arrived or marginalised voices. These limitations are addressed through triangulation with archival sources and cross-referencing across memory walks, consistent with established oral history methodology.

Through the careful analysis of the discrepancies and missing details between the archive and the oral histories, a requirement assessment was conducted to inform both traditional data collection and AI-based reconstruction. The combination of archive and oral histories, as well as the integration of physical artifacts with the narrative and experiential contexts of these artifacts, underscores the importance of a comprehensive approach to the cultural landscape. The interviews conducted to date aim to record traces of undocumented daily life by capturing the memories of former and current residents, thereby expanding and deepening the documentary record. Transcripts are summarised, entered the database, and will serve as source material for text-to-image GenAI visualisation in Phase 2. To date, three in-depth interviews have been completed out of a target of thirty. A key finding emerging from this initial set is that, during the 1970s, informal communication and mutual trust among neighbourhood tradespeople declined markedly, signalling that the cohesive neighbourhood culture of earlier decades was already fragmenting. This finding not only corroborates the archival evidence of physical loss but also enriches the dataset with a social-historical dimension that written records alone cannot capture.

3.3 Data Entry Interface and System Architecture

The data entry application was developed using the Flutter framework and utilizes a Java Spring Boot and MySQL backend to ensure efficient performance on multiple operating systems. This data-driven application that requires high security is hosted on Ubuntu 24.04 LTS server and backed up using automated cloud backup services. The application used for accurately locating historical monuments on the map uses the OpenStreetMap data and was developed using the Flutter framework to leverage its benefits of high-performance rendering, native cross-platform support, and extensive GIS libraries.

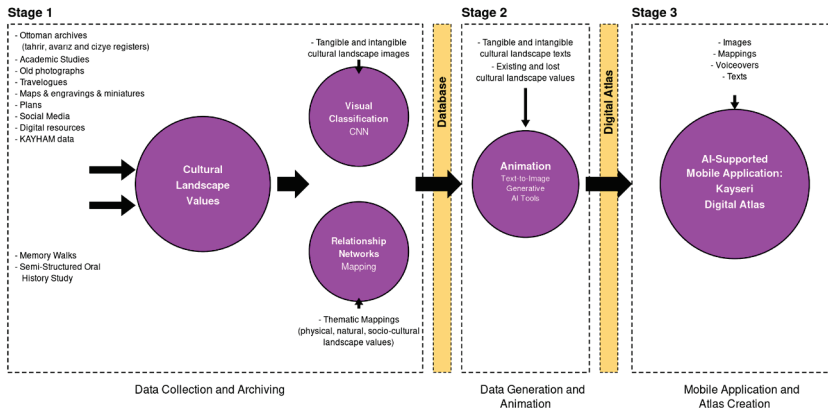

Fig. 2. Methodological flow diagram showing the three stages of the Kayseri Digital Atlas project.

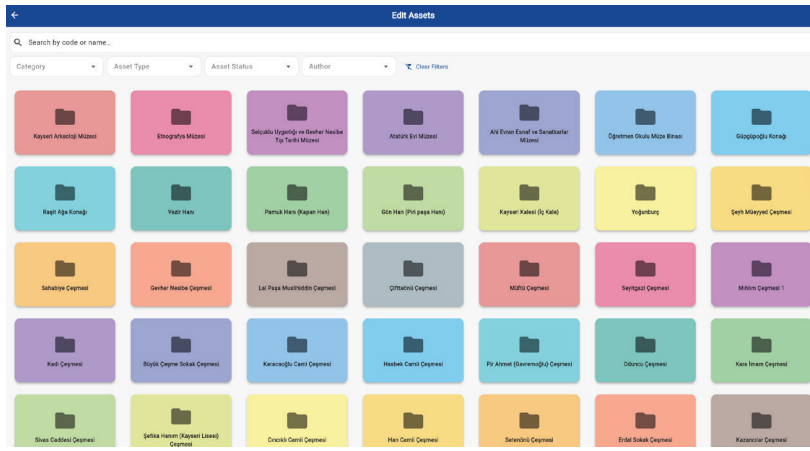

Fig. 3. The Flutter-based data entry interface for the Kayseri Digital Atlas.

The data entry interface detailed in Figures 3 and 4 presents a structured, sequential methodology designed to document inventories of tangible and intangible cultural her-

itage. Each data entry set consists of asset typology (architectural, archaeological, natural, or intangible), physical condition, coordinate-based geolocation, historical period, author information, and descriptive explanations. Visual, audio, and documentary media components are integrated into the system through a metadata hierarchy that includes source, date, and copyright information, and are linked to the relevant asset. Additionally, the platform includes a module that enables the bulk transfer of archival data, as well as a validation mechanism that identifies gaps or logical inconsistencies in datasets.

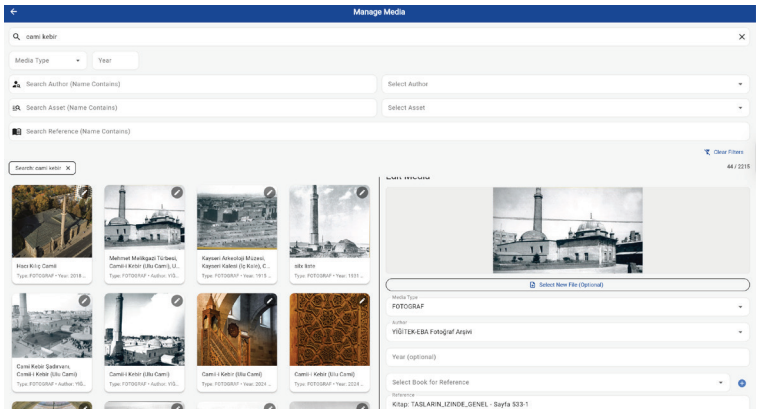

Fig. 4. Detailed views of the data entry interface.

Table 2. Summary of the Kayseri Digital Atlas database as of Phase 1 completion.

Database Table	Record Count
Category	39
Book	31
Media	2,215
Media Type	9
Author/Creator	112
Heritage Asset	407
Asset Status	3
Asset-Media Links	4,625
Asset-Author Links	411
Asset Type	3

3.4 Database Structure and Quantitative Overview

Upon completion of Phase 1, the database contains records across 10 core relational tables. The quantitative distribution of records across these tables is summarized in Table 2, which reflects the scale and diversity of the collected material. The 407 heritage asset records span three asset types (architectural, natural, and intangible) and three condition categories; the 2,215 media records - comprising photographs, archival scans, audio files, and video clips - are distributed across nine media types and linked to asset records through a junction table containing 4,625 entries.

The volume of media material assembled, over 2,000 individual items, reflects the breadth and depth of the archival survey and oral history program. The 112 author and creator records encompass the wide range of individuals who produced the collected material, from nineteenth-century Ottoman cartographers and early Republican architects to contemporary residents who contributed personal photographs and testimonies. The 39 category records provide a thematic taxonomy for asset classification aligned with the cultural landscape framework.

Figures 5a and 5b provide a visual overview of the database content. Figure 5a shows the distribution of the 407 heritage assets across the primary category taxonomy: architectural and urban heritage (mosques, baths, inns, madrasahs, residential structures, commercial buildings, and public spaces) and intangible heritage items (oral traditions, culinary practices, craft knowledge, social ceremonies). Figure 5b illustrates the distribution of 2,215 media items across the nine recognised media types, showing that historical and contemporary photographs together account for the majority of the collection, followed by scanned archival documents and audio recordings from oral history sessions.

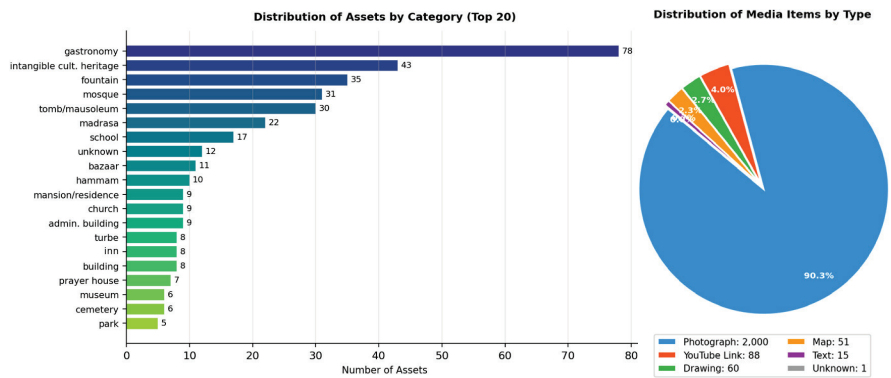

Fig. 5. (a) Distribution of the 407 catalogued heritage assets by primary category. (b) Distribution of the 2,215 media records by type.

4 Phase 1 Implementation: The Closed-Beta Mobile App

4.1 Application Architecture and Navigation Logic

The Kayseri Digital Atlas mobile application was developed in Flutter and supports both Android and iOS. The application is currently in a closed beta phase, accessible to a controlled group of users, including project team members, invited heritage specialists, and a representative sample of residents. The closed-beta phase tests core functionality under realistic conditions, collects structured user feedback, and identifies technical issues before the planned public release in a subsequent phase of the project. At this stage, beta access is limited to the project team; testing focuses on interface consistency and data gap identification rather than the collection of user behaviour metrics.

Qualitative observations from this phase have already yielded actionable insights: testers identified several interface inconsistencies in the media upload and geolocation workflows; a number of data gaps were flagged in the intangible heritage records, particularly in audio metadata and geographic coordinates; and invited specialists provided structured feedback indicating that the asset classification scheme required additional sub-categories for commercial buildings. These findings have been documented and are being systematically addressed prior to the public beta release. Statistically meaningful evaluation of user experience will be conducted in the forthcoming public beta phase, once interface stability is confirmed and the dataset is complete.

The application offers three navigation layers: a map-based overview with color coded asset markers (tangible & intangible heritage); a thematic browse interface filterable by category, period, or condition; and a curated walking route that sequences assets into a coherent heritage narrative. Each asset detail view aggregates all associated media, swipeable image galleries, archival PDFs, and playable oral history recordings, alongside a timeline module and a related-assets panel. This layered structure is designed to serve casual visitors and scholarly users alike.

In Figure 6, from left to right: (a) the thematic browse interface organized by heritage category, (b) the map-based asset discovery interface with colour coded markers, and (c) the asset detail view showing a historical photograph, descriptive text, and related assets.

4.2 Interactive Experience Design and Heritage Integration

The experience design of the Kayseri Digital Atlas application is guided by two complementary principles: informational completeness and emotional resonance. The first principle requires that each asset presented in the application be accompanied by sufficient scholarly documentation to satisfy the needs of researchers and heritage professionals: historical sources, bibliographic references, condition assessments, and spatial data. The second principle requires that this documentation be presented through narrative strategies that convey the neighbourhood's lived experience to general users, including those with no prior knowledge of Kayseri's history.

This second principle is most fully realised in the oral history audio and video content integrated into asset profiles. When a user views the record of a particular inn or fountain, they can listen to a neighbourhood resident recounting their childhood memories of that place; when they browse the category of culinary intangible heritage, they can hear descriptions of traditional recipes and food-preparation practices associated with specific households and communal events. The combination of archival documents with personal testimonies creates a unique experience that neither a typical heritage database nor a standard museum display can easily emulate. Visitors are encouraged not just to learn about the heritage but to experience it first hand through the perspectives and voices of those for whom it holds personal significance.

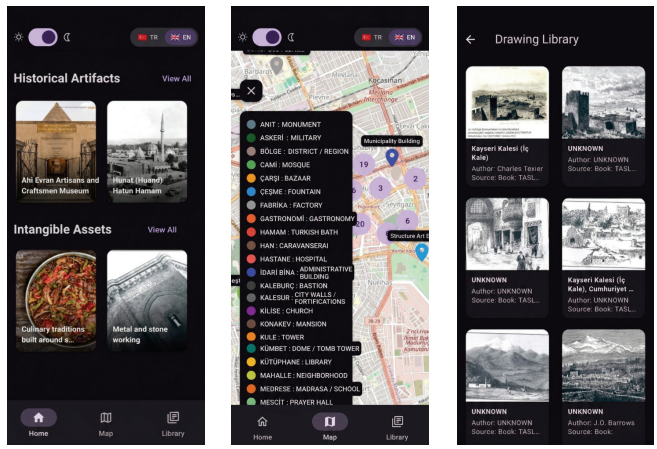

Fig. 6. Screenshots from the Kayseri Digital Atlas closed-beta mobile application.

Incorporating both tangible and intangible heritage into one platform reflects a deliberate approach in methodology and design. Conventional documentation practices tend to treat architectural fabric and social practice as separate objects of study, addressed by different disciplines and managed by different institutions. The Kayseri Digital Atlas deliberately resists this separation, linking physical assets to the oral traditions, craft practices, and ceremonial knowledge associated with them in the database and presenting those links to users through the asset detail interface. This integrative approach reflects the theoretical framework of cultural landscape, which insists on the co-constitutive relationship between the built environment and the social life it shelters (Kevseroğlu et al., 2021).

5 Conclusion

The Kayseri Digital Atlas integrates archival research, oral history, and memory walks with a Flutter-based data-entry system to produce a database of 2,000+ media items linked to 407 catalogued heritage assets in Cumhuriyet Neighbourhood, accessible through a multi-layered mobile application. Methodologically, the project treats the gap between archival and oral memory as an analytical tool; technically, it offers a replicable architecture (Flutter, Spring Boot, MySQL, OpenStreetMap); and theoretically, it operates the cultural landscape framework in a digital medium. Phase 2 will add CNN-based classification-and fine-tuned text-to-image reconstruction alongside LLM-based semantic search of oral history transcripts. The platform will be released under an open-access license, with full technical documentation to facilitate replication. Future work will explore scaling the methodology to other historic neighbourhoods within the Kayseri city, ultimately, to comparable Anatolian urban contexts. Phase 2 (CNN-based image classification) has not been omitted from the project scope; it is scheduled to commence following completion of the data collection phase, as a sufficient and well-labelled training dataset must first be assembled. Likewise, the public beta release and its associated user behaviour analysis represent planned future work: the current closed-

beta phase is confined to the project team and focuses on interface stability and dataset completeness, not on user experience evaluation. Future work will therefore include: (i) CNN-based classification and LLM-assisted semantic search of oral history transcripts (Phase 2); (ii) public beta deployment with structured user evaluation and analysis of usage patterns; and (iii) scaling the methodology to additional historic neighbourhoods in Kayseri and comparable Anatolian urban contexts.

Long-term data preservation is a recognised risk: the project addresses this through automated cloud backup with a recovery time objective of under 15 minutes, and by adopting a cloud-provider-agnostic architecture that permits rapid migration to an alternative hosting environment if required. Technological obsolescence is mitigated through the exclusive use of open-source frameworks (Flutter, Spring Boot, MySQL, OpenStreetMap) and the planned publication of full technical documentation under an open-access licence. Data format longevity is ensured by storing media in widely adopted non-proprietary formats (JPEG, MP3, PDF). Nonetheless, the long-term institutional commitment required to sustain, update, and curate a living digital archive remains a challenge that extends beyond the current project scope and will require ongoing support from the funding body and partner institutions.

Declaration of Generative AI use in the writing process

During the preparation of this work, the authors used generative AI tools (Claude Sonnet 4.6 and Gemini 3.1 Pro) for language editing and proofreading purposes to improve readability. These tools were not used to develop scientific ideas, conduct data analysis, or draw conclusions. After using these tools, the authors comprehensively reviewed and edited the manuscript. The authors take full accountability for the accuracy, originality, and integrity of the final publication.

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