

Improving Museum Visitor Experience Using QR Code Technology: Creation of a Mobile Application for Al Ghaydah Museum

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ABSTRACT: Digital transformation entails the application of digital technologies to optimize processes, augment productivity, and elevate knowledge. This study examines the design and development of an innovative mobile application for the Al Ghaydah Museum, enabling visitors to identify objects with QR code technology and access information about them. It also seeks to highlight archaeological sites in Al Mahrah Governorate. The project aims to tackle the difficulties museum visitors encounter in obtaining information about items and familiarizing themselves with historical sites and landmarks. The project aims to design and develop a mobile application that enables straightforward and precise access to historical details and information regarding artifacts, alongside the creation of a database encompassing extensive information about artifacts and historical landmarks within the governorate.

KEYWORDS: Mobile Application Development, QR Code, Digital Museum Guide, Cultural, Al Ghaydah Museum

I. INTRODUCTION

The outdated criteria for assessing a nation's development have become obsolete in today's technologically advanced, information-centric world dominated by digitalization, information networks, and scientific innovations. The contemporary world is regulated by novel concepts. Digital transformation occurs when we enhance various processes via the application of digital technology and capabilities. It exemplifies the rapid integration of sophisticated technologies in contemporary development projects [1]. Quick Response (QR) technology is a modern technique utilized for the swift and effective storing and delivery of information [2]. QR technology employs a two-dimensional (2D) code consisting of data encoded in a square format, where information is depicted by configurations of black and white pixels (dots). This code is deciphered by specialized scanning devices, including mobile phone cameras, and the information may encompass electronic links, telephone numbers, text messages, codes, or various other forms of data. QR technology enables users to rapidly access specific information by scanning a QR code with their mobile device's camera [3]. The Al Ghaydah Museum in Al Mahrah Governorate is a significant cultural and historical institution in the region. The museum was founded in 1987 to document and preserve the historical objects and traditions of our forefathers. In light of the significance of cultural and historical objects within the governorate, we proposed a project to create a mobile application that enables users to identify these items through Quick Response (QR)

technology. The program seeks to offer a straightforward and effective means of accessing comprehensive information regarding the objects housed in the Al Ghaydah Museum. The lack of accessible and user-friendly electronic applications that provide information on items' histories and details is a problem in Al Mahrah Governorate. This is especially true for museums and antiquities. As a result, we set out to design this one-of-a-kind software to bring the Al Ghaydah Museum's antiquities to life and make the automated guide procedure easier for guests. What follows is an outline of the rest of the paper: Section II provides a literature review on the subject; Section III describes the system designed and methods used; Section IV gives the outcomes of the experiments; and Section V draws a conclusion and suggests avenues for future research.

II. RELATED WORK

Following the prior technological revolution and significant advancements in computer science, numerous research have aimed to use current technology into various governmental sectors, including e-tourism. [4] In 2022, a mobile application for cultural tourism in Oman utilizing augmented reality was developed. A survey of 120 visitors to Malaysian museums revealed that fun expectations, program content expectations, performance expectations, effort expectations, and social influence positively affect visitors' intention to utilize a mobile AR application, demonstrating a high explanatory power of 61.2% [5].

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In 2012 [6], Tsai and Sung conducted a study to investigate the impact of mobile applications on improving the tourist experience in museums and galleries. The research examines the functionality of multimedia tour programs that enable tourists to personalize their tours and move effortlessly throughout museums. The study examines tour games and mobile app- based search games, which are novel approaches for engaging tourists and significantly improving their experience. These technologies are shown at prestigious institutions including the Tate Modern in London and the Smithsonian American Art Museum. Contemporary mobile applications have language packs and voice functionalities that assist users in surmounting the linguistic obstacles encountered with conventional human guide systems. The principal rationale for the development of mobile applications is to mitigate the difficulties encountered by visitors at museums and monuments, leading to the emergence of the automated museum guide [1]. Table I presents many research that employed augmented reality applications and technology to enhance museums and archeological sites.

TABLE I. SIMILAR PREVIOUS STUDIES

Year	Title	Museum L.	Study
2023	Investigating Experience of Mobile Application in Museum: The Case Study of the Nationalmuseum	Stockholm, Sweden	[7]
2019	The Impact of Mobile Technologies on the Museum Experience	Urbino, Italy	[8]
2023	A prototype mobile application for the Athens Numismatic Museum	Athens, Greece	[9]
2021	AUGMENTED REALITY MOBILE APPLICATION FOR MALAY HERITAGE MUSEUM	Universiti Putrajaya, Malaysia	[10]
2022	Contributions to the design of mobile applications for visitors of Botanical Gardens	Lisbon, Portugal	[11]
2022	EFFECTIVENESS OF USING INFORMATION AND COMMUNICATION TECHNOLOGY IN DEVELOPING MUSEUM EXHIBITIONS: THE CASE OF THE SHARJAH MUSEUMS	SHARJAH, UEA	[12]
2024	Distance Learning through the Grand Egyptian Museum: Leveraging Modern Technology to Teach about Ancient Egypt among Schools and National Museums	Cairo, Egypt	[13]

2024	Original Research Article Using augmented reality and deep learning to enhance tourist experiences at landmarks in Makkah	Makkah, KSA	[14]
2025	Improving Museum Visitor Experience using QR Code Technology: Creation of a Mobile Application for Al Ghaydah Museum	AL-Mahrah, Yemen	this study

III.SYSTEM DESIGN AND METHOD

Here, we take a broad look at the program, break down the system requirements, figure out who will be using it, and break down the functional and non-functional needs. In order to accurately and quickly develop the application, we also make sure to explain the desired deliverables in terms of functional and supplementary features. In order to show how the various parts of the application interact with one another and how data is transferred between them, we create system diagrams such as "Use Case and Scenario Diagram," "Class Diagram," "Data Flow Diagrams," and "Entity Relationship Diagrams" during this part.

We met with the curators of the Al Ghaydah Museum, representing the General Authority for Antiquities and Museums, Al Mahrah Branch. During the visit, we acquired archaeological and historical insights into the exhibits at the museum, as well as an overview of the principal historical sites in Al Mahrah Governorate.

A. system requirements

The system requirements are categorized into functional and non-functional needs. It is essential to differentiate between them to ascertain the application's functional requirements (what it should accomplish) and non-functional requirements (necessary features and services).

1) Functional Requirements :

- **Barcode Scanning:** The application must possess the capability to scan barcodes of archeological objects and retrieve their corresponding information from the database.
- **Information Display:** The application must present comprehensive details regarding archeological items and historical landmarks, encompassing descriptions, photos, dates, and cultural relevance.
- **Incorporating fresh Data:** The application must enable registered users to input fresh information regarding archeological objects and historical landmarks.
- **Administrator:** The administrator must possess the capability to alter and remove data within the software.

2) Non-functional Requirements:

- **Data Security:** The stored data must be safeguarded against unwanted access.

- **Program Performance:** The program must function seamlessly and present information promptly without latency.
- **Cross-device Compatibility:** The application must be functional and user-friendly across diverse Android devices and many screen dimensions.
- **User Interface:** The user interface must be intuitive, aesthetically pleasing, and tailored to user specifications.
- **System Responsiveness:** The application must accommodate a substantial user base without compromising performance.

B. System Design

The Museum Al-Mahra application consists of three main interfaces and a subinterface, in addition to two main user types in the application. The external user has the permission to identify and access, while the administrator user has the permission to add, delete, and modify. As part of our work, the application was built using a variety of diagrams that helped with project comprehension and examining the interrelationships of the different parts of the system. Figure 1 is a category diagram that shows the interconnections and categories in the Ghaydah Museum app. This diagram serves as a guide for comprehending the overall layout and interconnections of the application’s primary parts. Figure 2 further supports this point. The Museum App’s sequence diagram illustrates the interplay between various entities and objects as a result of user activities and database searches. An overarching perspective of interactions within the app is given.

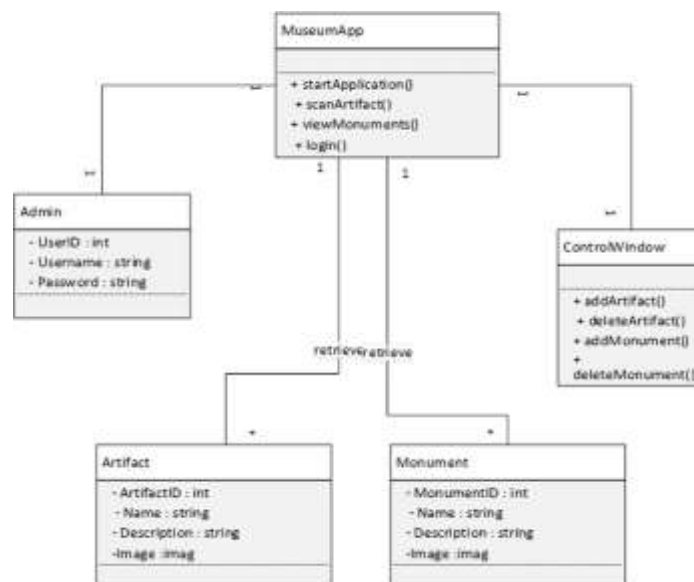


Figure 1 Class Diagram of Ghaydah Museum app.

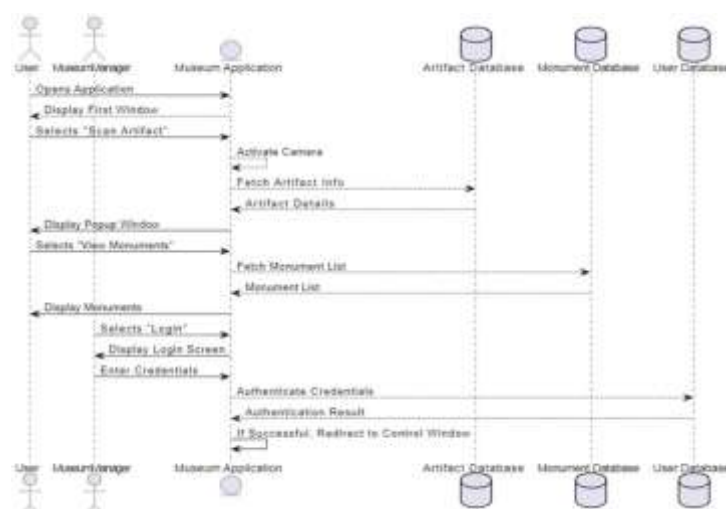


Figure 2 Sequence Diagram of Ghaydah Museum app.

C. System Implementation

The Al-Mahra museum application features three main interfaces and a sub-interface, catering to two primary user types: external users and administrators. External users have access to identification and browsing capabilities, whereas administrators possess elevated privileges, including adding, deleting, and modifying content.

The application was developed using Android Studio, a comprehensive integrated development environment (IDE) designed specifically for Android app development. Kotlin, a modern programming language, was employed for its concise syntax and advanced features, such as compile-time error checking. Jetpack Compose, a modern UI development framework, was utilized to create an intuitive and innovative user interface. Additionally, SQLite, a lightweight database management system, was used for local data storage, and the ZXing library was integrated for barcode and QR code recognition.

The development environment consisted of a computer with a Core i7 processor (quad-core or higher), 8 GB of RAM, and a 1 TB hard disk drive, running on Windows

10. These specifications ensured efficient development, testing, and deployment of the application. The combination of these tools and technologies enabled the creation of a robust and user-friendly application for the Al-Mahra museum.

Following the scanning process, the Display Interface takes over to provide a more detailed view of the artifact's information. It may include high-resolution images, textual descriptions, and links to related artifacts or sources. This ensures users gain a comprehensive understanding of the scanned item.



Figure 3 Scanner Interface of Ghaydah Museum app.

IV. INTERFACES AND RESULTS

A. Scanner Interface

The Scanner Interface serves as the initial point of interaction for users upon launching the application. As soon as the app is opened, the camera is activated automatically within the interface, allowing users to scan barcodes that are affixed to various artifacts immediately. This streamlined process is designed to enhance user convenience and reduce the number of steps required to access information. The camera remains continuously active until a barcode is detected and successfully scanned. Figure 3 shows this process.

Once the barcode is scanned, a pop-up window appears on the screen displaying key details about the artifact. This may include the artifact's name, origin, historical significance, date of discovery, and any other relevant data stored in the application's database. The information is presented in a clear and concise format to ensure it is easily understandable to the user. Figure 4 displays an example of the display interface after scanning.

The interface also includes a navigation toolbar located at the bottom of the screen. This toolbar provides users with quick access to other major sections of the app, such as the home screen, artifact collection, search functions, and user settings. The design of the toolbar aims to promote seamless navigation throughout the application.



Figure 4 screen displaying of Ghaydah Museum app.

B. Control Panel Interface for Artifact Management

The Control Panel Interface is a central administrative component designed to facilitate the management of artifact

and archaeological monument records within the system’s database. Positioned at the top of the interface is an integrated search bar, which enables users to efficiently locate existing entries by inputting keywords or full names associated with the artifacts. This dynamic search functionality supports partial matching and returns a list of relevant results based on the query. Figure 5 explains the Control Panel Interface for Artifact Management.



Figure 5 Control Panel Interface of Ghaydah Museum app.

Upon selecting a specific item from the search results, its comprehensive details are populated across several editable fields, including an image display, title, and descriptive text. This allows for direct interaction with the selected entry. To modify any of the displayed attributes, the user may update the relevant fields and then confirm the changes by clicking the **Edit button**, which is prominently displayed in green at the bottom of the interface. This action triggers an immediate update to the underlying database, ensuring that all changes are accurately and promptly recorded.

Alternatively, if the user intends to remove the item from the system, a **Delete button**, colored in red for visual distinction, is available. Once clicked and confirmed, the record is permanently deleted from the database.

For the addition of new artifacts, users must populate all required fields, including the image, title, and description. The **Add button**, represented in blue, initiates the insertion process. Before finalizing the addition, the user is prompted to specify the contextual location or category for the new entry. Upon confirmation, the data is immediately written to the database, reflecting the addition in real-time. This interface ensures efficient and user-friendly CRUD (Create, Read, Update, Delete) operations, essential for maintaining an accurate and up-to-date digital inventory of archaeological and cultural heritage artifacts. The color

coded buttons and real-time database integration further enhance usability and reduce the potential for human error in data management workflows.

V. CONCLUSION AND FUTURE WORK

The development of the Android application for the Al-Mahra Museum has led to several significant conclusions regarding the digital preservation and dissemination of cultural heritage. First, the application has succeeded in creating a unified platform through the establishment of a centralized database. This allows for the systematic collection, organization, and presentation of a wide array of information related to archaeological artifacts and heritage sites within Al-Mahra Governorate. The centralized approach ensures consistency, improves data accuracy, and facilitates easier access for both administrators and end-users. Moreover, the application provides a seamless and user-friendly experience, thanks to its intuitive design and navigation structure. Visitors can easily search for and access detailed information about specific artifacts, enhancing their engagement with the museum’s content. In this way, the application acts not only as a digital companion for onsite visits but also as an informative resource for remote users.

In addition, the platform serves as a powerful promotional tool for the region’s archaeological heritage. By showcasing detailed descriptions and high-quality images of artifacts and historical sites, the application raises public awareness and encourages further exploration of Al-Mahra’s rich cultural landscape. This can potentially contribute to the development of cultural tourism in the region. The inclusion of administrative functionalities—such as the ability to add, edit, and delete records—offers a high degree of flexibility and scalability. These features enable museum staff to keep the database current and reliable, supporting the sustainable growth and long-term relevance of the application. Lastly, by digitizing and preserving archaeological data, the application plays an important role in the protection and promotion of Al-Mahra’s cultural heritage, ensuring that it remains accessible to future generations.

Looking ahead, several areas of improvement and expansion have been identified to enhance the application’s utility and impact. One important direction is the incorporation of multilingual support. By providing content in multiple languages, the application can become more inclusive and accessible to a global audience, thereby enriching the museum experience for non-Arabic speakers.

Another promising area involves the integration of interactive features, such as virtual tours, 360-degree imagery, and augmented reality experiences. These immersive technologies would transform the way users engage with the artifacts and historical sites, offering a more dynamic and educational experience that goes beyond static text and images. Furthermore, the application can be expanded beyond the Android platform to include iOS

support, enabling users on iPhones and iPads to access the same functionalities. This cross-platform availability is crucial for reaching a wider user base and enhancing the overall accessibility of the museum’s digital services.

Finally, integrating the application with a cloud-based hosting service would provide significant technical advantages. It would allow for real-time data synchronization, remote access, automatic updates, and greater storage scalability. This infrastructure would support the growing needs of the museum and ensure the application remains responsive and efficient as user demands evolve. This comprehensive digital initiative represents a meaningful step toward modernizing cultural institutions in Al-Mahra and provides a replicable model for museums in similar contexts.

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