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Development of a User Friendly Mobile Application for Campus Navigation Leveraging Google Maps API and UI/UX Strategies

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Abstract: Navigation within large campuses often poses challenges to new students, visitors, and even staff. The SmartNav Navigation System was developed to address this challenge by providing a mobile and web-based platform for guiding users around the Federal Polytechnic Nekede campus. The system leverages the Google Maps API for outdoor navigation, allowing users to view the campus layout and identify major buildings such as departments, hostels, lecture halls, and administrative offices. The backend was simulated using Python and JSON data structures to store building information, while the interface was sketched with wireframes to guide future UI/UX development. Although the current prototype focuses primarily on basic map visualization, future upgrades will include route generation, indoor navigation, real-time notices, and academic tools such as timetables, lost and found, and past questions. The app was hosted on GitHub Pages for testing and reviewed by students, who confirmed its potential usefulness as a smart campus solution. This project demonstrates that with minimal resources and open-source technologies, a scalable and user-friendly campus navigation system can be achieved. It further provides a foundation for continuous development and future integration into the broader vision of a smart campus.

Keywords: *Campus Navigation, SmartNav Navigation System, UI/UX Development, Google Maps API.*

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I. INTRODUCTION

Navigating large and complex tertiary institutions is a recurring, practical problem for students, staff, visitors and contractors. Campuses commonly consist of dozens of buildings; lecture halls, department blocks, administrative offices, hostels, clinics, cafeterias and specialized laboratories distributed across wide grounds where signage is often insufficient, outdated or confusing [1]. At the start of every academic session, freshers and visiting stakeholders experience delays, missed appointments and anxiety caused by inability to locate rooms quickly. Even returning students sometimes lose time locating relocated venues, temporary examination halls, or newly opened facilities.

Mobile devices and web services present an accessible platform to address these problems. Global positioning systems (GPS), digital maps and location-based services are now inexpensive and widely available on commodity smartphones [2]. Many universities worldwide use campus mobile apps or map integrations (Google Maps/Mapbox/OpenStreetMap) to provide searchable maps, event locations and routing [3]. In low-resource contexts, however, many institutions do not have a dedicated campus navigation solution; they rely on physical maps, word-of-mouth, and manual noticeboards [4]. Federal Polytechnic Nekede is an example of an institution where a lightweight, pragmatic navigation solution can deliver real benefit: reduce lost time, improve orientation for freshers, assist visitors, and streamline campus logistics.

The Nekede SmartNav project focuses on designing and prototyping a Smart Campus Navigation System tailored to Federal Polytechnic Nekede. The core module, the Navigation System, aims to provide an accessible, mobile-first map interface that highlights campus buildings and key service locations, supports searchable lookup of destinations, and

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displays information pop-ups for each location. The project places emphasis on creating a stable foundation (data model, map integration, and search capability) that can be extended later to route guidance (turn-by-turn directions), indoor navigation, timetable integration and other campus services.

➢ *Problem Statement:*

Despite the availability of smartphones and online maps, Federal Polytechnic Nekede lacks a dedicated campus-specific navigation system that provides an authoritative map with labeled buildings, hostels, and service points, and a single interface for locating them. This gap leads to freshers and visitors wasting time searching for venues, students missing classes or exams due to poor signage or venue changes, administrative delays during peak periods, and increased staff workload from repeated inquiries.

General mapping tools like Google Maps lack the detailed campus information such as block names, departmental entrances, and lecture hall identifiers needed for daily navigation. Therefore, a lightweight, campus-focused navigation module is needed to support efficient movement and serve as a foundation for the SmartNav platform.

➢ *Objectives of the Study*

The primary objective of this study is to design and implement a prototype Campus Navigation System (the core module of Nekede SmartNav) for Federal Polytechnic Nekede that displays major campus buildings on a digital map, allows searchable lookup of campus locations, and provides an extensible data structure for future route guidance and service integration. Specifically, this research aims to:

- Identify and record GPS coordinates (or approximate grid coordinates) and descriptive metadata for key campus locations (departments, hostels, administrative blocks, library, clinics, halls).
- Design a mobile-first user interface (UI) and prototype screens (wireframes) that provide a clear home dashboard, a map view, a searchable lookup field and location detail pop-ups.
- Integrate a map service (Google Maps API in the prototype) to display the campus map centered on Federal Polytechnic Nekede and render building markers from the location dataset.
- Implement an efficient client-side search that returns matching campus entities by name, category or keyword and centers/zooms the map on the selected location.
- Design the location data format and local storage approach (JSON / dictionary-like structure) so new buildings and categories can be added easily without changing the codebase.
- Evaluate the prototype by demonstration and limited user testing (students and staff) to verify usability, correctness of locations and ease-of-use.
- Documentation & Roadmap: Produce technical documentation and a development roadmap that clarifies how the prototype can be extended to support routing, indoor navigation and integration with academic services (timetables, notices).

The SmartNav Navigation Module addresses an immediate, practical need for Federal Polytechnic Nekede while providing a generalizable blueprint that other tertiary institutions with similar constraints can adopt.

➢ *Scope of the Research*

The project focuses on delivering a basic but functional campus navigation prototype. It will provide a web/mobile-friendly interface featuring a Google Map centered on Federal Polytechnic Nekede, with major campus buildings plotted as markers. Users will be able to search for buildings through a simple client-side search box that recenters the map. All location data will be stored locally using a lightweight JSON/JavaScript structure. Basic UI wireframes and brief documentation will also be produced.

II. METHODOLOGY

The methodology adopted in developing the SmartNav Navigation System for Federal Polytechnic Nekede describes the conceptual framework, system architecture, data structure, and user interface design that guided the development process. It also explains the techniques used to integrate the Google Maps API, alongside code examples that illustrate how the system's key features such as mapping, search functionality, and building information display were implemented. Through this methodology, the study demonstrates how a lightweight, functional navigation prototype was designed, developed, and tested.

➢ *System Concept*

The SmartNav Navigation System is designed as a web-based and mobile-accessible application that provides digital navigation for Federal Polytechnic Nekede. The prototype centers on three ideas:

- Location Mapping: Capturing and displaying key buildings on campus.
- Search Functionality: Allowing users to search for and locate buildings.
- Information Access: Providing descriptive details about buildings when clicked.

While the prototype currently focuses on navigation, it has been designed with extensibility in mind, so other features like lost & found, timetable, and real-time notices can be added in future upgrades.

➢ *System Architecture and Data Structure*

The architecture of SmartNav is divided into three main components:

- Frontend Interface:
- Backend Logic (Prototype Level)
- Data Storage

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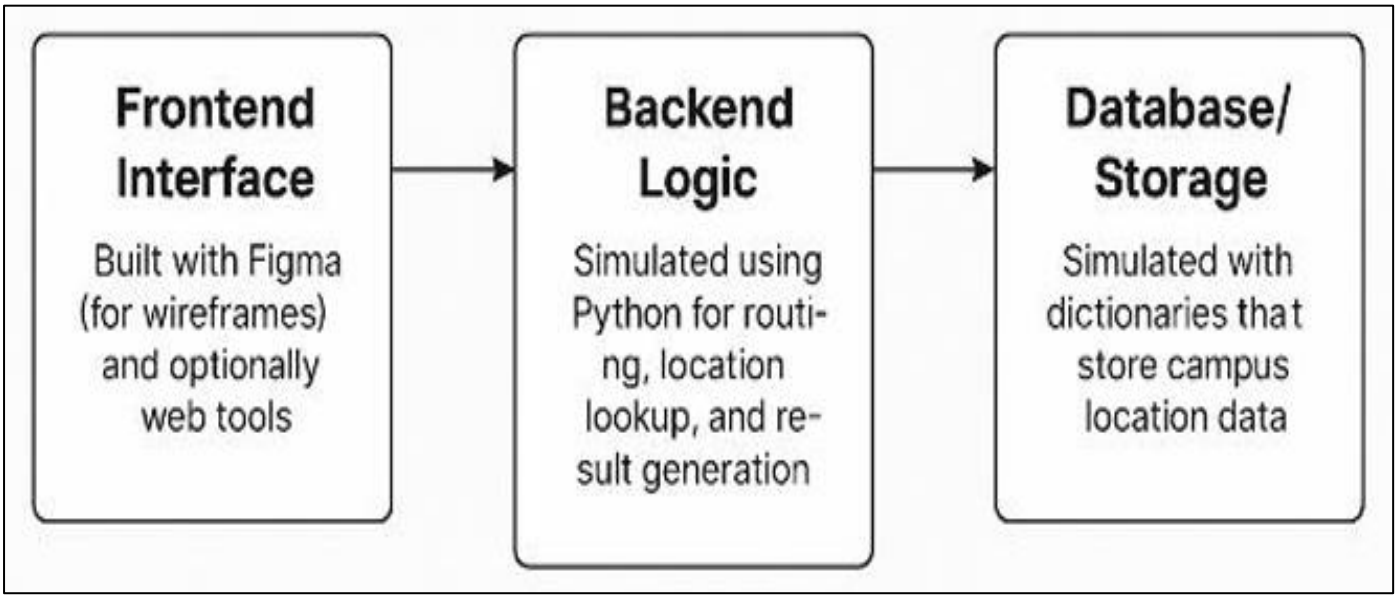

Fig 1 System Architecture Overview ((Frontend, Backend Logic, Data Storage interconnected)

Data for campus buildings is stored in a JavaScript object array. This makes it easy to add or remove buildings without altering the entire system

Sample Data Structure (buildings.js):

```
const buildings = [
{
name: "Electrical Engineering Dept",
lat: 5.4865,
lng: 7.0185,
description: "Main engineering block with lecture halls and staff offices."
},
{
name: "Library",
lat: 5.4868,
lng: 7.0179,
description: "Main school library with reading rooms and e-resources."
},
{
name: "Admin Building",
lat: 5.4871,
lng: 7.0182,
description: "Administrative offices for the Polytechnic."
}
];
```

➢ *Sitemap of the Application*

The sitemap describes how users navigate between different sections of SmartNav

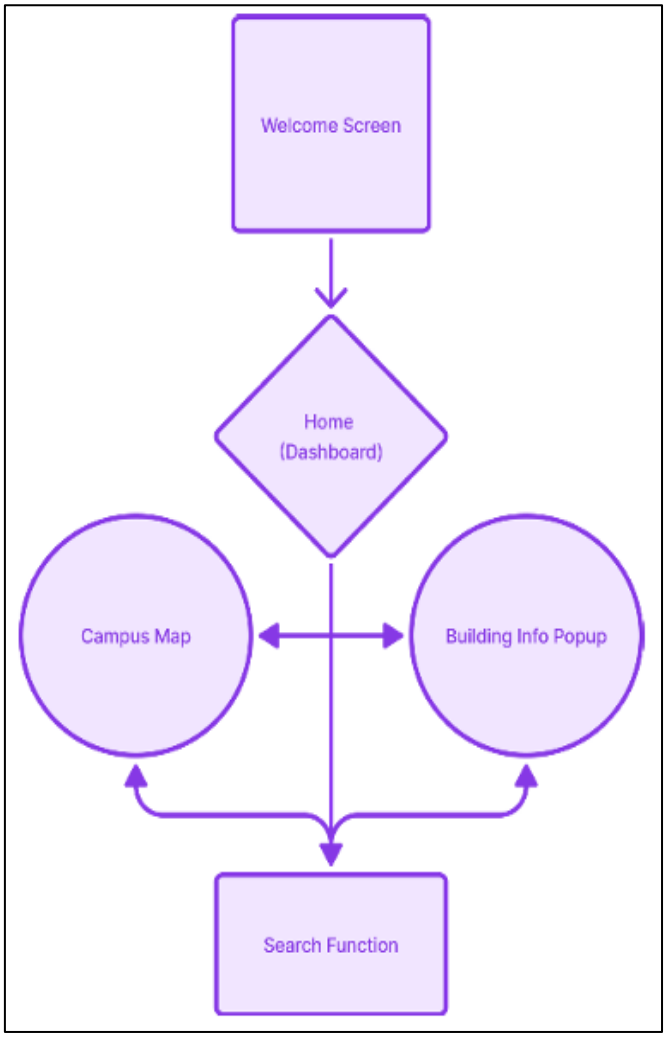

Fig 2 Sitemap of the Application

➢ *Wireframe Design*

Wireframes are visual sketches of the user interface. For SmartNav, low-fidelity wireframes were developed to illustrate:

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- Home Screen: Contains the search bar and navigation menu.
- Map View: Shows Google Map with markers for buildings.
- Info Popup: Displays details when a building marker is clicked

Fig 3 Home Screen Wireframe.

Fig 4 Map Screen Wireframe

Fig 5 Building Info Popup Wireframe.

➢ *Code Snippet*

- *Google Maps Integration*

```
<!DOCTYPE html>
<html>
<head>
<title>SmartNav Map</title>
<script
src="https://maps.googleapis.com/maps/api/js?key=YOUR_
API_KEY"></script>
<script src="buildings.js"></script>
<script>
function initMap() {
// Center the map on Federal Polytechnic Nekede
var campusCenter = { lat: 5.4864, lng: 7.0181 };
var map = new
google.maps.Map(document.getElementById("map"), {
zoom: 17,
center: campusCenter
});

// Loop through buildings array
buildings.forEach(function(building) {
var marker = new google.maps.Marker({
position: { lat: building.lat, lng: building.lng },
map: map,
title: building.name
});

// Info popup
var infoWindow = new google.maps.InfoWindow({
```

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```
content:
`<h3>${building.name}</h3><p>${building.description}</p
>`
});
marker.addListener("click", function() {
infoWindow.open(map, marker);
});
});
}
</script>
</head>
<body onload="initMap()">
<h2>Federal Polytechnic Nekede - SmartNav</h2>
<div id="map" style="height:500px; width:100%;"></div>
</body>
</html>
```

- *Search Functionality*

```
function searchBuilding(name, map) {
var found = buildings.find(b => b.name.toLowerCase() ===
name.toLowerCase());
if (found) {
map.setCenter({ lat: found.lat, lng: found.lng });
map.setZoom(18);
alert("Found: " + found.name);
} else {
alert("Building not found!");
}
}
```

- *Directory Layout*

The project files are organized as follows:

✓ SmartNav/
✓ Index.html → Main page with map
✓ Style.css → Styling for UI
✓ App.js → Core logic
✓ Buildings.js → Building data
✓ /assets/ → Images/icons
✓ /modules/ → Future modules (timetable, lost & found, etc.)

III. RESULTS AND DISCUSSION

The SmartNav system was successfully designed and implemented as a functional web-based campus navigation application. The prototype was built using the Google Maps Application Programming Interface (API) and deployed online via GitHub Pages for easy accessibility and testing. Upon completion, several key system outputs were observed, as outlined below.

➢ *Campus Map Display*

When the application is launched, the system automatically centers the map on Federal Polytechnic Nekede, Owerri, displaying both satellite and street views through the Google Maps API. The interface was designed to load directly from the hosting link, ensuring smooth access on both laptops and mobile devices.

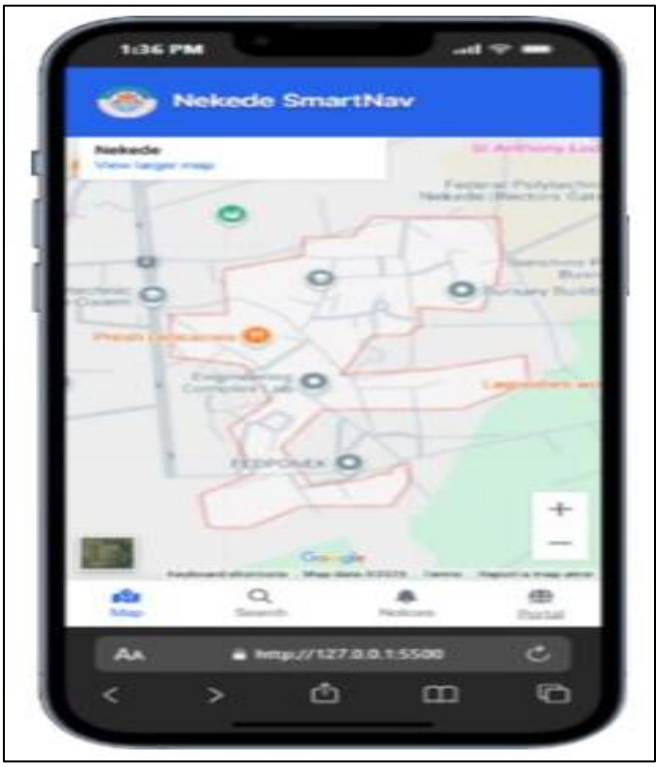

Fig 6 Map View Centered on Nekede Campus

➢ *Building Markers*

Key campus landmarks such as the Bursary Building, Library, Administrative Building, and School of Engineering were added to the database. Each marker is interactive when clicked, it displays the building's name and short description through an information popup

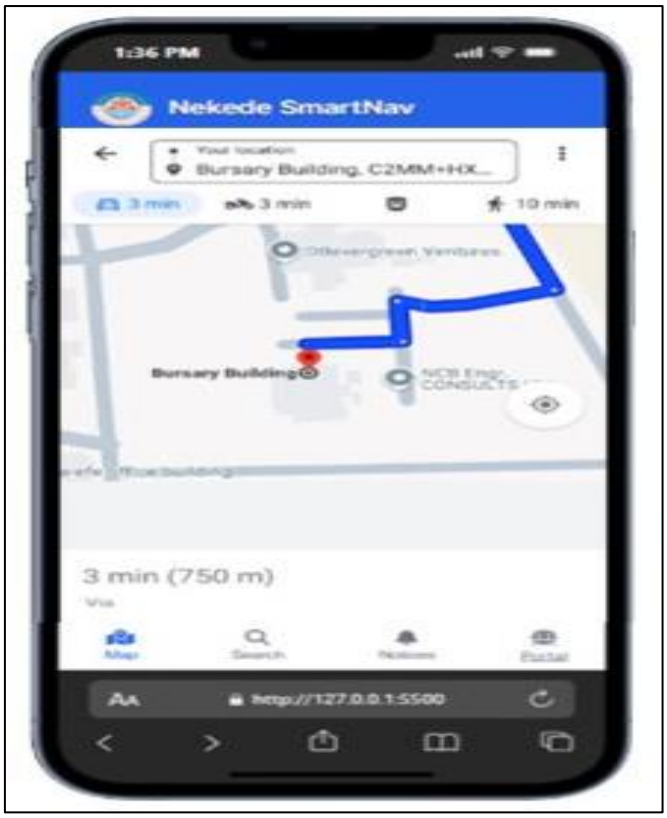

Fig 7 Marker with Info Popup Showing "Bursary Building

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➢ *Search Functionality*

The application allows users to search for a building using a text-based search bar.

- When a valid building name is entered, the map automatically zooms in and centers on the building's location.
- If the building is not found in the dataset, the system displays an alert notification indicating that no match was found.

This functionality significantly enhances user experience and efficiency in locating campus buildings.

➢ *Info Windows*

Clicking on a building marker opens an information window containing details such as the building's name, department, or purpose. This helps new students and visitors to quickly identify facilities without requiring external assistance.

➢ *GitHub Hosting and Deployment*

The SmartNav system was hosted online using GitHub Pages, enabling remote access and real-time testing.

- The hosted link allowed seamless testing across multiple platforms including PC browsers (Google Chrome, Mozilla Firefox) and Android smartphones.
- The deployment confirmed that the system could function effectively outside the developer's environment, verifying its portability and web compatibility.

➢ *Testing the Live Hosted Version*

To evaluate performance and usability, the live hosted version of SmartNav was tested by a group of students from Federal Polytechnic Nekede. Testing was carried out on both laptop browsers and Android mobile devices.

➢ *Observations from Testing*

- The map loaded successfully across all tested devices.
- Students were able to click markers to view corresponding building information.
- The search function operated accurately, focusing on the queried building location.
- No installation was required; users accessed the system directly through the GitHub Pages link.

➢ *Feedback from Students*

- Users appreciated the ease of access since no app installation was necessary.
- Participants suggested including an autocomplete search feature for quicker input.
- They recommended integrating a routing function (from the user's GPS location to destination).

Students also proposed adding offline access, considering inconsistent internet connectivity across campus

➢ *Discussin of Results*

The outcome of the testing confirmed that the SmartNav web prototype is both functional and practical for campus navigation. Several key findings emerged from the implementation and testing phases:

- Ease of Use: The system's interface was considered intuitive and familiar, largely because it mimicked the layout of Google Maps while incorporating campus-specific information. This contributed to positive user feedback and minimal learning curve.
- Accessibility: Hosting the system on GitHub Pages eliminated the need for installation or storage space on mobile devices. This cloud-based approach increased accessibility and demonstrated the potential for large-scale deployment.
- Scalability: The modular nature of the dataset (stored in JSON format) allows for easy updates and inclusion of additional buildings or facilities in future iterations. This means the system can evolve alongside campus expansion.
- System Limitations: Despite its success, certain limitations were observed:

✓ *Lack of Routing Functionality*: The system does not yet support real-time navigation from the user's current GPS position to the selected destination.
✓ *No Indoor Navigation*: Buildings with multiple departments or floors cannot currently be navigated internally.
✓ *Internet Dependency*: Full functionality requires a stable internet connection, as map rendering relies on Google's online API resources.

These findings affirm the technical feasibility and user acceptability of a smart navigation solution for Federal Polytechnic Nekede. The project establishes a strong foundation for future enhancements such as offline maps, voice guidance, and real-time routing.

IV. CONCLUSION AND FUTURE WORK

The SmartNav Navigation System was developed as a prototype to address the navigation challenges faced by students, staff, and visitors at Federal Polytechnic Nekede. The system successfully:

- Integrated Google Maps API to provide a digital map centered on the campus.
- Displayed key campus buildings using a structured dataset.
- Allowed users to search for buildings and view details through information popups.
- Was deployed online using GitHub Pages, ensuring accessibility across devices.

The objectives of the study were achieved, as the prototype demonstrates the feasibility of a web-based navigation system tailored to the school. The project further highlights the potential of students to design innovative solutions even without funding or official support, using free hosting and open-source tools.

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➢ *Future Work*

To transform SmartNav into a fully functional smart campus platform, the following recommendations are made:

- *Enhance Navigation Functionality*: Integrate turn-by-turn routing using the Google Directions API or similar services; add support for indoor navigation through QR codes or Wi-Fi-based positioning.
- *Offline Access*: Implement offline caching to allow the system to work in areas with poor internet.
- *Continuous Updates via GitHub*: The project should continue to be hosted on GitHub Pages for free access and version control.
- *Migration to Stronger Hosting Platforms*: For long-term deployment, the system should migrate from GitHub Pages to more robust solutions. Firebase Hosting for real-time database integration and authentication. School ICT Department Servers for official adoption and security. This will allow SmartNav to handle dynamic data, including real-time notices, lost & found, and timetable updates.
- *Expand Features (Future Work):* Lost & Found Portal for student support. Timetable & Exam Schedules with notification reminders.
- *User Experience Improvements*: Add autocomplete search and custom icons for better usability. Improve interface design for accessibility across all devices.
- *Collaboration and Institutional Support*: The project should be formally adopted by the Polytechnic management. Partnerships with ICT departments, sponsors, and government agencies can provide the funding and resources needed for full deployment.

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