E-BOOK OF EXTENDED ABSTRACT

THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025

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YIN-YANG URBAN TOOLKIT: BALANCING HERITAGE AND MODERNITY IN ALOR SETAR THROUGH AI AND QR-BASED PEDESTRIAN INFRASTRUCTURE

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ABSTRACT

This research explores the development of an interactive urban toolkit that integrates artificial intelligence (AI), geographic information systems (GIS), and QR code-based interfaces to guide sustainable urban planning, heritage-rich cities with a focus on Pekan Cina, Alor Setar, Kedah. Inspired by the Yin & Yang zoning concept, the toolkit enables urban designers to balance traditional cultural preservation (Yin) with the dynamic demands of tourism and modernisation (Yang). The proposed model generates sustainable urban layouts by simulating inputs such as noise tolerance, pedestrian density, vehicle flow, and cultural activity zones. In parallel, it introduces AI-enhanced pedestrian pathways embedded with QR code features designed to enrich user experiences, promote walkability, and encourage cultural engagement. This study adopts a mixed-methods approach by merging spatial analysis, community mapping, and AI prototyping to validate the toolkit. Findings suggest that the model effectively enhances social sustainability by promoting local identity, reducing spatial conflicts, and supporting inclusive urban design. This study provides a scalable, tech-driven framework to guide other small cities in integrating heritage preservation with smart urban growth.

Keyword: Artificial Intelligence, Geographic Information Systems (GIS), QR Technology, Sustainable Living, Pedestrian Infrastructure, Community Engagement

1. INTRODUCTION

1.1 Integration of QR and Artificial Intelligence Experience

Small heritage cities like Alor Setar face growing challenges in balancing cultural preservation with rapid urbanization and increasing tourism demands. Often, urban plans prioritize economic growth at the expense of historical identity and pedestrian comfort. This research introduces a conceptual Yin & Yang Urban Toolkit that applies AI and QR-based digital systems to create urban zoning solutions that respect both the city's essence (Yin: locals, culture, tranquility) and its vibrancy (Yang: tourists, commerce, activity). By leveraging AI simulations and interactive public interfaces, this project aims to create sustainable, walkable, and culturally enriched urban environments.

1.2 Integration of Sustainable Development Goals (SDG)

This study strongly aligns with the principles of the Sustainable Development Goals (SDGs) by promoting innovative infrastructure, inclusive community development, and long-term economic sustainability. The use of clearly designed pedestrian crossings enhances walkability and supports safer, more accessible, and environmentally friendly mobility, contributing to a more connected and livable urban community.

2. METHODOLOGY

The research employs a mixed-methods design combining both qualitative and quantitative approaches. ArcGIS Instant App was used to plan, implement, and manage QR code technology and other sustainable infrastructure components.

The process began with spatial data collection, including key cultural and historical sites, pedestrian pathways, and potential QR code installation points. This data was uploaded to ArcGIS, where it was analyzed to determine optimal locations for interactive installations and pedestrian improvements. QR and AI experiences were then designed using ArcGIS Instant Apps.

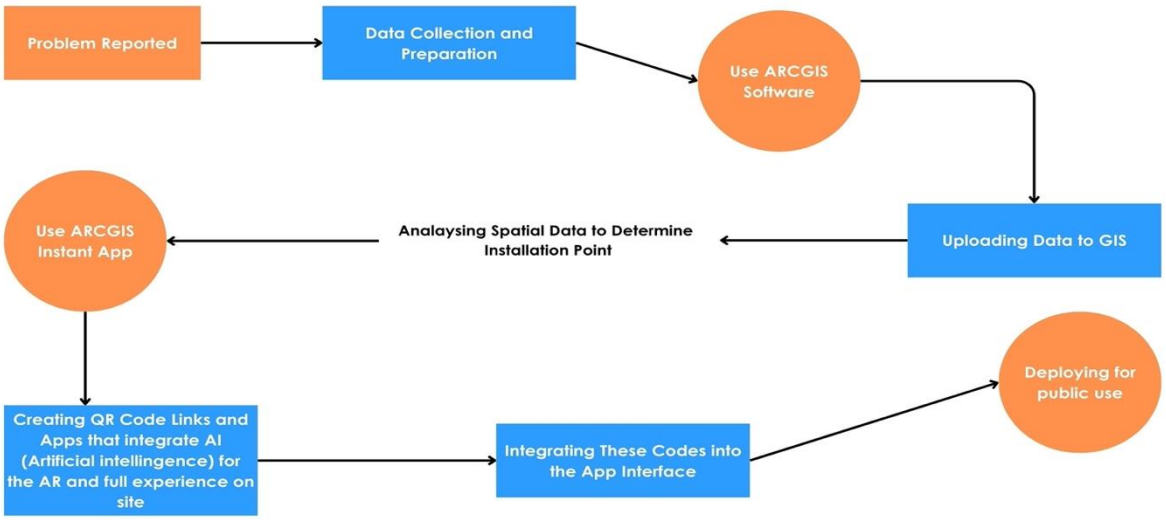

Figure 1 Workflow methodology for leveraging QR technology for sustainable living

3. FINDINGS

This study found that combining AI zoning tools with QR-based features successfully improved the planning and experience of pedestrian areas in Alor Setar. The AI simulator helped create balanced urban layouts that separated calm, heritage-rich zones from busier tourist areas, supporting the Yin & Yang zoning approach. QR-coded walkways made walking more engaging by offering interactive AI content that told stories about local culture and landmarks. Tourists responded positively in surveys, saying they enjoyed the easy access to cultural information and felt more connected to Kedah's identity. The AI experience, especially with the local mascot "BAO" in Pekan Cina, made exploring the city more fun and meaningful.

Daily tasks through the QR system kept people engaged, while AI helped track how users interacted with the space, providing data to improve future planning. Residents and visitors alike felt a stronger connection to culturally designed spaces, supporting social sustainability and pride in local heritage. The project also aligns well with the Sustainable Development Goals by improving pedestrian safety, accessibility, and public space quality. More people were encouraged to walk, helping reduce car use, traffic, and pollution, thereby making the city healthier and more sustainable.

Figure 2 Yin & Yang infrastructure in Pekan Cina, Alor Setar, Kedah

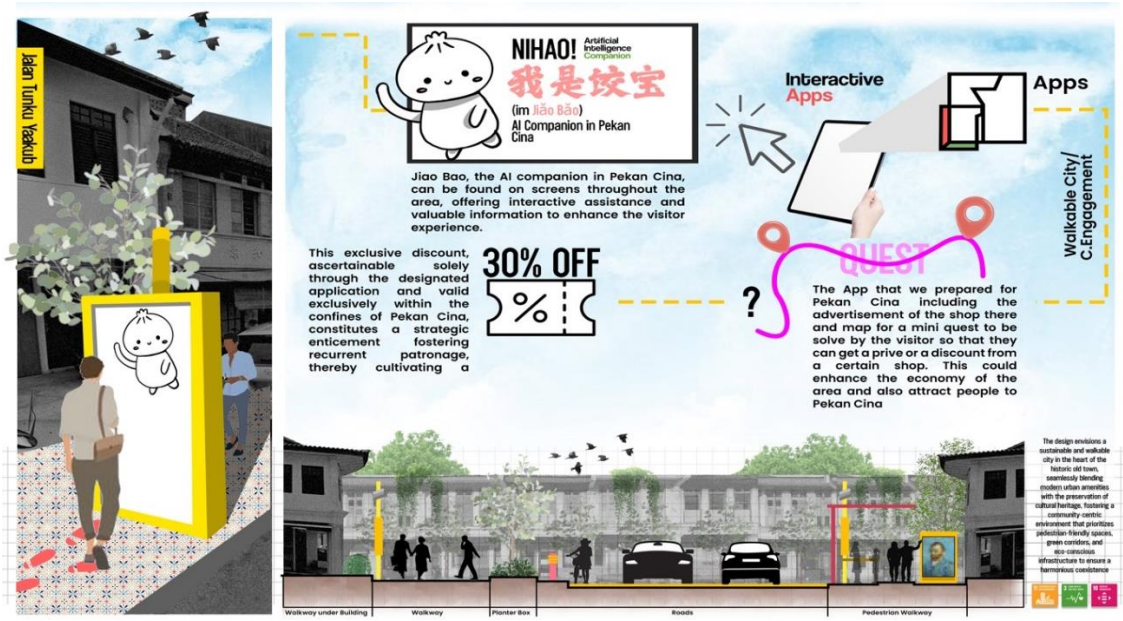

Figure 3 Deployment of QR and AI technology and the integration of SDGs

4. CONCLUSION

This research presents a replicable urban design model that bridges the digital and physical realms to support culturally resilient and sustainable small cities. The Yin & Yang Urban Toolkit offers a proactive planning solution that addresses both heritage preservation and modern urban activity. In Alor Setar context, the integration of AI simulation and QR-based storytelling enhances place identity, reduces spatial friction, and promotes inclusive urbanism. The presence of the local mascot "BAO" in Pekan Cina has strengthened the sense of place and community identity, while the daily tasks embedded in the QR platform have deepened public engagement. Essentially, this toolkit serves as a smart planning guide and digital toolset designed to help small cities like Alor Setar modernize without losing their cultural heritage. Future research should focus on developing a more user-friendly interface for wider municipal adoption and on testing the toolkit's scalability in other Malaysian towns. Overall, this initiative not only aligns with the SDGs but also serves as a scalable example of how technology and culture can work together to promote sustainable urban living.

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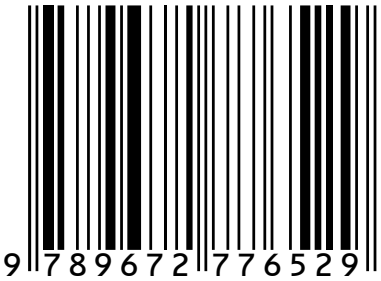

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