

# SafAR: Reimagining Cultural Heritage Tourism with Augmented Reality - A Case Study of Qutub Minar, Delhi



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## Abstract

SafAR explores incorporating augmented reality (AR) technology in cultural heritage exploration, specifically focusing on enhancing visitor experiences at historical sites such as Qutub Minar. Findings from interviews, user testing, and A/B studies provide valuable insights into user preferences, challenges, and expectations within heritage exploration. Highlighting the significance of cultural heritage as a link to personal history, the study emphasizes the crucial roles of storytelling and accessibility in boosting visitor engagement. The developmental process was iterative, incorporating interactive AR components and ideating on various needs and opportunities. Feedback from user testing validated the effectiveness of AR functionalities while proposing heuristic guidelines to steer the design of AR applications within the Indian context. The study concludes by delineating future prospects for continued innovation and expansion in AR-driven cultural heritage exploration, paving the way for ongoing advancements in this field.

## Research Objectives

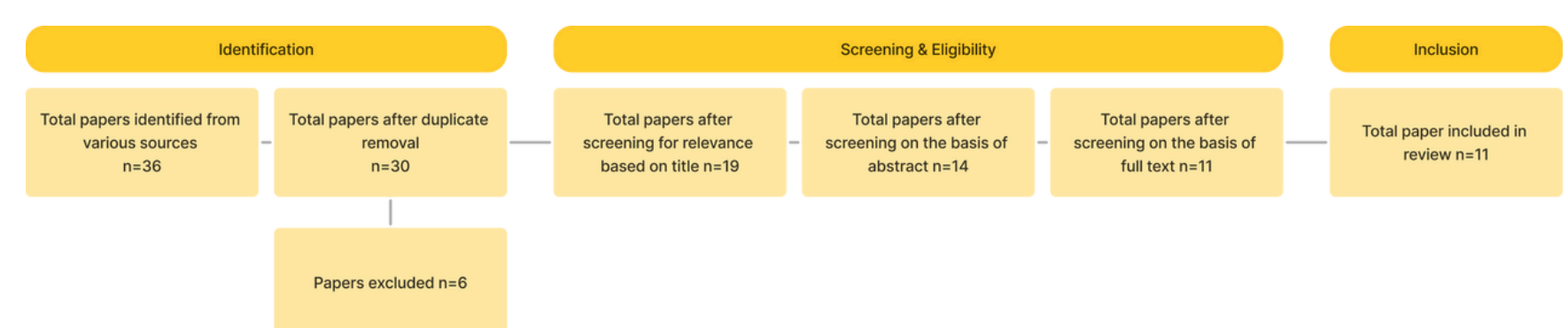
**Research Objective 1:** To explore the intersection of augmented reality (AR) technology and cultural heritage exploration.

**Research Objective 2:** To apply design principles and develop an AR experience tailored for cultural heritage exploration in India, emphasizing user-centric principles.

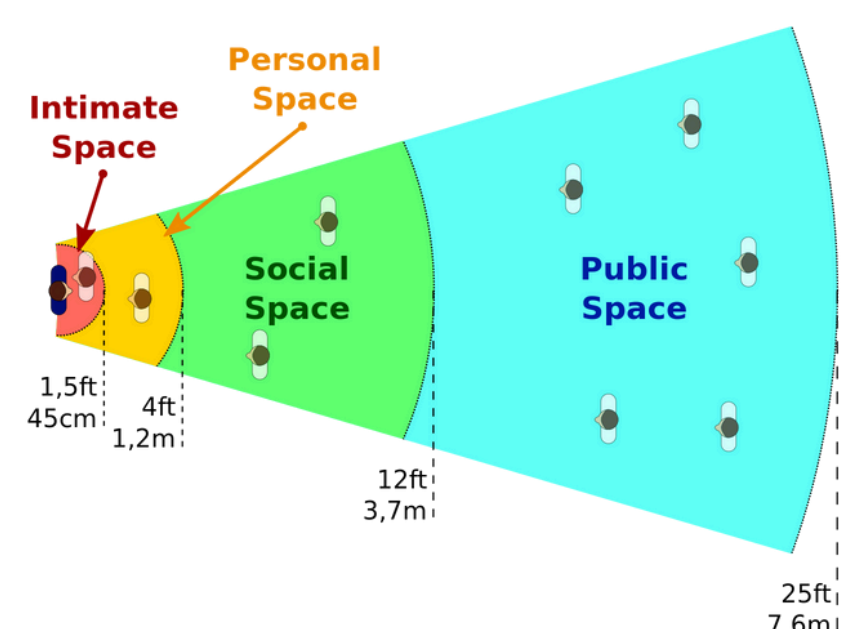
## Literature Review

Our literature review delves into two significant areas: the intersection of **AR, heritage, and India**, and the incorporation of **Proxemics into AR applications** in the context of cultural heritage.

**AR, Heritage & India-** This area explores how AR technology intersects with cultural heritage preservation, specifically within the Indian context. It encompasses studies on virtual tourism, usability challenges, and AR's role in enhancing museum narratives. The review highlights AR's potential to enrich cultural heritage experiences and support preservation efforts. Moreover, there's a call for studies focusing on 3D visualization, mapping, geolocation, and user-centric design to enhance the effectiveness of AR applications in cultural heritage preservation in India.



**Proxemics & AR-** This area explores the integration of Proxemics, the study of human use of space, into AR applications for cultural heritage exploration. It investigates how Proxemics influences user interactions at heritage sites and its potential to enhance the tourism experience.



## Research gaps-

- Limited papers on the intersection on AR, heritage, and India
- There is a need to address usability challenges and cultural authenticity, especially in tourism.
- AR being used to enhance visitor engagement.
- Lack of study on 3D visualization, mapping, geolocation, and user-centric design study.
- While there are limited papers on proxemics in the context of cultural tourism, its integration can help enhance the tourism experience.

## Research Design

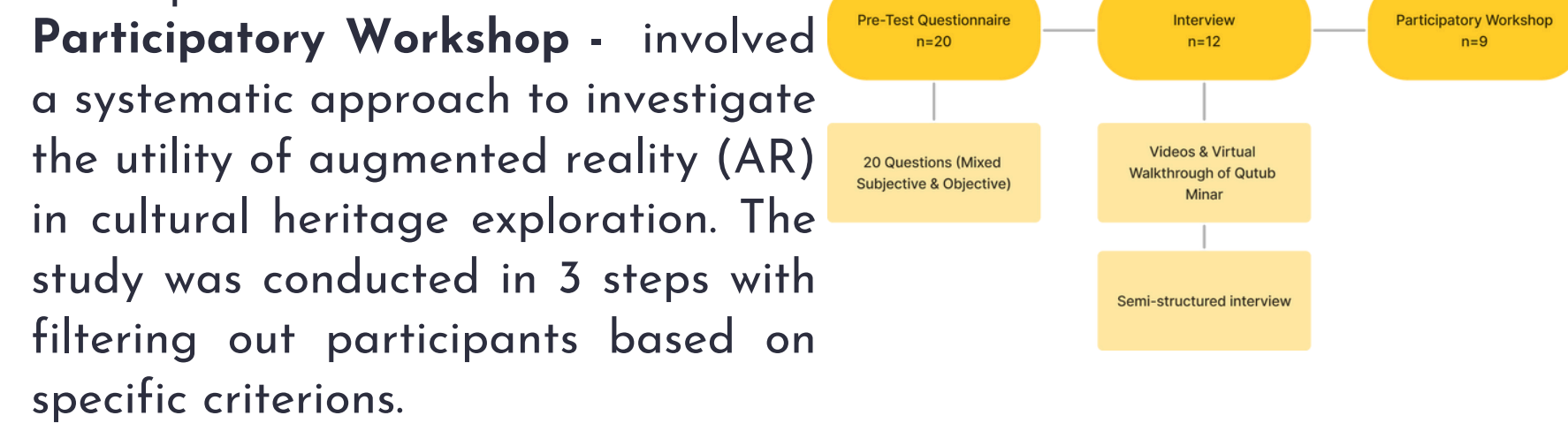
### Secondary Research

**Competitive Analysis** - We assessed similar services to refine our AR-based solution, identifying strengths and weaknesses of competitors. This analysis informed our approach to differentiate and improve existing cultural heritage exploration offerings.

	AR Component	Audio Guides	User Friendly	Free of Cost
Dahli Tourism	✗	✗	✗	✓
Yatra	✓	✓	✗	✓
AugTraveler	✓	✓	✓	✗
Hug On-Sahapedia	✗	✓	✗	✗

### Primary Research

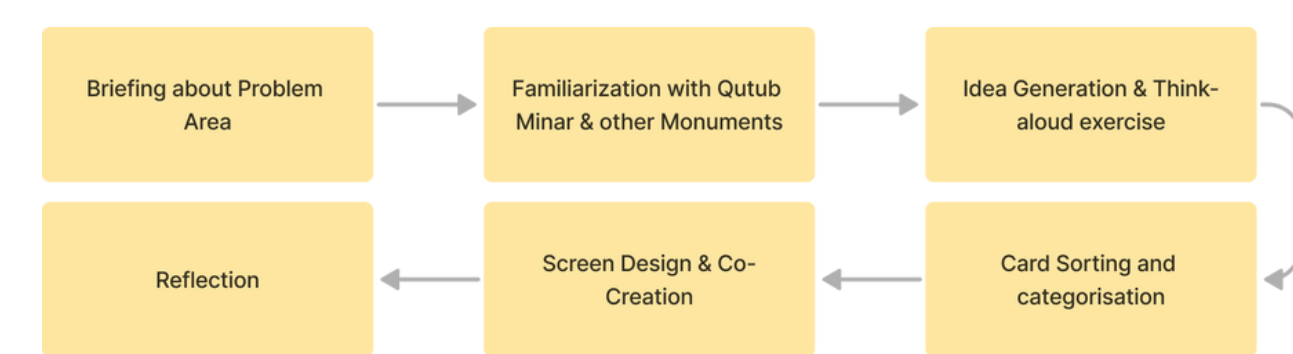
**Field Visit** - During our field visits, we immersed ourselves in the Qutub Minar complex to understand visitor experiences and identify areas for improvement. These insights guided the location selection and development of our AR intervention.



**Participatory Workshop** - involved a systematic approach to investigate the utility of augmented reality (AR) in cultural heritage exploration. The study was conducted in 3 steps with filtering out participants based on specific criteria.

- A **pre-test questionnaire** was administered to establish a baseline understanding of participants' knowledge and expectations regarding cultural heritage and AR.
- Semi-structured interviews were conducted to delve into participants' perceptions and experiences with AR, further informing the research findings.
- A subgroup of participants took part in a **participatory design activity**, where they collaboratively contributed ideas to design an ideal AR app. This interactive session involved brainstorming, sketching, and discussions. The selection criteria emphasized innovative ideas and active participation.

The participatory design workshop unfolded in six steps:



**User Centric Design Process-** Iterative design and usability testing ensured that the AR interface was refined based on feedback and tailored to meet the unique needs of cultural heritage site visitors.



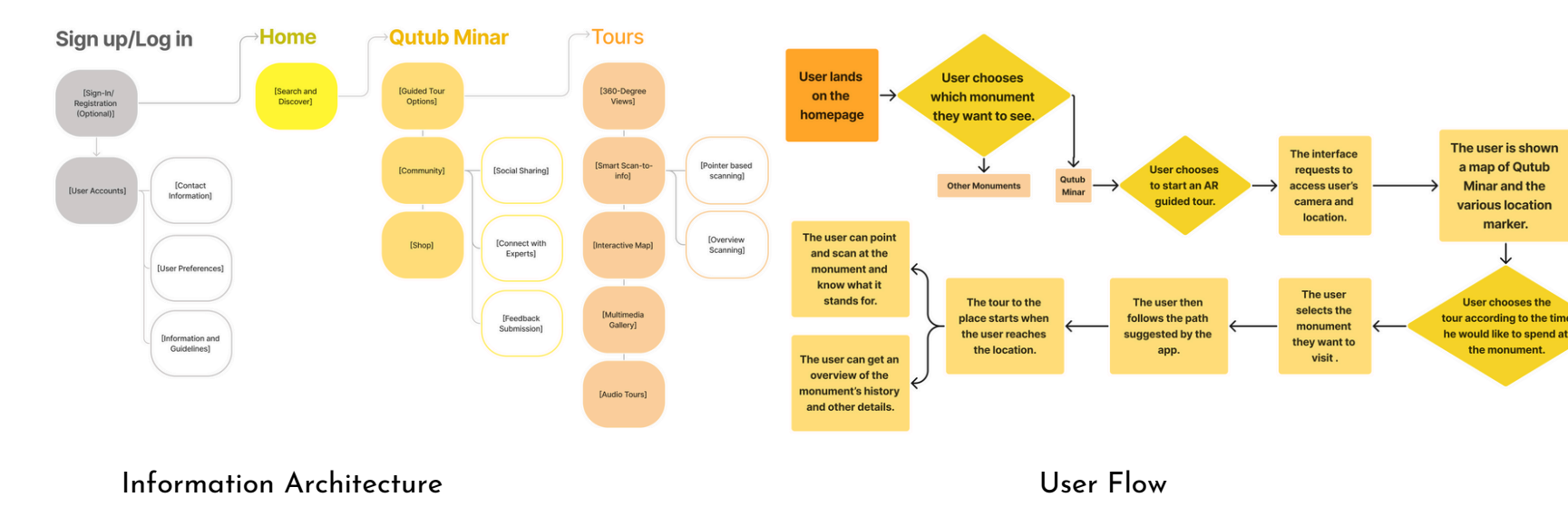
## Analysis- Heuristics Guidelines

The research findings were systematically processed to prepare a set of Heuristic Guidelines to be followed for designing and developing user-centric experiences for Augmented Reality Apps for Cultural Heritage tours. Following heuristics ensures that applications are designed to meet users' core needs and align solutions with user preferences.

- Ensure well-trained guides for accurate historical narratives.
- Verify information to prevent misrepresentation.
- Encourage emotionally resonant storytelling.
- Provide multilingual guides and digital aids.
- Offer translated materials and interactive apps.
- Balance guided tours with self-exploration.
- Incorporate Augmented Reality for personalized experiences.
- Tailor experiences to individual connections.
- Introduce attractions and cultural activities.
- Embrace a holistic perspective for storytelling and comfort.
- Create educational opportunities and hands-on experiences.
- Establish a feedback mechanism for continuous improvement.
- Implement sustainable practices and educate on conservation.
- Foster collaborations for a well-rounded experience.
- Utilize social media for virtual engagement.

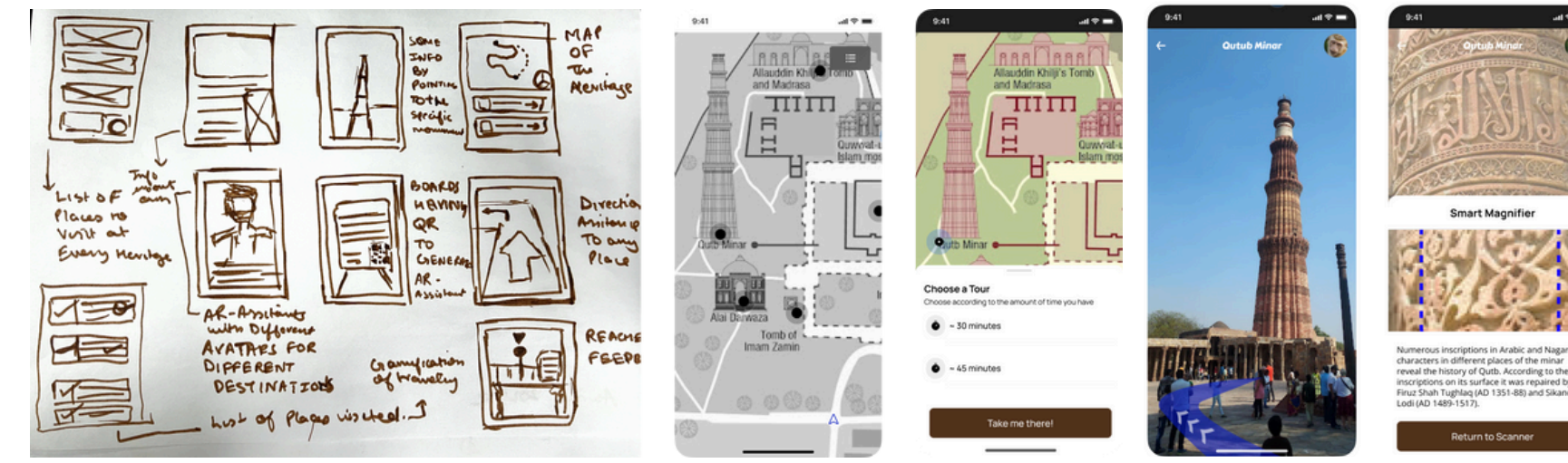
## User Experience Design

Based on the heuristics developed, we went on to the next part- designing the interface. We started with making an information architecture and a user flow based on the analysis from the co-creation activity done earlier.

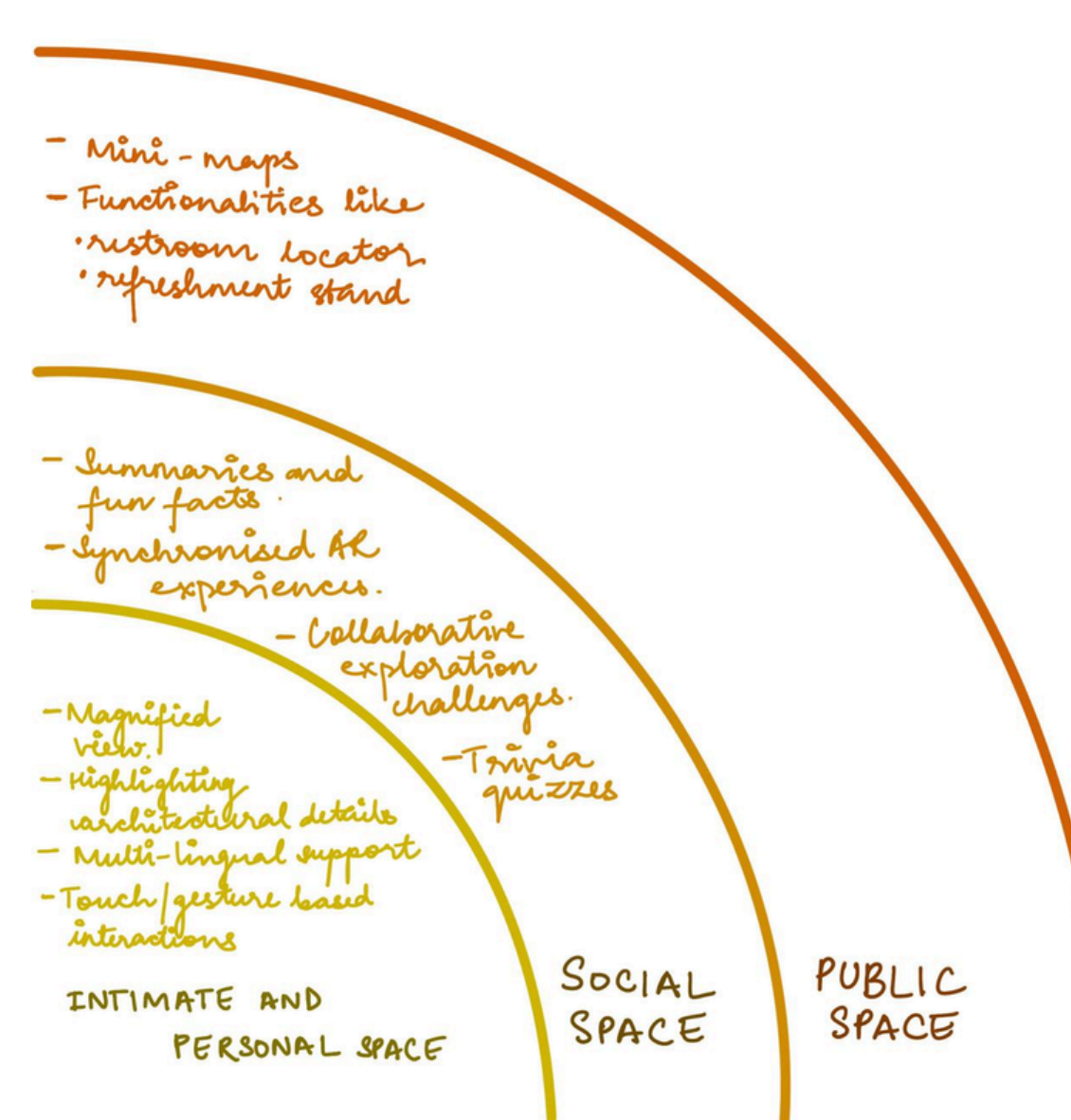


From our design findings, some key aspects we identified were users keen interests in **storytelling, interactive experiences and learnings** through **AR**, and suggestive recommendations. Users also prefer **self-exploration** of the site as they are self-paced. A concern that was brought up was the language barrier, suggesting a **multi-lingual support**. This helped us come up with key features of the app like **Search and Discover, Guided Tour Options 360-degree Views, Smart Scan-to-Info and Multimedia Gallery**.

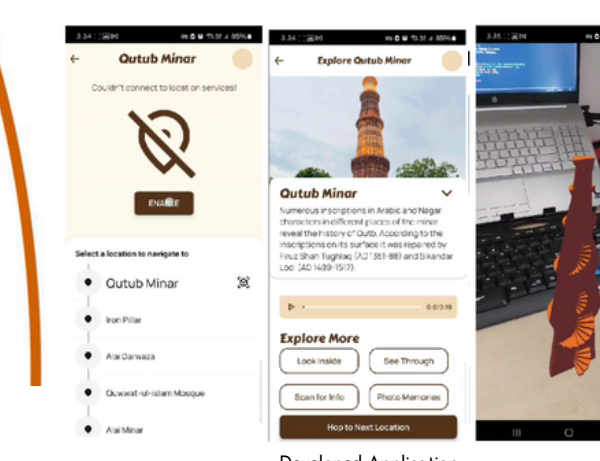
Based on the low-fidelity outcomes from the co-creation activity, we created mid-fidelity and high-fidelity prototypes.



Translation of these insights into action by developing a proof of concept for an AR user interface on our campus.

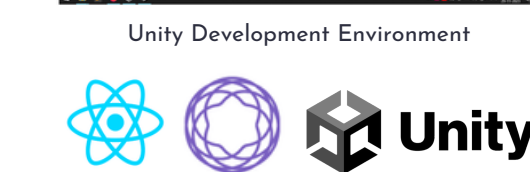
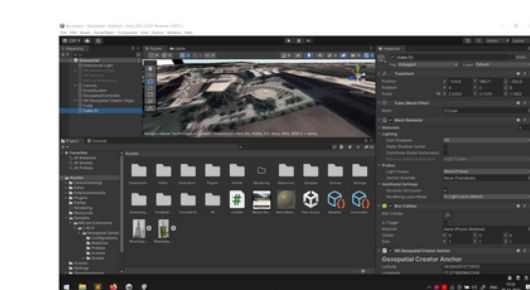


- Features**
- Search and Discover
  - Maginified Views
  - Guided Tour Option
  - 360-Degree Views
  - Connect with Experts
  - Community
  - Smart Scan-to-Info
  - Multimedia Gallery



## Development

We chose **Reactive Native, React Viro, React Native Maps, React Navigation, Axios and Axios Cache Interceptor** and **Geolib** for development. Their strong development framework and compatibility with various Android devices, ensures a cohesive user experience.



However, challenges emerged during development. Unity's UI development tools, less robust compared to its 3D capabilities, slowed progress. Additionally, the lack of readily available libraries for essential functionalities like map integration and web requests required custom solutions.

## User Testing

The testing phase involved evaluating the developed app, including a basic proof of concept. Participants were selected from pre-test phases, stratified according to their level of interest in heritage and familiarity with augmented reality (AR). A/B Testing was done with participants in the user testing phase encompassed four key areas: **Interest, Usability, Experience and Engagement**.



- Users found AR technology novel and immersive, expressing excitement for its use in heritage exploration.
- The app served as a comprehensive tour guide, offering features like scanning for deeper insights into historical sites.
- Suggestions for improvement included incorporating a conversational interface and ensuring offline accessibility.
- Participants emphasized the importance of accommodating both group and individual usage scenarios.
- Users highlighted the app's potential for enhancing bonding experiences during heritage site visits.

Aspect	Positive Outcomes	Negative Outcomes
Interest	- Heightened interest in exploring cultural heritage sites through AR technology. - Enthusiasm for novel AR features.	- Concerns about novelty wearing off over time, especially among users without AR functionality.
Usability	- High usability reported by both groups, with intuitive interface and easy navigation. - Praise for clear menus and interactive elements. - Accessibility to users of all skill levels.	- Usability issues encountered by some users with AR functionality, including difficulty in interaction and tracking inconsistencies. - Frustration among users due to technical challenges with AR implementation.
Experience	- Positive overall experiences reported, with AR features enhancing immersion. - Appreciation for interaction with virtual reconstructions.	- Concerns raised about app's ability to provide comprehensive understanding of heritage sites. - Feedback on lack of depth in historical context and interpretation with AR features.
Engagement	- Significant enhancement of user engagement with AR features. - Users actively seeking out virtual elements and hidden historical information. - Interactive nature of AR features keeping users engaged.	- Perception of non-AR version lacking interactive elements, leading to less engaging experience. - Suggestions for incorporating more interactive features to enhance engagement. - Importance of balancing innovation with user engagement highlighted.

The user testing phase yielded numerous **insights** regarding participants' experiences with the AR-based tourism app. Here are a few guidelines:

- Embracing Novelty
- Excitement for AR Exploration
- Fresh Perspective on History
- All-In-One Tour Companion
- Intriguing Scan for Information
- Potential for Conversational Interface
- Balancing Digital and Physical Experience
- Fascination with Monument Scan
- Anticipation for Future Features
- Group and Individual Usage
- Generative AI Chatbots
- Internet Accessibility
- Accessibility for Older Users
- Integration of User Feedback

## Future Prospects

Our research journey progressed through three stages: studying existing knowledge, gathering insights and developing and testing our solution. Our papers got accepted at ISS'2023, IndiaHCI'24. We await responses from a few more submitted conferences. The project offers opportunities for innovation and expansion in enhancing AR experiences at cultural heritage sites like Qutub Minar. Our proof of concept serves as a foundation for future work, demonstrating the potential of AR in heritage exploration. Though not actively pursuing further development, we hope our work inspires others to build upon it.



## Acknowledgement

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