Development and Preliminary Evaluation of Mobile AR NGO for Donation Visualization Facility Exploration and Child Learning

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ABSTRACT

It is crucial that small non-governmental organizations (NGOs) have access to a variety of digital tools to share information about their organization, engage with communities, and manage content. This paper presents a system called Mobile AR-NGO which consists of an Android mobile application and an online administration portal designed for an NGO, Persatuan Kebajikan Anak-Anak Yatim Kasih Sayang (PKAYKS), in Ipoh, Malaysia. The system is a mix of QR-code based visualization for donations, 3D facility exploration and interactive learning of the alphabets with audio support. The system was developed in a modular fashion with React Native, TypeScript, Expo, Three.js, Firebase and Cloudinary. System evaluation was done by conducting functional and security testing with 29 test cases, performance benchmarking on two Android smart phones, and separate User Acceptance Testing (UAT) survey of 32 mobile app users and 30 web portal users. All the defects identified were fixed and a 100% test case pass rate has been obtained. Technical evaluation showed that it took an average of 1.5 seconds to detect markers, which means that the right frame rate is between 35 and 55 FPS and APK package size on Android is around 28 MB. The survey responses showed that 78% agreed with the statements about donation appeal, trust of the organization, and educational usefulness. Although these results show that these technologies are usable and technically feasible, this study does not provide conclusive evidence of increased donation conversion rates, better learning outcomes, or reduced teacher preparation time. There are several limitations identified such as device testing limitations, simulated payment processing, design-to-implementation differences and unresolved documentation differences. The project provides a prototype of a digital engagement which is integrated, and sets the stage for future operational deployment and testing.

Keywords: Augmented Reality, Non-Governmental Organization, Donation visualization, Virtual tour, Alphabet learning, Mobile application, User acceptance.

INTRODUCTION

Community welfare organisations often use social media in addition to one-off operating channels in order to be visible. This ecosystem is also a fractured one making it difficult for smaller NGOs to keep track of donor priorities, conditions of facilities and education activities. To overcome these challenges, a Mobile AR-NGO platform was developed for Persatuan Kebajikan Anak-Anak Yatim Kasih Sayang (PKAYKS), an orphanage in Ipoh, Malaysia that cares for 24 orphaned and disadvantaged children (Wong, 2026). The project aims to tackle the demands of building a donor-oriented mobile app and a web admin portal for the management.

The mobile application combines three main operational modules in one application:

- Donation Need Communication: Provides information on current campaign details and visual progress updates.
- Facility Exploration: Interactive room media triggered using markers in the facility.
- Alphabet Learning: Enables young learners to learn through hands-on 3D models and audio pronunciation.

All system content is maintained by authorized staff through administrative web portal. The common architecture will remove digital service fragmentation and improve the interactive engagement with stakeholders. All system content is maintained by authorized staff through the administration web portal. This common architecture will remove the fragmentation of digital services and improve the interaction between stakeholders.

- RQ1: How to combine donation outreach, facility exploration and learning into a single mobile-web architecture?
- RQ2: How well does the prototype that has been developed perform technically and functionally?
- RQ3: What can the preliminary acceptance results show about the perceived usefulness, operational restrictions, and what could be done better?

A prototype implementation is given in the context of the study. Additional empirical studies are needed to assess the sustainability of the finance and the educational programs.

Related Literature

Augmented reality and interactive visualization

Azuma (1997) defines Augmented Reality (AR) as a system that integrates real and virtual content, delivers real-time interaction and registers 3D virtual objects in a real world space. QR Code triggered interactive overlays provide simple visual extensions without providing persistent spatial registration of simple barcode detection. In the Mobile AR-NGO application, features are based on either camera-overlay marker tracking or the normal 2D/3D progress indicators. This means that the application is assessed according to the different interactive requirements and not strictly by the requirements of real-time spatial registration on all screens.

Educational applications

Bacca et al. (2014) conducted a systematic review of 32 educational AR studies to describe their core applications, benefits, limits, and pedagogical design principles for specific target learners and contexts. In Mobile AR-NGO, the learning module is combined with 3D models of animals or objects and audio pronunciation of the alphabet. For the users, a successful scanning and high user satisfaction scores are a measure of the usability of the interface, but not a direct proof of better cognitive retention or educational achievement, which needs pre- and post-testing.

NGO accountability and digital information

Mohd Noor et al. (2022) analyzed the non-financial disclosure indicators of 40 websites of Malaysian NGOs and found significant gaps in user feedback and satisfaction measures. Real-time campaign progress and facility tours on digital platforms improves informational access. The use of dynamic visual displays, however, is not meant to be a substitute for formal financial reporting, independent audit, or transaction reconciliation.

Technical foundations and project focus

The app uses Expo Camera for video preview functionality and barcode detection (Expo, n.d.), and Cloud Firestore for the primary document database for synchronizing data in the back end (Google, n.d.). These components provide a solid base to address content management and QR workflows, but do not include any specific mechanisms for verifying transactions during operation.

METHODOLOGY

Study approach and requirements

The project was developed using an iterative development approach of 10 2-week sprints (a total of 21 weeks).

The development phases included requirements collection, data modelling, back-end configuration, mobile app development, integration of modules, building of an administrative portal, and testing the system.

Core system requirements were grouped into five categories: account management, donation campaign tracking, exploration of facility media, learning alphabet, and administrative content control. Secondary features, including daily menus, maintenance requests, event calendars, media galleries and automated notifications, were described during the design stages but not included in the final empirical performance tests.

Evaluation procedure

The four user roles are used for partitioning system interactions:

- Donors & Visitors: Check active donation campaigns, visualize progress and explore orphanages virtually in the Android app.
- Children / Learners: Play with physical alphabet markers and view 3D models and hear the alphabet's audio pronunciation.
- Teachers / Caregivers: Conduct learning activities with mobile application.
- Administrators: update media, manage campaigns, edit learning assets, audit record listings via web portal.

System Design and Implementation

Architecture and data management

The mobile application is built with Expo, React Native, and TypeScript, the web administration portal is created with HTML, CSS, and JavaScript and deployed to Firebase Hosting. SDK connections connect both the clients to the Firebase services. Cloud Firestore handles authentication, user authorization rules, JSON-like document collections (users, donations, campaigns, rooms, education, and children). External high-resolution images, videos and 3D Assets (.glb / .gltf) are hosted on Cloudinary, and a Cloudflare Worker handles the push notifications. Sensitive children's information is kept private from all campaign assets, thanks to strict Firestore Security Rules.

Donation visualization

The donation module includes live Firestore synchronization listeners. Progress bars update in real-time on all devices connected to the network. Along with 2D progress bars, there are experimental 3D progress overlays in the mobile client. There are currently no payment processing gateways that are secure for their purposes and no automatic payment receipt issuing, nor any financial ledger reconciliation, all of which will make it a full production environment.

Facility exploration and child learning

Room-Specific Markers: The room specific markers give room-specific information about the location, including information on the dormitory, dining hall, and study room.

Child Learning: This module uses expo-gl and three.js to render 3D object models, and to play pronunciations in .mp3 format when letter cards are scanned.

Administrative workflow

The administrative portal is a web- based interface with a desktop look for administration of campaign parameters, updating of room assets and upload of education material. Security testing confirmed that

unauthorized write requests to the database and unauthenticated structural changes to the database are prevented by backend security rules.

RESULTS

Functional testing

First testing revealed five software defects, such as not rendering models in low-light conditions and lack of dynamic listeners for real-time donation progress updates. All 29 test cases passed after the above problems were addressed.

Test category	Cases reported	Final result
Mobile application	14	14 passed
Administration portal	10	10 passed
Firestore security rules	5	5 passed
Total	29	29 passed (100%)

Reported technical performance

It was benchmarked against two targeted Android smartphones. Every metric was met or exceeded with regard to performance targets.

Metric	Reported result	Target Benchmark
Marker detection	1.5 seconds average	< 2.0 seconds
3D rendering	35 – 55 fps	30 – 60 fps
Firestore read latency	0.8 seconds	< 2.0 seconds
Firestore write latency	1.2 seconds	< 3.0 seconds
Audio response	0.5 seconds	< 1.0 second
Android package size	~ 28 MB	< 50 MB

User acceptance

Separate questionnaires were used to assess user acceptance for the mobile application (N = 32) and administrative web portal (N = 30).

- Mobile App Survey Results (N = 32): 78% agreed that AR features made donations more appealing, 78% believed virtual tours improved organizational trust, and 78% found the alphabet module to be educationally beneficial. Also, 72% said that real-time visual progress bars encouraged contributions and 4.0 / 5.0 was the overall mean score and 62.5% of the respondents said they would recommend the mobile app.
- Web Portal Survey (N = 30): 73.3% of administrators considered the donation management to be adequate, 66.7% believed the push notifications to be useful, and 66.7% were satisfied with child record

tracking. Of those who used the platform in unstructured ways, however, 50% noted that they had experienced occasional bugs, while 10% experienced frequent bugs.

DISCUSSION

The main novelty of this document is to show a working multi-module example of updating donations, facility tours, educational material, cloud administration for small non-profit organizations. With the content separated from the mobile client, staff can update it dynamically without sending out new application builds. Although UAT surveys show positive user feedback and trust in and engagement with the donor, they are subjective opinions and do not measure behavioral change. Long-term donation conversion would need to be assessed by integrating payment solutions, establishing baseline donation data, measuring unique visitor conversion, and longitudinally comparing the data to assess performance over time. Likewise, the assessment of learning utility does not take the place of adult evaluations of utility of formal learning. Child learning gains should be measured with structured pre- and post-test literacy assessments in age-defined control groups in future educational assessments.

Limitations and Future Work

There were a number of caveats:

- Sample and Hardware Scope: Two Android devices were used and the sample consisted mostly of young adult respondents.
- Financial and Operational Features: Financial flow is simulated and formal accounting integrations are not in place.
- System Testing: The platform needs to be further tested in low light settings, under poor network connections, and a wider iOS and Android device landscape.

Future research should include integration of payment gateways with real-time financial reconciliation, extension of target device support and formal pedagogical evaluations. Moreover, there are strict ethics board guidelines, parental consent procedures and data privacy restrictions based on roles to consider when publishing media that includes minors.

CONCLUSION

The Mobile AR-NGO is a mobile and web-based platform that facilitates tracking of donations, facility tours and alphabet learning for non-profit organizations. The system passed all the test cases with 100% success rate, met all the technical benchmarks mentioned in the targets and was positively received when tested by the initial users. Future efforts will involve integrating live payment gateways, supporting multiple platform devices and conducting empirical research on donation conversion rates and learning outcomes.

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