



UNIVERSITY OF CAPE TOWN



DEPARTMENT OF COMPUTER SCIENCE

CS Honours Project Final Paper 2024

Title: Nethi App Store: Exploring the Deployment and Impact of a Community App Store on a Local Wireless Network

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Project Abbreviation: iNethi App

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Category	Min	Max	Chosen
Requirement Analysis and Design	0	20	20
Theoretical Analysis	0	25	
Experiment Design and Execution	0	20	
System Development and Implementation	0	20	15
Results, Findings and Conclusions	10	20	10
Aim Formulation and Background Work	10	15	15
Quality of Paper Writing and Presentation	10		10
Quality of Deliverables	10		10
<u>Overall General Project Evaluation</u> (<i>this section allowed only with motivation letter from supervisor</i>)	0	10	
Total marks		80	

Abstract

This project explores the development and deployment of the iNethi App Store within the iNethi Community Wireless Network (CWN) in Ocean View, South Africa. The app store was designed to address connectivity challenges by consolidating local services and offering preinstalled apps, such as iNethi Radio, accessible offline. The research followed a participatory design methodology, utilizing Action Research (AR) and cognitive walkthroughs to ensure that the app aligned with community needs. The development process was guided by iterative feedback from workshops and focus groups, which led to key improvements in the app's user interface and enhanced engagement.

The iNethi App Store aims to promote digital inclusion by offering locally relevant content and empowering residents with accessible digital services. The research highlighted the importance of offline functionality and preloaded apps in areas with limited internet access. However, sustaining long-term engagement proved challenging beyond the workshop settings, and limited awareness of the app's features hindered its broader adoption. Future efforts will focus on expanding the app's offerings and fostering local developer participation to ensure long-term sustainability.

CCS Concepts

• **Human-centered computing** → **Human computer interaction (HCI)**; • **Networks** → *Community networks*; • **Information systems** → Mobile information processing systems.

Keywords

Community App Store, Participatory Design, Action Research, ICT4D

1 Introduction

The global digital divide remains a critical challenge, with approximately 4.2 billion people still lacking internet access, accounting for nearly 58% of the global population [33]. This divide is worsened by high data costs and limited infrastructure, particularly in developing nations. In South Africa, mobile internet costs are among the highest globally [11], making it difficult for low-income communities to afford reliable connectivity.

Community Wireless Networks (CWNs) offer a promising solution to this challenge by providing local, zero-rated access to digital services. For example, WirelessLeiden in the Netherlands demonstrated the potential of CWNs to create community-driven networks using low-cost technology and open-source software [32]. Similarly, iNethi, a non-profit organization in Cape Town, has deployed a CWN in Ocean View, a township where affordable internet access remains scarce [22]. However, despite offering services like iNethi Radio, these local offerings face low engagement, as users continue to rely on external, data-heavy platforms over local alternatives.

Mobile phone usage is widespread in South Africa, particularly in township areas [25], presenting an opportunity to leverage mobile applications to raise awareness and usage of local digital services. Initiatives like Zenzeleni in rural South Africa have demonstrated

that CWNs can be expanded and sustained through partnerships with key actors [29]. In response to these challenges, the iNethi project developed the iNethi App Store, a mobile platform that acts as a discovery point for locally developed applications. By consolidating services like iNethi Radio into a single, accessible interface, the iNethi App Store allows users to discover, download, and install community-developed apps and other apps. This platform aims to increase awareness of local content and encourage local developers to contribute new applications [18].

This paper examines the development and deployment of the iNethi App Store, focusing on its impact on the Ocean View community. Specifically, it evaluates how the app store enhances access to local content, improves user experience, and supports community-driven digital innovation. Additionally, we assess the app's effectiveness in fostering engagement through participatory design workshops and user feedback sessions, while identifying barriers to adoption and proposing solutions for sustained engagement with local digital platforms.

The study contributes to the field of Information and Communication Technologies for Development (ICT4D) by showcasing how community-focused apps can address local connectivity challenges and promote digital inclusion. By enabling access to relevant digital services and supporting local content creation, the iNethi App Store offers a scalable model for digital inclusion in underserved communities.

1.1 Problem Definition and Research Question

While the iNethi Community Wireless Network provides local services like iNethi Radio, their usage remains minimal compared to external platforms. This research investigates how a mobile app store, tailored to local needs, can increase community engagement and promote digital inclusion.

2 CONTEXT AND RELATED WORK

Previous research has focused on individual components like community radio and localized content sharing [15, 20], but integrating these services into a single platform within a community network is still an emerging concept. Projects like DakNet have demonstrated the potential of using local networks in underserved areas, emphasizing the importance of user-friendly interfaces and relevant services [14, 28]. However, while these projects provide valuable insights, they often lack the integrated approach needed to address the specific needs of diverse communities like Ocean View.

2.1 OV community group

This study collaborated with Black Equations, a locally owned Wireless Internet Service Provider dedicated to bridging the digital divide in Ocean View. Black Equations, led by Ganief Manuel, plays a key role in managing the iNethi Community Wireless Network, providing affordable and reliable internet access. The organization focuses on empowering residents through community-driven digital initiatives, which makes it a crucial partner in implementing the iNethi app store and ensuring it meets local needs.

2.2 Local Community App Store

Access to information and the ability to contribute to media production are critical in empowering individuals and communities [10, 16, 22, 24]. The app store within the iNethi Community Wireless Network serves as a gateway for the Ocean View community, offering a wide array of applications that educate, inform, and empower, thereby extending these principles beyond traditional media to digital platforms.

By providing a centralized platform for accessing locally relevant apps, the app store encourages non-profit organizations and local developers to create and distribute applications that meet the specific needs of the community. These apps can offer entertainment, educational content, health, and social services, contributing to improved quality of life, learning, and social change.

The app store also plays a role in enhancing digital literacy by exposing users to various applications, helping them develop technological skills essential for participating in the digital economy. This engagement not only supports personal and professional growth but also fosters local innovation and economic opportunities, encouraging entrepreneurship and job creation.

Moreover, by reflecting local culture, language, and issues, the app store strengthens community identity and cohesion. This localized approach makes technology more accessible and relevant, bridging the digital divide and ensuring all community members can engage with digital resources.

3 DESIGN PROCESS AND METHODOLOGY

3.1 Participatory Design, Action Research, and Cognitive Walkthrough

This project combined participatory design (PD), action research (AR), and cognitive walkthroughs (CW). Participatory design involves deep collaboration with users, who actively contribute to the design process to ensure the final product meets their needs and context [30]. The Ocean View community members engaged in co-design workshops, providing critical feedback that directly influenced the app's development.

Action Research was employed to structure the app's iterative development cycles, characterized by planning, action, observation, and reflection [17]. This approach allowed the project to remain responsive to the evolving needs of the community, with each iteration informed by participant input. The cognitive walkthroughs were incorporated into the usability testing to evaluate how easily new users could learn to interact with the app [3, 23]. This method focused on simulating the experience of first-time users, identifying potential usability challenges and areas for improvement.

An emergent design process, evolving through real-time feedback, ensured that the app was co-created with the community rather than being imposed by the developers [8]. This integration of PD, AR, and CW created a comprehensive and iterative methodology that allowed the app to adapt and improve based on direct user interaction and feedback.

3.2 Participants and recruitment

Participant recruitment was managed by Black Equations, with Ganief Manuel playing a key role in the process. A diverse group of

20 participants was recruited, ranging in age from 18 to their late 50s. This group included both individuals familiar with the iNethi network and those new to digital technology, ensuring a wide range of perspectives. The diversity in experience and familiarity with the technology was crucial for gathering comprehensive feedback and ensuring that the digital solution for appstore developed would be relevant and beneficial to all Ocean View residents.

3.3 Project Management

The study initially adopted an Agile project management framework using Scrum, with regular three-week sprints to allow for flexibility and iterative progress. However, the community-driven nature of the project, requiring interaction with Ocean View community members, made strict adherence to Agile's time-bound structure challenging.

Due to the need to align workshops with the community's schedule and delays in ethics clearance, Action Research (AR) proved more effective. AR allowed us to adapt by scheduling workshops at convenient times for participants, deviating from the fixed sprints typical of Agile. This approach offered the necessary flexibility and adaptability, aligning well with projects needing ongoing community engagement [21].

To mitigate the impact of ethics clearance delays, the researchers held weekly meetings with our supervisor and other student groups working on related iNethi projects. These meetings, which included presentations and feedback sessions, were invaluable in guiding our project and maintaining progress. While Action Research (AR) provided the necessary flexibility, it also posed challenges, such as limited time for community engagement and tight workshop schedules, which constrained our ability to implement feedback between sessions.

Despite these challenges, AR facilitated strong co-design and community involvement, allowing us to develop an app that aligns closely with the needs of the Ocean View community [21].

3.4 Ethics

To conduct the workshops and ensure ethical standards, researchers applied for ethics clearance from the University of Cape Town (UCT) Ethics Committee. This process was essential to align our study with the ethical guidelines that safeguard the rights and well-being of participants. Obtaining ethics clearance is crucial in demonstrating a commitment to transparency and honesty, particularly in community-based research. This approach not only helps in building trust but also ensures that the research practices are equitable and responsible, respecting the values of the community involved. Ethical research practices are crucial, particularly when working with vulnerable populations, to prevent "ethics dumping," where unethical practices are transferred from high-income to low-income settings without proper oversight [5, 6]. By adhering to the Global Code of Conduct for Research in Resource-Poor Settings, our project focused on building fair and equitable research partnerships, prioritizing the interests and well-being of the Ocean View community [4].

3.5 Participation phase

To ensure the workshops ran smoothly and effectively, the study first held a planning session with Ganief Manuel from Black Equations on the 2nd of August 2024. The primary goal was to create an environment where community members could actively contribute to the app’s design, ensuring that the final product would address the specific challenges faced by the residents of Ocean View. Using Keagan’s app, developed by Keagan, a developer and director at iNethi with previous experience on iNethi projects during his master’s studies at UCT, helped participants visualize the goal of integrating iNethi services like Jellyfin and iNethi Radio. This approach’s goal was to facilitate a deeper understanding of several key research questions central to the project.

3.6 Participant Engagement Timeline

3.7 Workshop 1

Following the preparation phase, the study conducted the first workshop in Ocean View on the 9th of August. During this session, participants signed consent forms and were introduced to the iNethi services, with a brief overview of their goals to bridge the digital divide. We gauged the participants’ familiarity with these services, discovering that only a few were aware of them. To provide a clearer understanding, Keagan’s app was introduced as a benchmark for how these services could be integrated.

The primary focus of this workshop was to identify barriers to awareness and accessibility of iNethi web services among residents. Participants were asked about their familiarity with these services and how easy they found them to use. It was evident that very few used them, mainly due to a lack of awareness. Additionally, we aimed to understand how residents perceive the usability and value of iNethi services compared to other internet options. Feedback varied, with both positive and negative insights.

The workshop also explored whether integrating these services into a mobile app would increase usage and satisfaction. The effectiveness of offline caching was examined, particularly for improving access among residents with intermittent connectivity. Understanding the types of content and services most relevant to the community was crucial for optimizing the app’s development. The project aimed to identify factors influencing the adoption and sustained use of the app in an underprivileged setting, and how the introduction of this app could enhance technology acceptance and engagement with local web services among Ocean View residents.

3.8 Workshop 2

The second workshop, held on August 13th, leveraged a WhatsApp group to distribute the app and gather feedback from participants. As the iNethi App Store was not yet available on the Play Store, WhatsApp was chosen for its simplicity and effectiveness in community-based information sharing. Studies have shown that WhatsApp can facilitate easy distribution of resources and foster engagement in settings where formal platforms are less accessible [9, 27]. Participants were guided through the installation process to ensure the app was correctly installed on their devices. During this session, the first iNethi App Store version was officially released. Due to challenges with deploying the app on the main

Date	Workshop	Activities	Outcomes
09/08/2024	Workshop One	Demonstrated the app store application using an emulator. Focused on gathering feedback about design preferences and critiques. Asked participants about their awareness of iNethi.	Discovered that none of the participants were aware of iNethi services, highlighting a gap in community awareness. Gathered feedback from a total of ten participants.
13/08/2024	Workshop Two	Created a WhatsApp group for ongoing communication and app distribution. Introduced a released version of the app. Participants interacted with the app on their phones. Used Grafana and Amplitude for tracking.	Identified compatibility issues on some devices. Participants proposed their own design ideas. Found Amplitude more effective for tracking due to its cloud-based capabilities.
20/08/2024	Remote Participation	Released a new version of the app with enhanced features. Shared the app through the WhatsApp group. Integrated Amplitude tracking for monitoring.	Successfully monitored user engagement remotely using Amplitude. Could not attend the workshop in person.

Figure 1: Workshop timeline with participants.

iNethi server, the app was hosted locally on a laptop, allowing participants to access both preinstalled apps and apps via a local F-Droid server [7, 34]. After the workshop, participants could only access preinstalled apps, as the server was not fully integrated. Compatibility issues were noted, particularly with devices running Android 11 and above, fortunately the majority of participants’ devices used android 10 and below.

The workshop integrated Participatory Design, usability testing, and cognitive walkthroughs. Participants interacted with the app prototype for 20 minutes, exploring the app store, downloading apps they found interesting, and navigating through the installation process of the apps. Although the process was generally smooth, the manual installation required following on-screen prompts. The think-aloud method was employed, allowing participants to verbalize their thoughts and struggles, providing insights into usability issues that might otherwise be overlooked [12, 13].

The cognitive walkthrough further simulated the experience of first-time users, helping to identify challenges in navigation and installation [3]. This ensured the app was intuitive for even inexperienced users.

Following this, participants were provided with paper, pencils, and markers and asked to independently design their own versions of the app store interface. The purpose of having participants work separately was to ensure that each design reflected individual ideas without being influenced by others, allowing for a broader range of feedback. After completing their designs, a group discussion was held where participants explained the rationale behind their concepts. Each design was reviewed in detail, identifying key features and ideas. By fusing the most valuable elements from each design, a final version that aligned closely with user needs was created. This collaborative process allowed the final design to not only reflect participant preferences but also incorporate core usability principles, such as simplicity and intuitiveness, consistent with Nielsen’s usability heuristics [26].

Based on the feedback from both the cognitive walkthroughs and co-design sessions, a final app interface was selected that prioritized simplicity and ease of navigation. This decision was influenced by user feedback highlighting the importance of a lightweight and

intuitive interface, especially given the technical limitations of older Android devices used by participants.

Data from these user interactions were tracked using Amplitude and Metric servers, feeding data into Grafana through Prometheus. This setup enabled real-time monitoring and analysis of user behavior, helping to identify the most effective strategies for tracking and enhancing the app's performance within the constraints of locally hosted services.

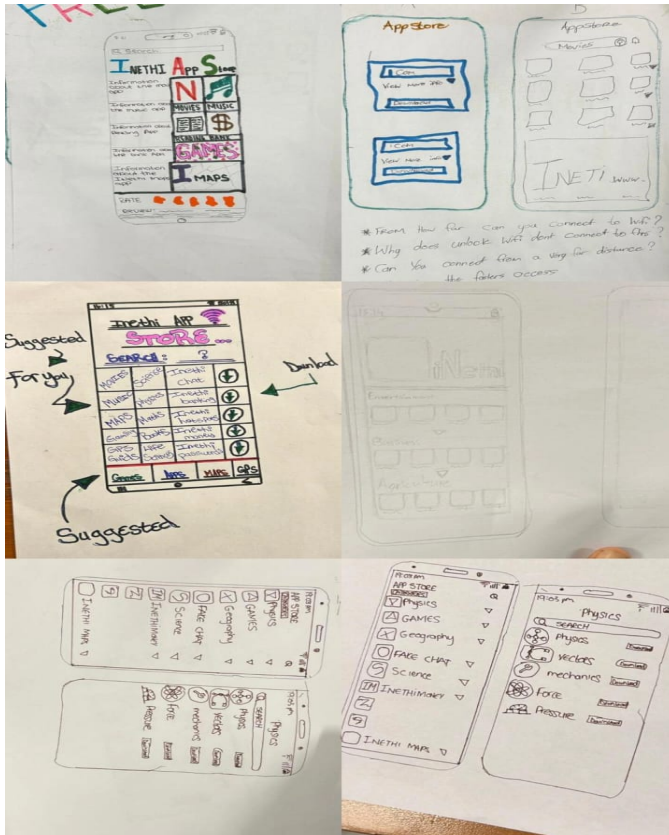


Figure 2: Participants' designs of the app store interface.

3.9 Workshop 3

The third workshop was scheduled for August 20th; however, the researcher was unable to attend in person. To ensure continuity, the latest version of the app was distributed through the WhatsApp group. This updated version featured compatibility with any Android device and enhanced Amplitude tracking capabilities. Participants provided feedback via WhatsApp, allowing the researcher to gather valuable insights and continue refining the app based on user experiences, even in the absence of direct observation. While in-person engagement would have been ideal, utilizing WhatsApp as an alternative for feedback collection and collaboration proved to be an effective and beneficial approach [31].

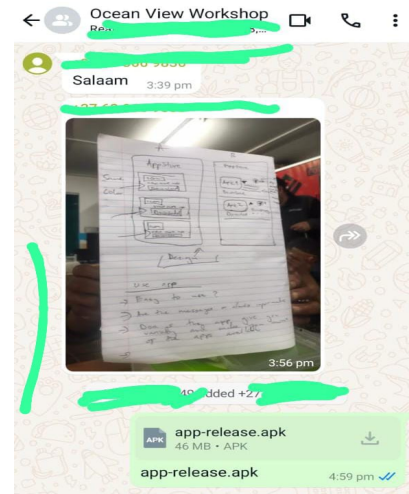


Figure 3: Ocean View for Whatsapp Group for app distribution and some feedback of the app

3.10 Focus Groups and User Feedback

During each workshop, participants were organized into focus groups to discuss their experiences with the released app. In Workshop 2, where the iNethi App Store was introduced, participants identified several areas for improvement. They noted that the app descriptions were unclear, making it difficult to understand what each app did before installation. Additionally, they highlighted the lack of a rating system, absence of a progress bar during downloads, and the missing search bar to easily find specific apps.

In response to this feedback, participants were encouraged to continue exploring the App Store and to download games or other apps they found interesting and useful, providing further feedback to help refine the platform.

3.11 Data analysis

To ensure a comprehensive understanding of user interactions and feedback, a methodological triangulation approach was employed in the analysis of the app store project. This involved integrating both quantitative and qualitative methods to cross-validate findings and provide a holistic view of user experience. Quantitative data were collected through tools such as Amplitude and Grafana, which tracked metrics including app downloads, usage statistics, and user interaction patterns. This data provided objective insights into user behavior, such as which apps were downloaded most frequently and how often users visited the app store. In parallel, qualitative data were gathered through direct user feedback obtained via WhatsApp, think-aloud protocols during usability testing, and participatory design exercises where users were asked to visualize their ideal app store interface. By combining these methods, the study aimed to capture not only the numerical aspects of user interactions but also the subjective experiences and preferences of the users.

This methodological triangulation is crucial in validating the research findings and minimizing biases that might arise from relying on a single data source or method. As Jonsen and Jehn (2009) advocate, using triangulation in qualitative research enhances the

credibility and reliability of the results by allowing researchers to cross-check and confirm the data from multiple perspectives. This approach ensures that the analysis reflects the complexity of user interactions with the app store, thereby providing a more robust basis for making informed decisions about app design and functionality improvements [19].

3.12 Outcomes

Not all feedback received from the workshops was implemented, primarily due to time constraints between each workshop and the limited time available to implement the suggested features. As a result, the latest release of the app does not yet include a search function or a rating feature, both of which were highly requested by participants. However, it is anticipated that at least one of these features will be fully implemented by the time of the final app release.

Additionally, the absence of personnel with the necessary expertise to deploy the F-Droid server on the iNethi server meant that a fully operational server hosting all the apps was not available. Consequently, users had to rely on preinstalled apps, which are selected to cover essential functionalities while minimizing memory usage. This workaround allowed continued testing and feedback collection, though it limited users' access to the full range of apps that would be available in a complete deployment.

3.13 Development Methodology

The development of the iNethi App Store began with an Agile methodology, selected for its flexibility and ability to adapt based on iterative feedback. Agile allowed the project to respond to the evolving needs of the Ocean View community through continuous feedback integration. Weekly sprints were organized with regular feedback sessions involving the project supervisor to ensure continuous progress, adaptability, and refinement.

In the first sprint, the focus was on setting up the infrastructure, including configuring Docker services and familiarizing the development team with iNethi's architecture. This foundational work enabled the backend to integrate with iNethi's infrastructure.

The second sprint involved developing a basic app store client with a wireframe interface, which allowed users to browse available apps. This prototype was essential for early testing and interface design.

The third sprint focused on creating a local F-Droid server, allowing the app store to query and retrieve apps from the F-Droid repository. This enabled the app to provide users with access to apps both online and offline, addressing the Ocean View community's connectivity challenges.

In the fourth sprint, the app store client was fully integrated with the F-Droid server, ensuring users could request and download apps seamlessly, including pre-cached iNethi apps like iNethi Radio for offline use.

The final sprint focused on enabling app downloads and installation while addressing Android permissions across different versions. Special attention was given to ensuring compatibility with older Android devices, improving app loading times, and minimizing installation time to under three minutes, even in low-bandwidth conditions.

However, the initial development process faced a significant delay due to the need for ethics clearance, which prevented direct engagement with the Ocean View community early on. During this period, development primarily relied on supervisor feedback and internal testing. Despite this limitation, Agile's iterative nature enabled the project to make meaningful progress through internal refinements.

3.14 Building on Existing Work

Building upon existing work was a key aspect of the development process. Rather than starting from scratch, the researcher, who also acted as the developer, built upon an existing app developed by Keagan, which already integrated the Jellyfin media server. By leveraging Keagan's initial app, developed using React Native, the researcher was able to reduce overall development time and focus on adding new features, such as the local app store. This existing foundation provided a strong technical base, though the researcher first had to familiarize themselves with React Native and Keagan's implementation in order to extend and adapt the app effectively.

This approach was appropriate because it allowed the researcher to build on previous work that had already been partially validated. This is particularly useful in community-driven projects where time and resources are limited. Additionally, using React Native ensured cross-platform compatibility for both Android and iOS, enabling future scalability.

3.15 Transition to Action Research (AR) and F-Droid Implementation

As the project evolved, a shift towards Action Research (AR) was necessary to better integrate feedback from the Ocean View community. AR allowed the development cycles to be shaped by real-world usage, with immediate adjustments made after each community workshop. Key refinements included improving the user interface, adding a search feature for easier navigation, and introducing a download progress bar to address the community's connectivity challenges.

A rating system was also implemented, enabling users to provide feedback on the apps, and compatibility issues with older Android devices were resolved to ensure broader accessibility.

This transition to AR demonstrated the project's adaptability, shifting from Agile's structure to a more responsive, community-driven process. By actively incorporating user input, the app evolved to meet the community's needs, ensuring it was both relevant and effective for its users.

3.16 Backend Configuration

The project required configuring several key backend services, including Grafana for monitoring, Traefik for reverse proxy, and Prometheus for metrics collection. These services had outdated dependencies, leading to compatibility issues that took time and effort to resolve. After multiple iterations, the compatibility issues were successfully fixed, and the system became stable and functional. Grafana and Prometheus were dockerized to track app usage, downloads, and user interactions, but because they were hosted locally, tracking was limited to the workshop sessions. To overcome this, Amplitude was implemented as a remote solution, providing real-time analytics and allowing for tracking beyond the workshops.

The combination of Grafana, Prometheus, and Amplitude enabled detailed monitoring of user behavior and app performance, supporting continuous improvement. This backend setup, though challenging, was essential for ensuring the app's long-term stability and scalability.

This local server setup was a practical solution given the limited internet access in the community. It allowed for immediate feedback on how well the app functioned under constrained conditions, and the feedback gathered during the workshop directly informed subsequent iterations of the app's design.

4 Architecture

The iNethi App Store utilizes the Model-View-Controller (MVC) architecture to ensure scalability, maintainability, and ease of testing. This design pattern enables a clear separation of concerns between the data, logic, and user interface, providing flexibility for future enhancements.

The View layer, also known as the App Store Client, handles the user interface, where users can browse available apps, initiate downloads, and access services like iNethi Radio. The Controller layer manages API requests, determining whether apps should be fetched from local caches or the Dockerized F-Droid server. The Model layer stores preinstalled iNethi apps for offline access while retrieving additional apps from the F-Droid repository when connected to the iNethi hotspot.

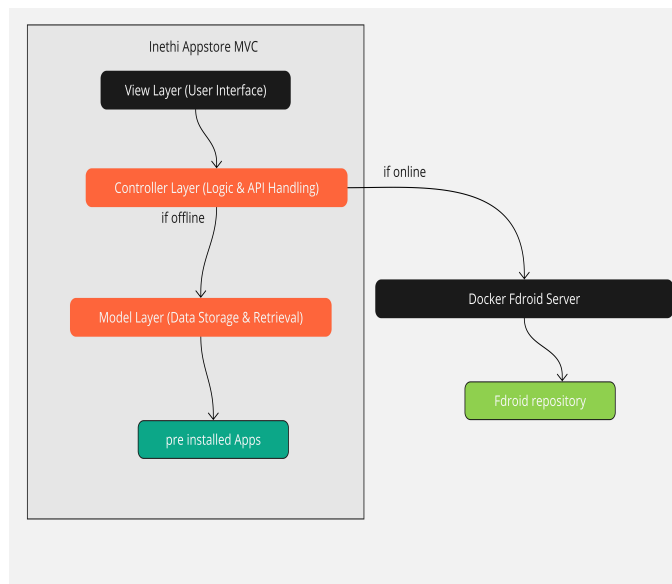


Figure 4: iNethi Appstore architecture

4.1 Special Feature: Offline preinstalled Apps

The iNethi App Store includes a five preinstalled apps that are available offline, eliminating the need for users to download them after installation of the appstore. This feature is particularly valuable in areas with limited internet connectivity, ensuring that essential apps are ready for use immediately.

To keep the app store lightweight, only five key apps were preinstalled, including iNethi Radio, which offers local radio stations and podcasts. These apps were carefully chosen to provide immediate utility without making the app too large.

4.2 Reasons for Using This Architecture

The iNethi App Store employs the Model-View-Controller (MVC) architecture, which provides a clear separation between the logic, data, and user interface. This modular structure enables independent modifications to each component, ensuring that new features or services can be integrated without disrupting the existing system. This makes the app scalable and easy to maintain, ideal for long-term use in the community.

A critical security feature of the iNethi App Store is Single Sign-On (SSO). Once logged in using Keycloak, a security token is issued, allowing users to access both preinstalled apps and request new apps from the app store. The controller layer handles app requests by using APIs that authenticate via the Keycloak token. This approach enhances security, ensuring that app requests and data access are properly authenticated and protected.

To maintain system consistency, each component—API, caching, and database—runs in isolated Docker containers, providing stable environments across development, staging, and production stages. Dockerization also ensures flexibility in deployment and minimizes environment-specific issues, making the system robust and adaptable.

4.3 F-Droid as the App Repository

F-Droid was chosen as the app repository for several reasons. As an open-source platform, it aligns with the iNethi App Store's goal of providing free and locally relevant content. The wide variety of apps available on F-Droid ensures that users have access to educational, productivity, and entertainment apps that may not be available on mainstream platforms like the Play Store. Additionally, F-Droid encourages community development, allowing local developers to contribute apps that meet the specific needs of the Ocean View community.

4.4 Comparison to Similar Systems

Unlike mainstream app stores such as the Google Play Store, which requires constant internet access, the iNethi App Store provides offline access to preinstalled iNethi apps, making it more suitable for low-bandwidth environments. Furthermore, its focus on local content and community engagement ensures that it remains relevant to the needs of users in Ocean View. By allowing local developers to publish their apps, the app store fosters a sense of ownership within the community, encouraging ongoing development and customization.

5 Findings

5.1 Usability Tests

The objective of the usability tests was to evaluate the usability and functionality of the iNethi App Store by gathering feedback from community members in a real-world setting. These tests aimed to

identify potential usability issues, assess the intuitiveness of the app interface, and understand user interactions with the app's features. The tests were conducted during workshops held on August 13th, 2024. Participants, referred to as "OV P" (Ocean View Participants), were given specific tasks to complete within the app. These tasks included navigating the app store, downloading and installing apps, providing feedback, and using offline caching features. This notation, "OV P," is used throughout the study to represent individual participants from the Ocean View community who were involved in the testing process.

The results and specific tasks of these usability tests are summarized in Table 1. These findings provided valuable insights into how the app was used, areas for improvement, and overall user satisfaction. Through these interactions, the study aimed to fine-tune the app's functionality and better align it with the needs and expectations of the community.

5.2 App feedback

Overall, the feedback from participants on the iNethi App Store was overwhelmingly positive. During one-on-one conversations, 8 out of 13 participants expressed satisfaction, with OV P4 stating, "The app works well for me; I would not change anything." Participants appreciated the speed and efficiency of the app, particularly when searching for apps. OV P2 remarked, "The searching is fast at looking up for apps," highlighting the responsive nature of the app's search functionality.

The app's user interface was also well received, with many participants praising the unique and neat display of the apps. OV P5 commented, "The way apps are displayed is very attractive and organized," showing that the app's design resonated well with users. Additionally, participants enjoyed the seamless installation process for preinstalled apps. OV P6 remarked, "The apps with the 'install' button, not 'download,' install straight away and very fast." This feedback demonstrates the success of the app's offline caching and the ease of accessing preinstalled apps, which significantly improved the overall user experience.

However, while participants appreciated the design and functionality of the app, some expressed a desire for a broader range of available apps. OV P7 noted, "I like games, and apps like PUBG are not available in the app store." This suggests that while the app store provides essential apps for the community, expanding the selection to include a wider variety of entertainment or popular apps could enhance user engagement further.

5.3 Usage Adoption

During the workshops, the usage of the iNethi App Store was notably high, with participants actively engaging with the app and exploring its features. However, after the workshop held on August 13th, there was a noticeable decline in app usage, with only a few participants continuing to use the app regularly. Interestingly, the release of the updated version of the app on August 20th led to a resurgence in engagement. The number of users accessing the app and the volume of apps downloaded both increased significantly.

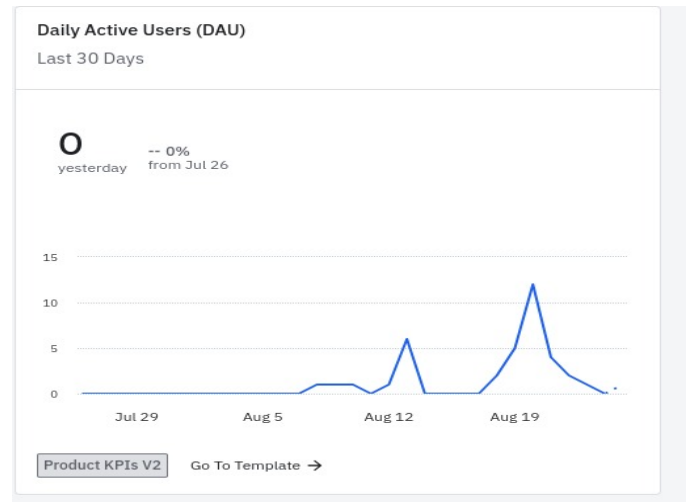


Figure 5: Appstore usage tracked by Amplitude

6 Discussion

The iNethi App Store saw high engagement during the workshops, with participants actively exploring appstore. This surge in usage (see figure 5) highlights the importance of structured environments for driving interaction, as participants were guided through the app's features and encouraged to engage with its functionality. However, this engagement dropped significantly after the workshops, a trend that has been observed in similar community-driven projects, such as in the study by Maccari and Lo Cigno, where user interaction with community networks decreased once formal workshops or events ended [22].

One potential reason for this decline is the sporadic availability of the iNethi hotspot. During the workshops the hotspot was not always up and running, participants faced challenges accessing the app store outside the structured setting of the workshop. The fact that the app store includes preinstalled apps helped mitigate some of these issues, as users could access a core set of services even when the network was unavailable. This underscores the value of preinstalled apps in community networks, especially in environments with inconsistent connectivity.

Another possible explanation is that users may be interacting with the preinstalled apps, but the lack of network connectivity could prevent the tracking data—such as app downloads—from being sent to the tracking servers, such as Amplitude and Grafana. This network issue could make it appear as though there is less engagement than what is actually occurring.

6.1 Importance of Preinstalled Apps

The inclusion of preinstalled apps proved to be a crucial feature for usability, particularly in a context where network access is not always guaranteed. The ability to access local apps like iNethi Radio offline was well-received by participants and highlighted the importance of offering essential services without the need for continuous internet connectivity. This feature not only improved the initial user experience but also ensured that the app store remained useful even when the iNethi hotspot was inaccessible.

The success of preinstalled apps in this context suggests that community networks in underserved areas could benefit greatly from bundling essential apps in offline mode. This design strategy allows users to engage with the app store immediately, reducing dependence on unstable network infrastructure.

6.2 Usability Testing and Inclusive Design

The combination of cognitive walkthroughs, think-aloud protocols, and co-design sessions used for usability testing proved to be highly effective. These methods not only provided valuable feedback but also encouraged greater inclusion and engagement from participants. During the second workshop, where these methods were more extensively applied, there was a notable improvement in both the quality of feedback and the level of participant engagement, compared to the first workshop.

The co-design approach, where users actively contributed to the design process, aligns with the principles of community-centered design. Studies, such as those by Bidwell and Winschiers-Theophilus, emphasize the importance of integrating Indigenous and Afro-Centric perspectives in technology design to create solutions that resonate with local communities [2]. Similarly, Adamu stresses the value of co-design in empowering local users to take ownership of technology [1]. The positive outcomes from this approach in the iNethi project demonstrate the importance of building technology solutions that prioritize the needs and inputs of the community over individual-centric approaches.

6.3 Limitations and Challenges

While the technical objectives and user requirements of the project were met, there were limitations that affected long-term engagement and broader awareness of iNethi services. One key limitation was the short project timeline, which not only made it difficult to significantly increase awareness of the iNethi App Store but also hindered efforts to encourage local developers to view the app store as a distribution center for their own mobile apps. The project's potential to inspire local developers to create and upload locally relevant apps was constrained by the limited time available to fully communicate this vision.

Additionally, the project was delayed by the late clearance of ethics approval, which significantly reduced the number of workshops that could be conducted. Originally, five workshops were planned, which would have provided more opportunities to engage with the community, collect feedback, and refine the app. However, due to the shortened timeline, only a few workshops could be held, limiting the scope for user engagement and feedback. More workshops would likely have encouraged further usage of the app store and offered more opportunities to refine and improve the app based on user input.

6.4 Implications for ICT4D

The findings from the iNethi project underscore the value of community-centered approaches in Information and Communication Technologies for Development (ICT4D). By involving participants directly in the design and testing process, the project was able to create a solution that aligns with the community's needs and encourages

local engagement. This is in contrast to more individual-centric approaches, which often fail to account for the socio-cultural context of technology deployment in underserved areas [1, 2].

Moreover, the importance of regular updates and new features was highlighted by the resurgence of app usage following the release of the updated version. This suggests that for community-driven technology projects to succeed in the long term, they must be flexible, iterative, and responsive to ongoing user feedback and evolving community needs.

7 Conclusion

In conclusion, while the iNethi App Store successfully achieved its technical objectives and improved usability, it faced challenges in sustaining long-term engagement beyond the structured workshops. The project demonstrated the value of preinstalled apps and offline functionality, particularly in areas with unreliable network access. However, limited awareness of the app store and its services, coupled with the short project timeline, hindered its potential to inspire local developers and drive broader app usage.

The use of interviews, questionnaires, and additional workshops could have provided deeper insights into the root causes of the decline in usage, offering more accurate results and a clearer understanding of user behavior. These methods may also have increased awareness of the local services available through the iNethi platform, thereby fostering greater community engagement.

8 Future Work

Future iterations of the iNethi App Store should focus on expanding the range of available apps to cater to a wider variety of user interests, including popular apps like games, which were requested by participants. Additionally, improving the coverage and accessibility of the iNethi hotspot would help ensure that more users can consistently access the app store and its services without the need to visit specific locations. Expanding the hotspot's reach across Ocean View could significantly enhance ongoing engagement and app usage.

Another key area for future work is fostering local app development. While this project demonstrated the potential of the iNethi App Store as a distribution platform, more time and resources are needed to fully realize its impact on local app creation. Encouraging developers to build and upload apps to the app store will be essential for sustaining long-term engagement within the community.

Currently, the iNethi App Store was developed exclusively for Android devices, given the widespread use of Android phones in the community. The app was built using React Native, a framework that allows for easier cross-platform development. This decision ensures that future releases can more easily support an iOS version, expanding the app's reach to a wider audience in the near future. Developing an iOS version will open the platform to more users and make the app store more inclusive across different mobile ecosystems.

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Appendix

Event count by Event name	
EVENT NAME	EVENT COUNT
user_engagement	342
screen_view	324
map_session_duration	154
find_hotspot_button_clicked	151
navigate_to_map	129
session_start	122
navigate_to_AppStore	45

Figure 6: event count tracked by amplitude

9 Usability tests table

TEST ID	Date	Purpose	Instruction	Expected Outcome	Actual Outcome
1	13 August 2023	Participants can navigate the app store and locate apps.	Navigate through the app store and locate three different types of apps.	It is expected that participants will find this task relatively easy as the app store is designed to be intuitive and user-friendly.	All participants were able to navigate through the app store and locate apps. Some took longer than others, indicating varying levels of familiarity with app stores.
2	13 August 2023	Participants can download and install an app from the store.	Download and install an app of your choice from the app store.	It is expected that this task will be straightforward, as the download and install processes are standard across most app stores.	Most participants successfully downloaded and installed an app. A few had trouble due to the absence of a progress bar, making it unclear if the download was in progress.
3	13 August 2023	Participants can provide feedback on apps.	Locate an app you have downloaded and provide feedback or rate it.	It is expected that participants might find this task challenging if they are not familiar with app rating features.	Only half of the participants were able to provide feedback on apps without assistance. The others required help, indicating a need for clearer instructions or prompts.
4	13 August 2023	Participants can use preinstalled apps .	Access preinstalled offline after disconnecting from the network and install them.	It is expected that participants will be able to access preinstalled content offline with ease.	Participants were generally able to access preinstalled apps offline. Some reported confusion about which apps were available offline, indicating a need for clearer indicators.
5	20 August 2023	Participants can use the search feature to find specific apps.	Use the search bar to find a specific type of app (e.g., educational).	It is expected that participants will find this task easy if the search functionality is clear and responsive.	The search feature was not initially available in the app, which led to frustration among participants. This feedback was crucial for prioritizing the addition of a search bar.

Table 1: Usability Test Plan for iNethi App Store

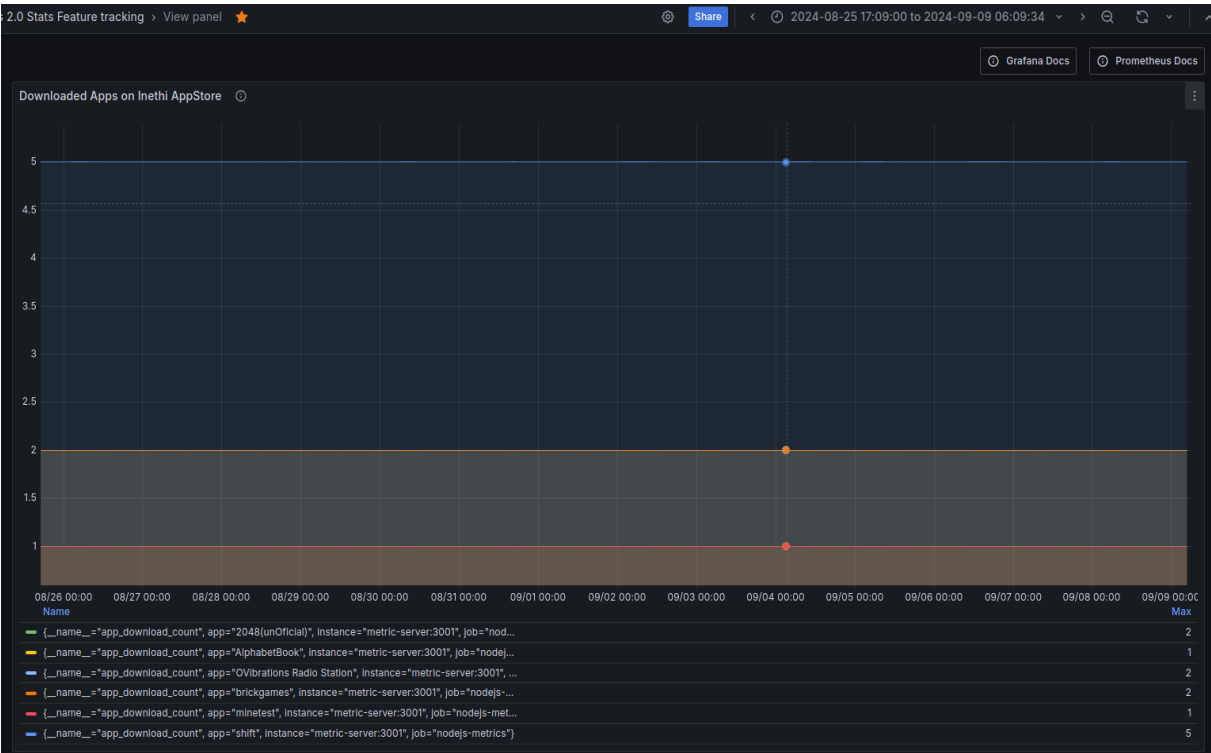


Figure 7: Apps downloaded tracked by grafana

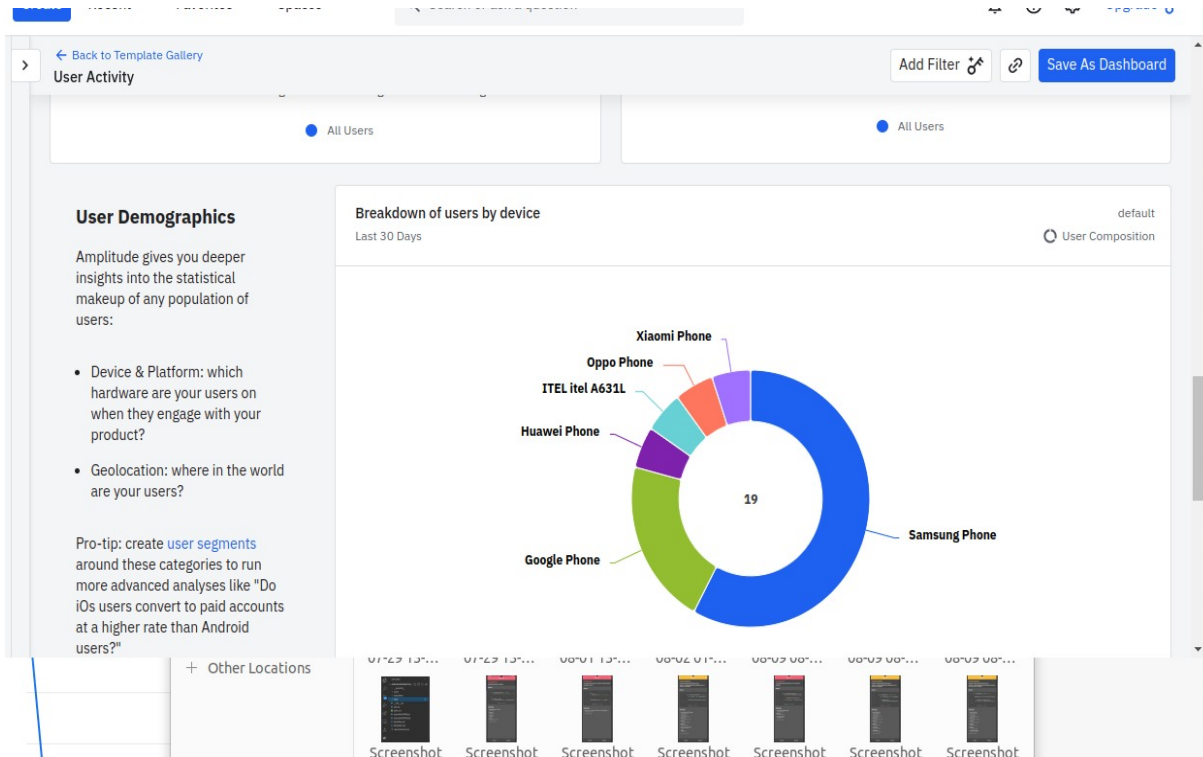


Figure 8: Apps downloaded tracked by Amplitude