

A WEB PROXIMITY-BASED DIGITAL TASK PLATFORM FOR INFORMAL WORKERS: A CASE STUDY OF KAMPALA-METROPOLITAN AREA

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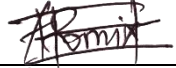
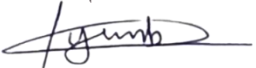
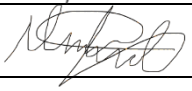
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DECLARATION

We hereby declare that the project titled "SkillBee: A Web Proximity-Based Digital Task Platform for Informal Workers" is our original work, carried out under the guidance of our supervisors. This project is designed to develop and deploy an innovative, web-based platform for the Informal workers like domestic workers, home-based workers and Gig and Digital platform workers.

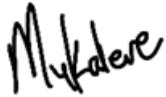
All references, materials, and sources used in the development of this project have been duly acknowledged. I confirm that the work presented in this project is not a replication of any other individual's work, and any assistance received during the course of this project has been fully disclosed.

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SUPERVISOR'S APPROVAL

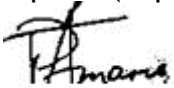
We certify that this project report is the original work of the above-named students, conducted under our supervision, and is ready for submission for examination.

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DEDICATION

This project is dedicated to our families for their unwavering support, encouragement, and sacrifices throughout our academic journey.

We also dedicate this work to the Faculty of Engineering Design and Technology at Uganda Christian University, for providing us with the resources, mentorship, and knowledge that enabled us to bring this project to fruition. A special thank you to our lecturers for their guidance and constructive feedback, which has been crucial to our success.

Lastly, we dedicate this work to informal workers across Uganda, whose resilience and contribution to the economy inspired the development of the SkillBee platform.

ABSTRACT

The informal sector remains the primary source of employment in Uganda, yet it is characterized by fragmented labour markets, limited worker visibility, weak trust mechanisms, and insecure payment systems. Informal workers and clients largely rely on word-of-mouth referrals, which restricts access to opportunities and exposes both parties to service and payment risks.

This study presents the design and feasibility assessment of **SkillBee**, a proximity-based digital task platform intended to connect informal workers with nearby clients in the Kampala Metropolitan Area. The study adopts a qualitative exploratory approach to examine labour-matching challenges, user readiness for digital platforms, and essential system features required to support trust and secure transactions.

Findings from preliminary observations and literature review indicate strong potential for integrating location-based matching, worker verification, rating systems, and mobile-money escrow payments within Uganda's informal labour ecosystem. The study concludes that a localized, trust-centered digital platform can significantly improve labour visibility, service reliability, and income stability for informal workers. The results provide a foundation for developing inclusive digital labour solutions aligned with Uganda's socio-economic context.

LIST OF ACRONYMS/ABBREVIATIONS USED

MoMo - Mobile Money

ILO - International Labour Organization

TAM - Technology Acceptance Model

KYC - Know Your Customer

API - Application Programming Interface

UX/UI - User Experience/User Interface

GPS - Global Positioning System

CDN - Content Delivery Network

JWT - JSON Web Token

OCR - Optical Character Recognition

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CHAPTER 1

INTRODUCTION

Unemployment and underemployment remain persistent socio-economic challenges in Sub-Saharan Africa, with Uganda serving as a representative case. According to national labour statistics, more than 70 percent of Uganda's workforce operates within the informal sector. Although this sector provides livelihoods for millions, it is characterized by unstable income, lack of job security, limited access to social protection, and inefficient labour-matching mechanisms.

Informal workers such as electricians, plumbers, carpenters, tailors, cleaners, and mechanics typically secure employment through roadside stands, community referrals, and word-of-mouth recommendations. While these methods are socially trusted, they present several challenges, including difficulty verifying worker competence, unpredictable job availability, payment disputes, and limited access to clients beyond immediate social networks.

Globally, digital labour platforms such as TaskRabbit and Upwork have demonstrated the potential of technology to reduce search costs, improve transparency, and efficiently match service providers with clients. However, these platforms are largely designed for highly digitized economies and often fail to address the contextual constraints found in developing countries, including limited digital literacy, inconsistent connectivity, preference for cash or mobile money transactions, and trust concerns.

Within Uganda, emerging digital initiatives show growing interest in technology-driven solutions for informal work, yet most platforms remain fragmented, sector-specific, or insufficiently localized. The Kampala Metropolitan Area—comprising Kampala City, Wakiso, and Mukono districts—offers a strategic environment for testing inclusive digital labour solutions due to its high population density, diverse informal workforce, and widespread use of mobile money.

In response to these challenges, this study proposes SkillBee, a proximity-based digital

task platform tailored to Uganda's informal labour market. SkillBee integrates location-based matching, worker verification, and mobile money escrow payments to enhance trust, improve payment security, and increase labour visibility. By aligning with local socio-economic realities and regulatory frameworks, SkillBee seeks to bridge existing gaps in informal service delivery.

1.1 Background of the Study

The informal economy in Uganda serves as the primary employment avenue for youth, semi-skilled artisans, and low-income populations. Despite the availability of mobile phones and digital financial services, labour-matching processes remain largely informal, unstructured, and inefficient. Workers often lack digital representation, documented proof of skill, and reliable income streams.

Mobile money platforms such as MTN MoMo and Airtel Money have significantly expanded financial inclusion, creating opportunities for secure digital transactions. However, attempts to digitize labour matching have been hindered by limited verification systems, inconsistent service quality, and user distrust of impersonal platforms.

The SkillBee platform is proposed within this context as a localized solution that leverages proximity-based matching, identity verification, and escrow-enabled mobile money payments. The platform is designed to enhance legitimacy, reduce search costs and mouth to mouth connection, and improve income reliability for informal workers.

1.1.1 Global Perspective

Globally, digital labor platforms have transformed service delivery by improving worker visibility and enabling efficient client-worker matching. These platforms rely on digital identity systems, online payments, and reputation mechanisms. However, their success is largely dependent on strong digital infrastructure and high levels of digital literacy, conditions that are not uniformly present in developing economies.

1.1.2 Regional Perspective (Africa)

Across Africa, informal labour dominates urban employment and operates through community trust and interpersonal relationships. While countries such as Kenya and Nigeria have experimented with digital gig platforms, challenges related to trust,

verification, and regulation persist. Successful platforms in the region must integrate cultural norms, mobile money systems, and localized design approaches.

1.1.3 National Perspective (Uganda)

In Uganda, the informal sector employs the majority of the population, yet lacks a scalable digital system for labour matching. Although smartphone usage and mobile money adoption are high, trust issues and limited platform awareness have slowed digital transformation in informal employment. SkillBee aims to address these gaps by offering a contextually appropriate digital solution.

1.1.4 Problem Statement

Despite being the main source of employment in Uganda, the informal labour sector remains fragmented and inefficient. Workers face limited visibility and income instability, while clients struggle to identify reliable service providers. Existing global digital platforms do not adequately address Uganda's socio-economic and technological realities. There is therefore a need for a localized digital labour platform that enhances trust, improves worker visibility, and secures transactions within the informal economy.

1.1.5 Aim / General Objective

The main aim of this project is to design and develop **SkillBee**, a web-based proximity-driven digital platform that connects informal workers with nearby clients in the Kampala Metropolitan Area while providing worker verification, service ratings, and secure mobile money payments.

Specific Objectives

The study is guided by the following specific objectives:

1. To analyze the existing labour-matching methods used by informal workers in the Kampala Metropolitan Area.
2. To design a proximity-based digital system that enables clients to find nearby informal workers based on location and skill category.
3. To determine the essential platform features needed to support legitimacy, such as worker verification, ratings, and payment assurance.

4. To implement a secure mobile money payment system that minimizes payment disputes and enhances transaction reliability.
5. To test and evaluate the functionality and usability of the SkillBee platform within a simulated user environment.

1.1.6 Project scope

This project focuses on the **design and development of a web-based digital task platform** for informal workers operating within the **Kampala Metropolitan Area**, which includes Kampala, Wakiso, and Mukono districts.

The scope of the system includes:

- Registration of workers and clients on the platform
- Worker profile creation including skills and service categories
- Location-based search for nearby service providers
- Job posting and task request features
- Worker rating and review system
- Mobile money payment integration for secure transactions.

The project will primarily target **selected informal service categories** such as:

- Electricians
- Plumbers
- Carpenters
- Cleaners
- Tailors
- Mechanics and extra

The system will be developed as a **web application prototype** and tested in a controlled environment to demonstrate feasibility.

However, the system will **not cover full nationwide deployment, large-scale payment gateway integration, or full regulatory compliance implementation**, as these fall outside the academic project timeline.

1.1.7 Significance of the Study / System

The development of the SkillBee platform is expected to contribute to multiple stakeholders within Uganda's informal labour ecosystem.

Informal Workers

The platform will improve worker visibility and enable informal workers to reach a wider customer base beyond traditional word-of-mouth referrals. This can help increase job opportunities and income stability.

Clients

Clients will benefit from the ability to easily locate verified service providers nearby. The rating and review system will also improve confidence when selecting workers.

Digital Economy Development

The platform contributes to the growing adoption of digital solutions in Uganda's informal sector, supporting innovation in labour marketplaces and digital financial services.

Academic Contribution

This project provides practical insights into designing localized digital labour platforms for developing economies, which may inform future research and technological development in this domain.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature related to digital labour platforms, informal employment systems, and proximity-based service applications. The review helps to identify gaps in existing solutions and establish the relevance of the proposed SkillBee platform.

Existing research shows that informal labour markets across developing economies are primarily sustained through interpersonal trust/legitimacy, social reputation, and localized networks rather than formal systems (ILO, 2024). Studies on platform-based labour models in Western contexts — such as TaskRabbit, Handy, and Upwork — demonstrate that digital platforms can enhance labour transparency and reduce friction through user ratings, digital identity, and secure payments (Schor, 2020). However, scholars note that these global models often assume high digital literacy and standardized digital identity systems, conditions not always present in African contexts (Graham & Wood, 2018).

2.1.1 Informal Employment in Uganda

The informal sector plays a critical role in Uganda's economy, employing a significant portion of the workforce. According to labour reports, the majority of workers in urban areas depend on informal jobs such as construction, repair services, domestic work, and small-scale trade.

Despite its importance, the informal labour market lacks structured systems for connecting workers with potential clients. Most job opportunities arise through **personal networks, referrals, and roadside visibility**, which limits opportunities for workers who lack strong social connections.

African research suggests that technology adoption is shaped heavily by contextual trust/legitimacy, mobile-money culture, and the need for culturally attuned design

(Porter et al., 2021). In Uganda specifically, research on mobile-money penetration and digital inclusion reveals that citizens are increasingly familiar with mobile-based transactions, yet remain cautious about trusting platform-mediated labour interactions (Kavuma, 2022). This indicates that digital platforms for informal labour must not merely replicate Western solutions but instead integrate local behavioral norms and trust mechanisms.

Despite limited localized research on service-matching platforms for informal labor in Uganda, initial attempts by startup platforms in East Africa offer insight into necessary design features including user verification, escalation protocols, transparent rating systems, and mobile-money escrow. This literature gap highlights the need for systematic investigation into how platforms like SkillBee can be optimized to meet the socio-economic realities of informal workers and clients in Kampala.

2.1.2 Digital Labour Platforms

Digital labour platforms have transformed service delivery in many parts of the world by enabling online marketplaces where workers and clients interact.

Platforms such as global gig marketplaces demonstrate several advantages:

- Reduced search costs for services
- Increased worker visibility
- Reputation-based trust mechanisms
- Secure online payment systems

However, most existing platforms are designed for environments with **high digital literacy, stable internet connectivity, and established online payment systems**. These conditions do not fully reflect the realities of developing countries like Uganda.

2.1.3 Location-Based Service Platforms

Location-based platforms use geographic positioning technologies to connect users with services located nearby. These systems are widely used in transportation, food delivery, and logistics services.

Key features of location-based platforms include:

- Real-time service discovery

- Distance-based matching
- Efficient task allocation

For informal labour markets, proximity-based matching can significantly reduce the time required for clients to locate workers and enable faster service delivery.

2.1.4 Legitimacy and Verification in Digital Marketplaces

One of the most important factors influencing the success of digital labour platforms is **legitimacy**. Users should believe that its right, appropriate or acceptable for that worker competent with skills and that payments will be handled securely on the platform.

Common legitimacy mechanisms used in digital platforms include:

- Identity verification
- Worker ratings and reviews
- Escrow payment systems
- Service completion confirmations

These mechanisms help reduce fraud and disputes between service providers and clients.

2.1.5 Mobile Money and Digital Payments in Uganda

Mobile money services have played a major role in improving financial inclusion in Uganda. Many individuals, including those in the informal sector, rely on mobile money for everyday financial transactions.

Mobile money provides several advantages for digital platforms:

- Easy peer-to-peer payments
- Secure transactions
- Accessibility without traditional banking systems

Integrating mobile money into digital labour platforms can help ensure secure and reliable payments between clients and workers.

These observations highlight the importance of designing SkillBee as a low-barrier, culturally appropriate system that mirrors existing behavioral patterns while improving reliability, accountability, and access for both workers and clients.

CHAPTER 3

METHODOLOGY

2.1 Introduction

This chapter describes the methods used to design, develop, and evaluate the SkillBee platform. It explains the research approach, system design methods, tools used in development, and testing procedures.

2.1.1 Research Design

This study adopts a qualitative exploratory research design to understand user perceptions, challenges, and feasibility of adopting SkillBee within Uganda's informal labour market. This approach allows for capturing lived experiences, behavioral patterns, and trust dynamics among workers and clients.

2.1.2 Study Population

The target population includes informal service providers (electricians, plumbers, carpenters, cleaners, mechanics, etc.) and clients (households, small businesses, and individuals seeking labour services) within the Kampala Metropolitan Area.

2.1.3 Sampling Technique & Sample Size

Purposive sampling will be used to intentionally select participants with direct experience in informal labour exchanges. Estimated sample size: 15-20 participants, including both workers and clients.

2.1.4 Data Collection Methods

- Semi-structured interviews to gather in-depth qualitative insights
- Focus group discussion(s) to explore collective experiences and shared perceptions
- Observational study to assess real-world labour-matching behaviors
- Document review of existing literature on labour platforms, digital payments, and

2.2 Data Analysis

Thematic analysis will be used to identify recurring patterns, categories, and themes emerging from the collected data. Transcriptions will be coded using iterative categorization to capture key conceptual elements.

Validity and Reliability Measures

- Triangulation of multiple data sources
- Clear documentation of data collection procedures
- Peer verification of emerging themes
- Anonymization of participant responses

Ethical Considerations

- Informed consent will be obtained from all participants
- Participant identities will be kept confidential
- Data will be securely stored
- Respondents may withdraw at any time without penalty

2.2.1 Relationship Between Study Objectives and Methodology

The methodology directly aligns with the research objectives to ensure that the study produces valid, contextually grounded findings for the SkillBee platform. The main objective – to assess feasibility and design requirements – is supported by the qualitative exploratory design, which captures user perceptions and real-life labour exchange experiences.

For the first objective (identifying labour-matching challenges), semi-structured interviews and observation allow participants to describe existing problems in their own terms. For the second objective (evaluating user readiness to adopt a platform), focus

groups and interviews provide insights into user attitudes, digital familiarity, and behavioral preparedness.

The third objective (identifying required features such as verification and payment security) is addressed through targeted questioning and thematic analysis that reveal users' trust requirements and platform expectations. The fourth objective (exploring mobile-money's role in secure transactions) is examined through interview data and document review reflecting Uganda's digital finance practices. Finally, the fifth objective (developing a conceptual framework) is informed by synthesizing findings from all methods and integrating them with existing theoretical literature.

Thus, each objective is paired with a method that collects the most relevant information, ensuring a coherent research strategy where methodology supports objectives in a logical and evidence-driven manner.

2.2.2 System Design and Development

The architecture of SkillBee is based on a modular, service-oriented microservices configuration, ensuring scalability, fault-tolerance, and maintainability. The system is divided into four distinct layers: the Mobile Client Layer, the Edge Layer, the Application Layer, and the Data Layer, with additional integration to external services. Each layer is dedicated to a specific functional responsibility, promoting separation of concerns and enabling parallel development.

Mobile Client Layer This layer contains the three primary user interfaces:

- Worker App
- Client App
- Admin Dashboard

These interfaces provide user interaction functionalities such as:

- task posting
- worker selection
- verification upload
- wallet section

- administration review
- Task tracking system
-

This layer communicates with the backend via secure API calls using the API Gateway.

Edge Layer

This layer enhances availability and performance:

- CDN / Static Asset Distribution ensures fast delivery of static content (e.g., images, JS bundles).
- Real-time WebSocket Service enables live messaging, task status updates, and worker-client interactions.
- API Gateway + Rate Limiting provides authentication routing, request throttling, and endpoint security. The presence of rate-limiting is crucial to mitigate denial-of-service attacks and excessive request flooding.

Application Layer The core functionality resides here. It consists of multiple microservices:

Core Services

- Task Service - handles task posting, retrieval, assignment logic
- Matching Service - determines optimal worker selection using proximity, ratings, and availability
- Wallet Service - manages escrow payment flows and micro-transactions
- Verification Service - manages KYC, ID validation, document processing output
- Auth Service - controls login, authentication, JWT tokens
-

Support Services

- Notification Service - manages emails, push notifications, and messaging
- Rating Service - records client feedback, worker review history This layer ensures

that each service functions autonomously, communicates via message queues, and scales independently.

Data Layer This layer provides storage and backend data persistence:

- PostgreSQL + PostGIS for spatial data (GPS worker location, mapping proximity)
- Redis Cache for rapid session storage and fast-access queries
- S3-compatible Storage for worker documents and verification artifacts
- RabbitMQ / Kafka for asynchronous messaging between microservices The design ensures that frequently accessed data (e.g., worker availability) remains cached for performance optimization.

External Service Integrations The system integrates seamlessly with external APIs:

- Mobile-money APIs (MTN MoMo & Airtel Money) for escrow holding and payment releases
- Mapbox / Google Maps for real-time geolocation services
- Email + SMS Gateways for user alerts and communication These integrations allow SkillBee to operate securely within Uganda's digital ecosystem.

2.2.3 System Development Approach

Development Methodology an Agile/Iterative engineering model will be adopted, consisting of:

- incremental feature development
- continuous user feedback
- progressive testing cycles
- rapid deployment of micro-components

Phase Development

1. Prototype UI
2. Core service implementation (auth, verification, matching)
3. Worker verification automation

4. Real-world pilot testing

Worker Verification Workflow Your second diagram illustrates the verification pipeline:

1. The worker uploads document photos
2. The system runs automated OCR and face-match
3. Confidence score is produced
4. System then either auto-approves or flags for manual review
5. Admin reviews manually if required
6. Worker receives verified or rejected status
7. Verified workers receive task-acceptance privileges This creates a trust-reinforcement mechanism to ensure vetted service providers.

A rigorous testing strategy will be implemented to ensure that SkillBee is reliable, secure, and user-friendly prior to full deployment. Testing will focus not only on technical correctness but also on real-world usability in the Ugandan informal labour context. Both automated and user-driven tests will be applied to validate system functionality, task matching accuracy, payment reliability, and accessibility for users with varying digital literacy levels.

Microservices Architecture Using a single custom API Gateway service

2.2.4 Verification Enhancement (Proposed Confidence Scoring)

To improve the efficiency and scalability of the verification process, a confidence scoring mechanism is proposed as an enhancement to the current system.

The existing system supports document upload and manual administrative review. However, to reduce the workload on administrators and improve verification speed, the system will incorporate automated pre-processing techniques such as Optical Character Recognition (OCR) and basic facial comparison.

These techniques will generate a confidence score indicating the likelihood that submitted identity documents are authentic and consistent with user-provided data.

Based on this score:

- High-confidence submissions will be automatically approved
- Medium-confidence submissions will be flagged for manual review
- Low-confidence submissions will be rejected

This enhancement integrates into the existing verification service and supports a hybrid verification model combining automation with human oversight.

2.2.5 Testing Strategy

- Unit Testing: verifies individual microservices and software components
- Integration Testing: ensures interoperability between services (auth, wallet, matching, verification)
- System Testing: validates overall end-to-end functionality of the platform
- Performance & Load Testing: checks response time, concurrency handling, and scalability
- Security Testing: ensures data encryption, safe authentication, and fraud prevention
- Usability Testing: evaluates ease of navigation, UI clarity, and app accessibility
- Field Testing / Pilot Deployment: real-world testing with actual workers and clients
- Regression Testing: ensures that new updates do not break existing features

2.2.6 Importance of Testing

- Ensures the system functions reliably under real operating conditions
- Prevents service failures that would weaken user trust
- Protects sensitive user data and identity documents
- Detects and fixes bugs before public release
- Ensures payment and escrow transactions are accurate and secure
- Improves user experience, particularly for low-literacy users
- Provides insights that inform iterative improvements
- Supports system credibility and adoption among informal workers & clients

CHAPTER 4

PRESENTATION AND DISCUSSION OF THE RESULTS

4.1 Introduction

This chapter presents the progress made in the design, implementation, and testing of the SkillBee platform. As of March 2026, the project has advanced through the initial development phases outlined in the proposal, with a functional prototype now operational for pilot testing. The results are discussed in terms of the designed technology, specifications, requirements, and implementation outcomes, highlighting how they address the identified challenges in Uganda's informal labour market.

2.3 Requirements

The development of the SkillBee application focused on meeting the core functional and non-functional requirements defined during the system analysis phase. The system successfully achieved the following requirements:

User Authentication & Role Management: The system successfully handles secure registration and login processes, accurately distinguishing between "Client" and "Tasker" roles.

Geolocation and Proximity Matching: Using Leaflet and browser Geolocation APIs, the system can determine user locations and execute an RPC (Remote Procedure Call) algorithm on the database to match taskers to clients by proximity and required service type.

Tasker Document Verification: To ensure safety and authenticity, a document verification workflow was implemented. Taskers can successfully submit documents such as National IDs and academic certificates, which are securely stored via Supabase Storage for review.

Task Booking Workflow: Clients can seamlessly post service requests with budgets and locations, while taskers can accept or decline these requests through a fully functioning task-lifecycle state machine (Pending → Assigned → In Progress → Completed).

2.4 Sequence Diagram

This diagram illustrates the chronological flow of messages between the system components when a client requests a service and a Tasker accepts it.

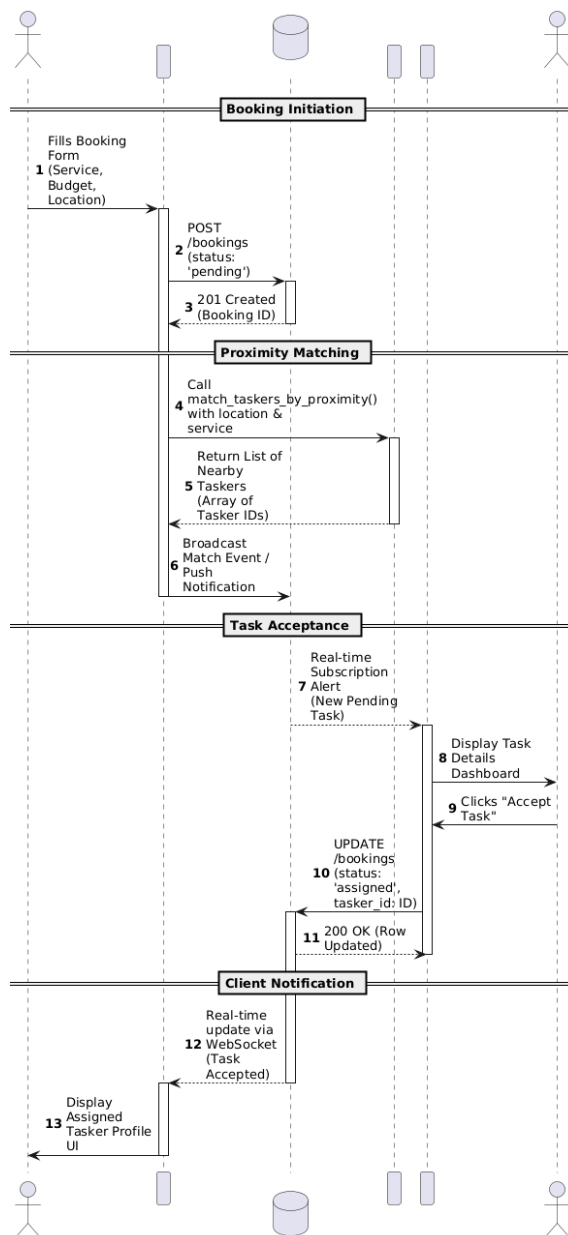


Figure 1: Sequence Diagram

This sequence diagram outlines the "Task Booking and Assignment" flow. It highlights the asynchronous communication passing between the Client's device, the Supabase backend server, the PostgreSQL proximity matching function, and the Tasker's device. Real-time updates ensure that when a Database table Row (Booking) changes, the counterpart UI is

instantly notified without requiring a manual page refresh.

2.5 Entity-Relationship Diagram (ERD) & Data Models

This describes the Supabase PostgreSQL database schema, highlighting the relationships between User profiles, their Wallets, Bookings, and Transactions.

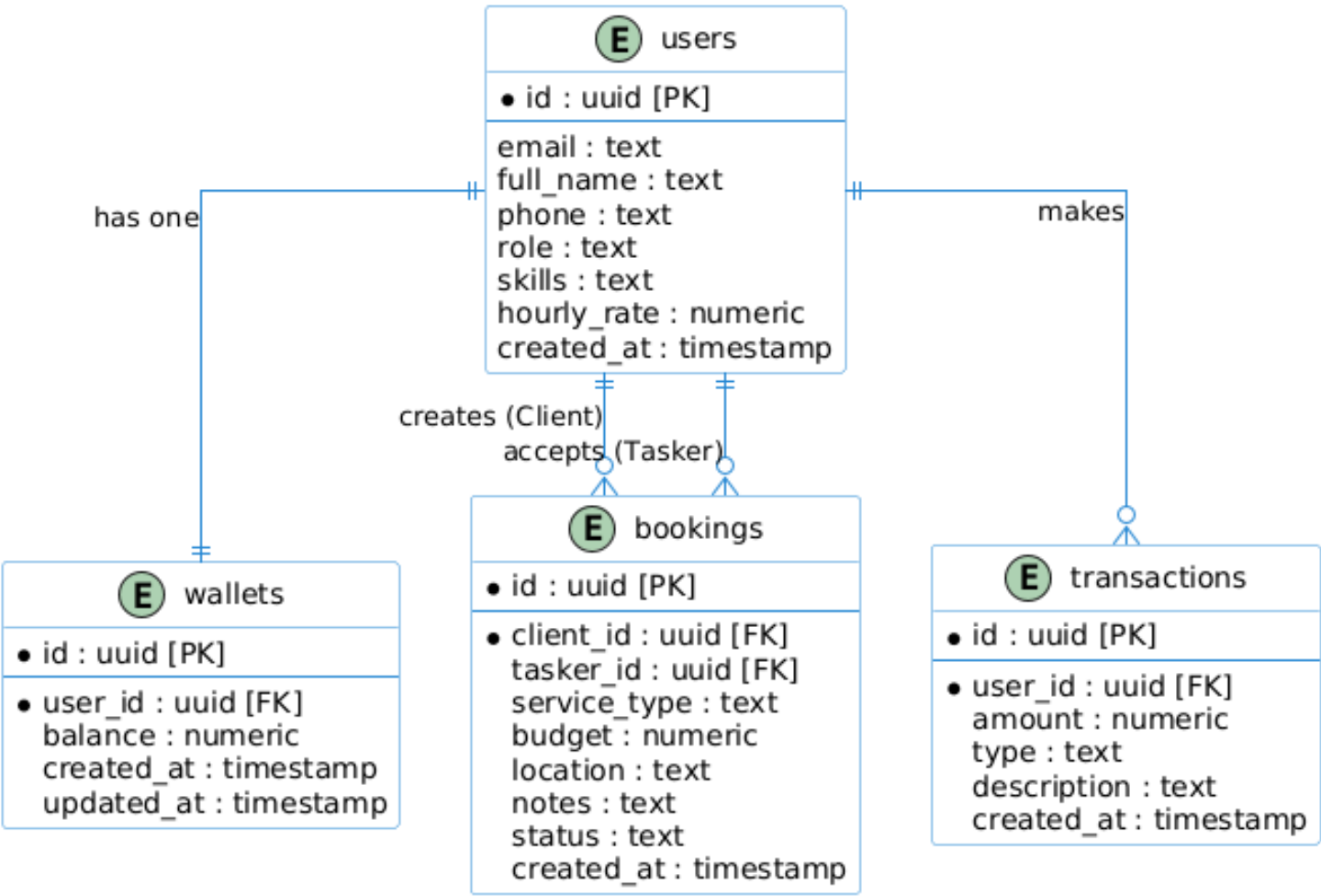


Figure 2:ERD Diagram

Users: The core entity representing both Clients and Taskers, differentiated by the *role* attribute. It acts as the central hub.

Wallets: A 1-to-1 relationship with the Users table. Every registered user automatically gets exactly one wallet to track their balance.

Bookings: Represents a service contract. It has a 1-to-many relationship with Users (a Client can make many bookings, and a Tasker can accept many bookings).

Transactions: A 1-to-many relationship tracking the financial history (deposits, payments)

linked directly to a specific user.

2.6 System Flowchart Diagram

This flowchart demonstrates the decision-making logic and state transitions within the application, specifically focusing on the Booking Lifecycle from start to completion.

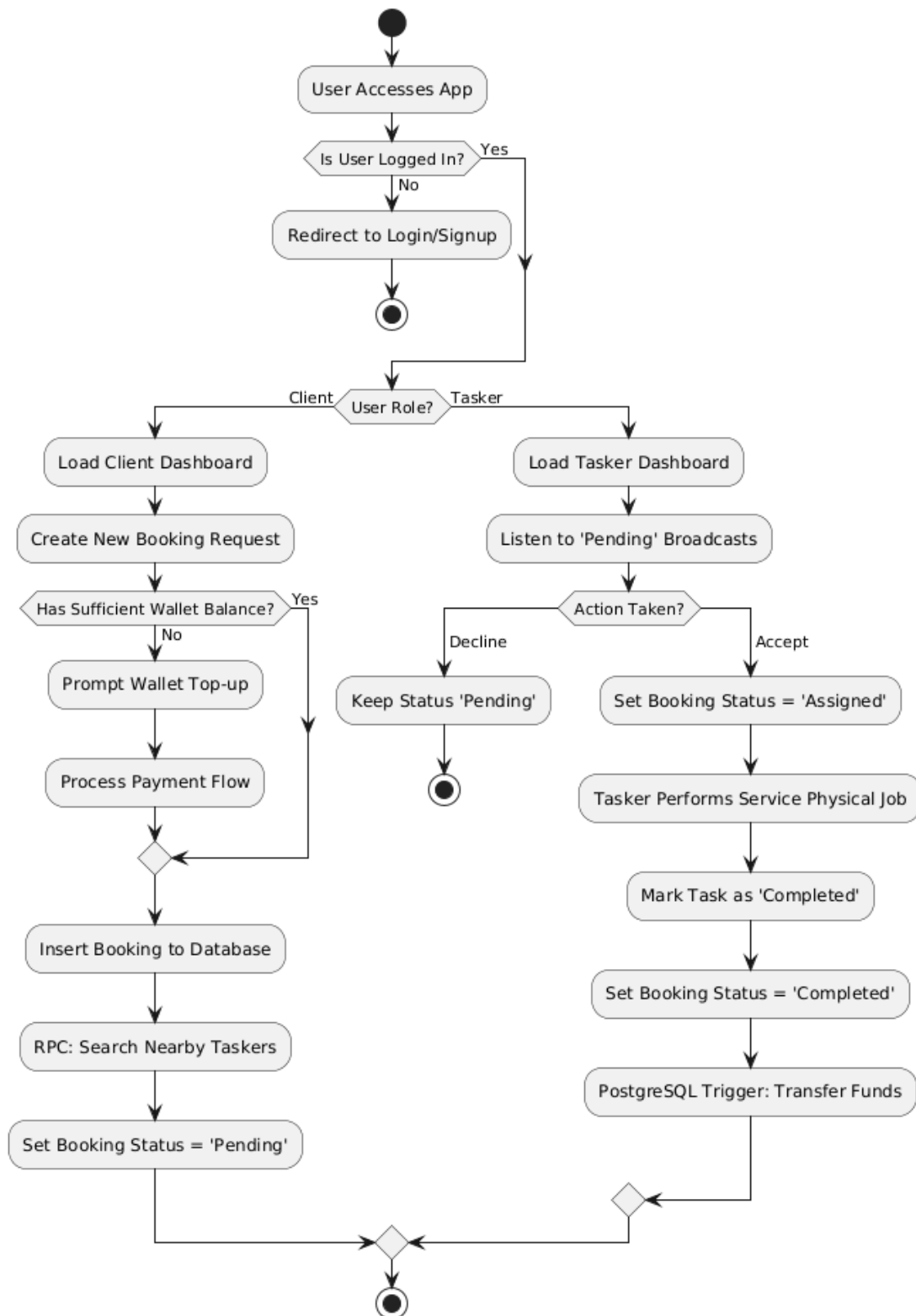


Figure 3:Flowchart Diagram

This flowchart maps user journeys based on Role-Based Access Control (RBAC).

1. It begins by routing to the appropriate dashboard based on authentication status and user role.
2. For a Client, it details the conditional requirement of having sufficient wallet funds before a booking is committed to the database.
3. For the Tasker, it outlines the decision node of accepting or declining a job broadcasted via Supabase Realtime subscriptions.
4. Finally, it demonstrates how marking a task as Completed acts as the trigger event to execute database wallet deductions computationally safely.

The flow is divided into three major phases: Authentication, Client Request Initiation, and Tasker Fulfilling the Request.

Phase 1: Authentication and Routing

1. System Access: The process begins when any user accesses the SkillBee application.
2. Authentication Check: The system verifies if the user has an active authenticated session via Supabase Auth.
 - If No, the user is redirected to the Login/Signup page to authenticate or create a new account.
 - If Yes, the system checks the user's registered role.
3. Role-Based Routing: Based on the role attribute in the database, the user is routed to either the Client Dashboard or the Tasker Dashboard.

Phase 2: Client Request Initiation (Client Flow)

When a user is identified as a Client, they can initiate a service request:

1. Form Submission: From the Client Dashboard, the user fills out a new booking request, specifying the required Service Type, their Budget, and their current Location.

2. **Wallet Validation:** Before the booking is finalized, the system checks the Client's digital wallet balance.
 - If the balance is insufficient to cover the budget, the system pauses the booking and prompts the user to top up their wallet via the payment integration. Once topped up, it resumes the flow.
 - If the balance is sufficient, the system proceeds.
3. **Database Commit:** The new booking is securely inserted into the Supabase database.
4. **Proximity Matching Trigger:** The insertion triggers a PostgreSQL Remote Procedure Call (RPC) named `match_taskers_by_proximity()`. This function scans the database for Taskers whose skills match the requested Service Type and ranks them based on proximity to the Client's Location.
5. **Status "Pending":** The newly created booking is marked as Pending while the system awaits a Tasker's response.

Phase 3: Tasker Fulfillment and Completion (Tasker Flow)

Concurrently, users logged in as Taskers are listening for available jobs:

1. **Real-Time Broadcast:** Taskers receive an instant, real-time alert on their dashboard regarding the newly created Pending task, provided they match the skill and location criteria.
2. **Decision Node (Accept/Decline):** The Tasker reviews the job details (budget, notes, location) and chooses an action:
 - If the Tasker selects Decline, they are removed from that specific match queue, and the task remains Pending for other matched Taskers to see.
 - If the Tasker selects Accept, the flow moves forward.
3. **Status "Assigned":** Upon acceptance, the database securely updates the booking's `tasker_id` and changes its status from Pending to Assigned. Both the Client and the Tasker are notified of the successful match.
4. **Service Execution:** The Tasker physically travels to the location and performs the

required service.

5. Status "Completed" & Settlement: Once the job is done, the Tasker marks the task as complete in the app. The booking status changes to Completed.
6. Financial Trigger: This final status change fires an automated database trigger that securely deducts the predefined budget from the Client's wallet and credits it to the Tasker's wallet, officially concluding the workflow.

2.7 Implementation

The system was implemented using a modern JavaScript stack, adopting a decoupled client-server architecture.

- **Frontend Development:** The User Interface was built using **React 18** and **Vite** for rapid development and optimized builds. The application utilizes functional components and strict React Hooks for state management. Routing is handled by **React Router DOM v6** restricting access to protected pages (like Dashboards) via custom Require AUTH wrappers.
- **Styling & UI: CSS Modules** were heavily utilized to scope styles locally to components, preventing global style conflicts. **Lucide React** was used to provide a consistent iconography system throughout the platform.
- **Backend & Database Integration:** The backend is powered entirely by **Supabase**, leveraging its PostgreSQL database. The database schema relies heavily on relational tables (users, bookings, wallets, transactions) enhanced with PostgreSQL Triggers and Row Level Security (RLS) policies to ensure users can only access their authorized data.
- **Mapping & Location Services:** React-Leaflet was integrated to provide interactive map interfaces, making location-picking and proximity visualization intuitive for clients and taskers.
- **Tracking of Accepted tasks:** All task that were accepted by the tasker are tracked so the client can know which status is on.
- **In-App Messaging :** We added in the messaging feature where the client and tasker can communicate from so as to follow up each other apart from the Task tracking

system.

2.8 Testing

To ensure the reliability and usability of the SkillBee application, various testing strategies were employed during development:

- **Manual & Functional Testing:** Core user flows were repeatedly manually tested using the Vite development server (npm run dev). Flows such as account creation, submitting verification documents, and creating a booking were tested sequentially to ensure the application logic held up without crashing.
- **Static Code Analysis:** ESLint configured with React rules was actively used to enforce code quality, catch unused variables, prevent incorrect useEffect dependencies, and fix fast-refresh limitations.
- **Database Testing:** Supabase database functions (such as the proximity matching RPC and trigger-based wallet balance updates) were tested using raw SQL edge-cases to guarantee backend data integrity before integrating them into the React frontend.
- **Responsiveness Testing:** The user interface was tested across different viewport sizes using browser developer tools to ensure the design remained accessible and usable on mobile devices, considering on-the-go taskers.
- **Tracking system for task:** The users are able to see the status of the accepted task to follow up with the tasker on their request.
- **GPS/Map proximity:** A client is able to get taskers around his/her location to do the task with the implemented map box feature.

Chapter Five

Evaluations

5.1 Limitations on the Technology

Despite the successful implementation of the platform, the chosen technology stack presents a few inherent limitations:

Single Page Application (SPA) SEO:

Since SkillBee is built as a standard React SPA without Server-Side Rendering (SSR), web crawlers may struggle to index public pages, potentially limiting organic search engine discoverability.

Third-Party Backend Dependency:

Relying entirely on Supabase means the application is subject to the platform's API rate limits, WebSocket connection caps for real-time updates, and storage constraints on the current tier.

Geolocation Accuracy:

The application relies on the HTML5 Geolocation API, whose accuracy depends highly on the user's device hardware and network. Furthermore, users can deny location permissions, which breaks the proximity-matching feature.

Client-Side Rendering Performance:

As the application scales and the component tree becomes drastically larger, rendering times could slow down on older mobile devices since the heavy lifting of UI construction is done entirely on the client's browser.

5.1.1 Problems Encountered

Several technical and logical challenges were encountered during the development lifecycle:

Implementation of Automated verification ID and Documents:

We have an issue of adding the API for verifying the clients ID and documents uploaded.

We got information for the identification where we can use smile ID for National ID also NITAs API but then for the Academic documents it seems its hard to get the API freely since UNEB does not give free access to the database.

Complex Database Triggers & RLS:

Writing complex PostgreSQL triggers to automatically deduct/credit wallets synchronously upon booking completion was challenging. Additionally, configuring Row Level Security (RLS) policies to allow file uploads to Supabase Storage while preventing unauthorized access required extensive debugging.

State Management Bottlenecks: Managing complex component states, especially regarding real-time UI updates (e.g., when a task is immediately accepted by a tasker), frequently led to ESLint dependency warnings and infinite re-render loops within React's useEffect hooks.

Asynchronous Race Conditions: Ensuring that the user's wallet table and profile table were fully instantiated before the user was routed to their dashboard after a sign-up event required careful handling of asynchronous Supabase API promises.

5.1.2 Recommendations/Future Research

To improve upon the current system, the following features and architectural shifts are recommended for future iterations:

Integration of a Real Payment Gateway: The current internal wallet system should be integrated with actual payment processors (like Stripe, PayPal, or Flutterwave) to allow users to pull actual funds from debit cards or mobile money.

Migration to Next.js: Porting the application to Next.js would allow for Server-Side Rendering (SSR) and Static Site Generation (SSG), drastically improving initial page load speeds and SEO.

Implementation of Automated Testing: Future development should adopt End-to-End (E2E) testing frameworks like Cypress, and unit testing tools like Jest to automate the verification of critical paths (e.g., booking tasks) to prevent regression bugs.

5.1.3 Feasibility improvements

While the SkillBee platform successfully demonstrates a functional and scalable prototype, certain design assumptions required adjustment to ensure practical deployment within the Ugandan context.

During development, it was identified that some advanced features—particularly automated identity verification using external APIs such as UNEB and NIRA/NITA—are constrained by limited access, cost, and regulatory restrictions. As a result, feasibility improvements were introduced to ensure that the system remains operational and deployable even in the absence of such integrations.

5.1.3.1 Hybrid Identity Verification Model

To overcome limitations associated with external verification APIs, the system adopts a hybrid verification approach combining automated processing with manual administrative review.

In the current system, users are able to upload identification documents such as National IDs and academic certificates. As a feasibility improvement, the system introduces a proposed automated pre-processing stage which includes:

- Optical Character Recognition (OCR) to extract text from submitted documents
- Basic facial comparison between the user's selfie and ID photograph
- Validation of consistency between user-provided data and extracted document data

These processes will generate a confidence score (0-100%) representing the likelihood that the submitted identity is authentic.

Based on this score:

- Scores above 85% will be automatically approved
- Scores between 60% and 84% will be flagged for manual administrative review
- Scores below 60% will be rejected

This approach ensures that the verification process remains efficient and scalable without relying on unavailable third-party APIs.

5.1.3.2 Manual Verification as a Fallback Mechanism

To ensure robustness and reliability, manual verification is maintained as a core fallback mechanism within the system.

Administrators are able to:

- Review uploaded documents directly
- Approve or reject users based on visual inspection
- Handle cases where automated scoring is inconclusive

This hybrid approach reflects real-world systems where automation is complemented by human oversight, particularly in environments with limited digital verification infrastructure.

5.1.3.3 Phased Deployment Strategy

To improve implementation feasibility, the system adopts a phased deployment approach:

Phase 1: Prototype Stage (Current System)

The system operates as a functional prototype with manual verification and a simulated wallet system.

Phase 2: Pilot Deployment

The system can be deployed within a limited geographical area such as Kampala, using real users while maintaining hybrid verification.

Phase 3: System Expansion

Future integration with external APIs and scaling to additional regions as access and partnerships become available.

This approach ensures gradual system growth while maintaining stability and usability at each stage.

5.1.3.4 Payment System Feasibility

The current implementation includes an internal wallet system that simulates transactions and escrow-based payments between clients and taskers.

However, full integration with mobile money platforms such as MTN MoMo and Airtel Money requires API access and regulatory compliance.

To address this:

- The system currently uses a **simulated wallet** for testing and demonstration
- Future deployment will integrate real mobile money APIs once access is secured

This ensures that the system remains functional during development while allowing for future financial integration.

5.1.3.5 Adaptation to the Local Context

The SkillBee platform has been designed to align with the socio-economic and technological realities of Uganda.

Key considerations include:

Support for mobile money transaction models

Simple and intuitive user interfaces for users with varying digital literacy levels

Proximity-based matching to reduce search and transportation costs

Trust mechanisms such as verification, ratings, and reviews

These adaptations enhance both usability and adoption within the informal labour market.

The introduction of hybrid verification, manual fallback processes, and phased deployment significantly improves the feasibility of the SkillBee platform.

By aligning the system with real-world constraints such as limited API access, infrastructure challenges, and user behavior, the platform becomes practical, scalable, and suitable for deployment within the Ugandan environment.

5.1.4 Conclusion

The SkillBee application successfully demonstrates the viability of a modern, localized freelance marketplace. By leveraging robust web technologies like React and a scalable backend like Supabase, the project met its core objectives of connecting clients with nearby taskers securely. While challenges such as complex asynchronous state management and real-time database syncing were encountered, they were successfully mitigated. Ultimately, the system provides a strong, user-friendly foundation that can be scaled and adapted for real-world commercial deployment with the integration of live payment gateways and enhanced testing protocols.

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APPENDIX

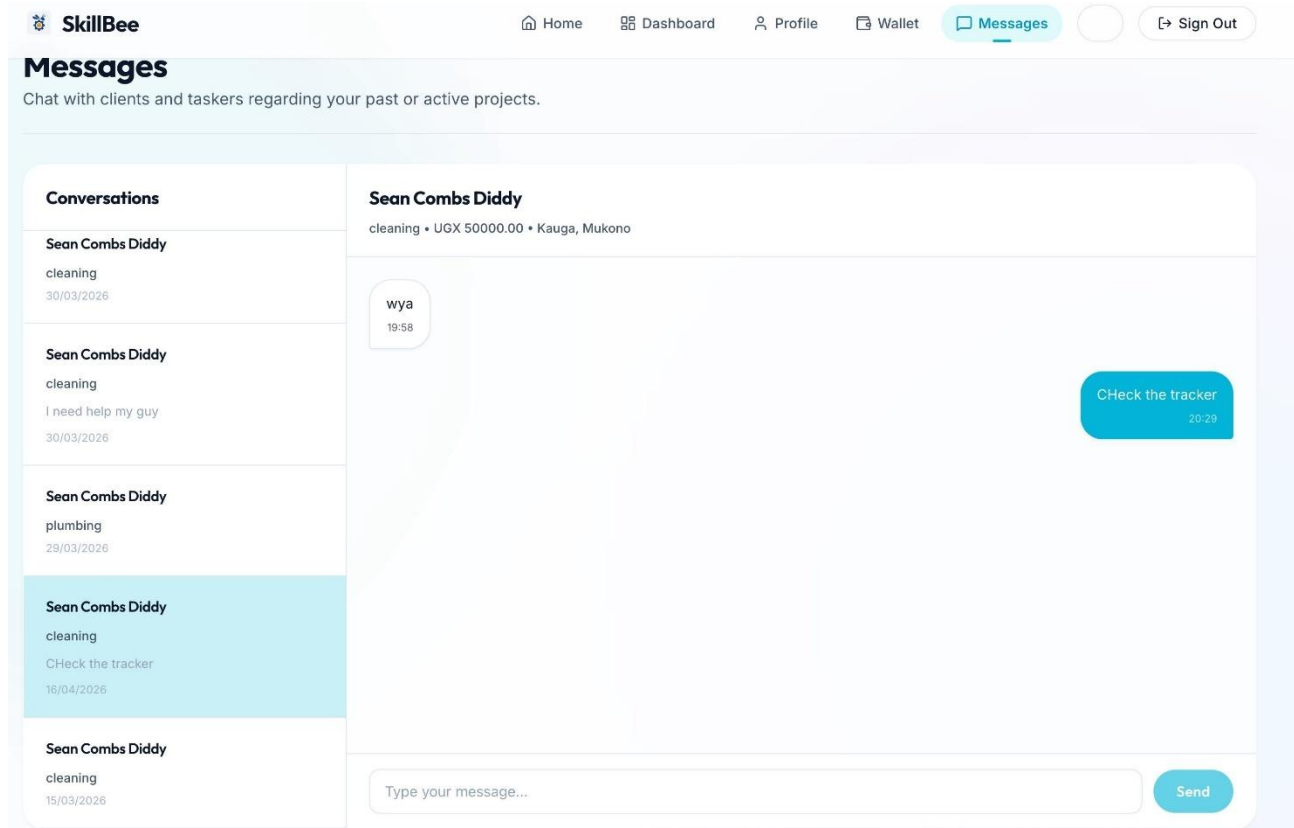


Figure 4: In Application messaging

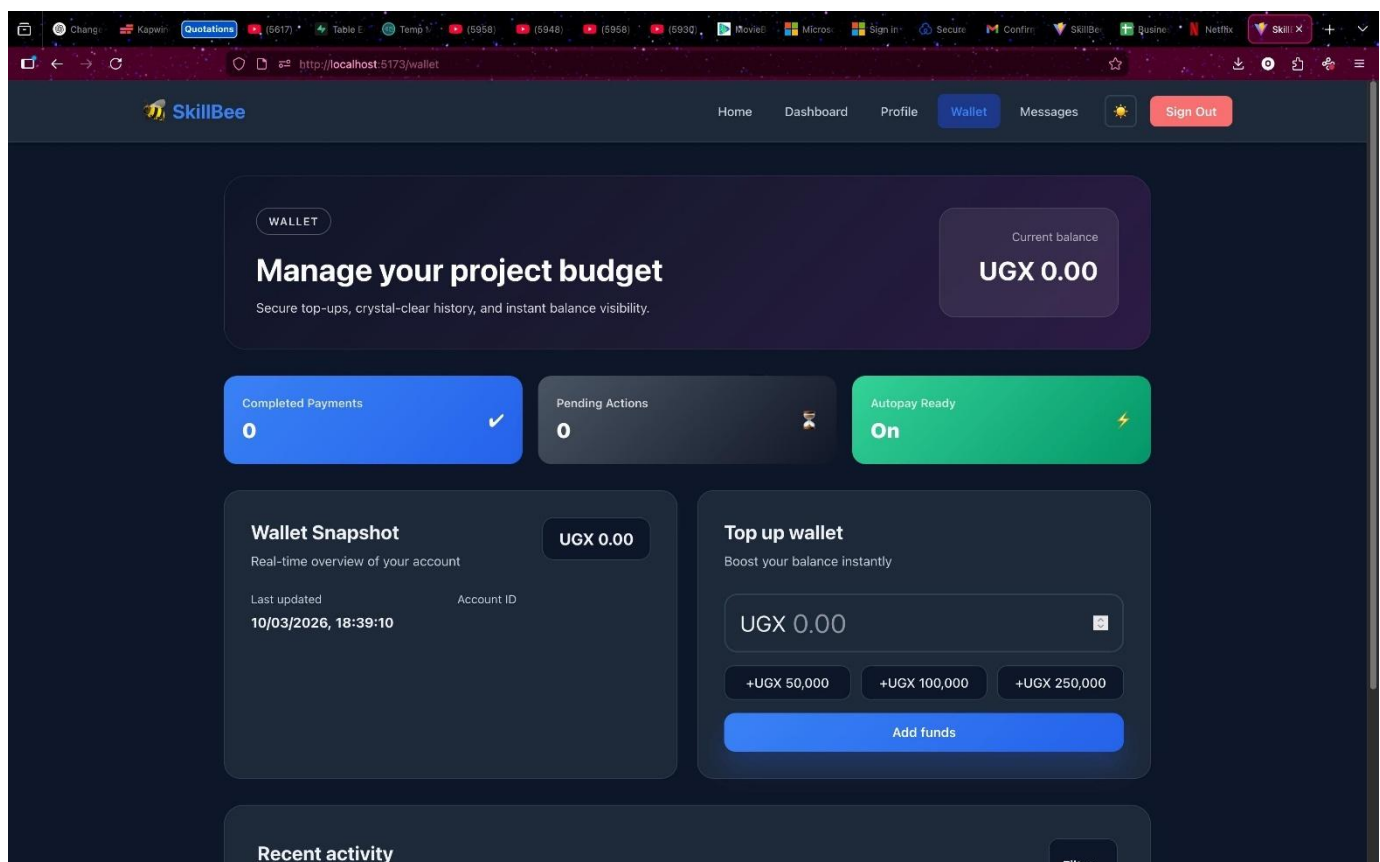


Figure 5: Wallet section

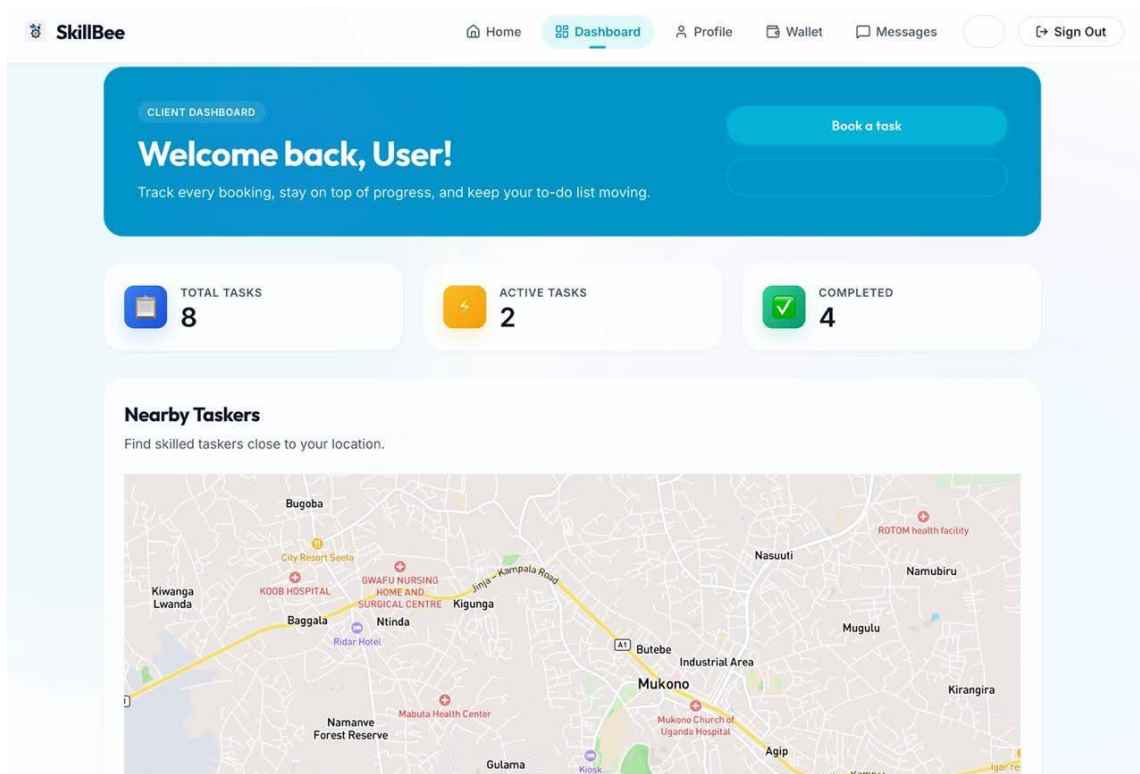


Figure 6: User Dashboard

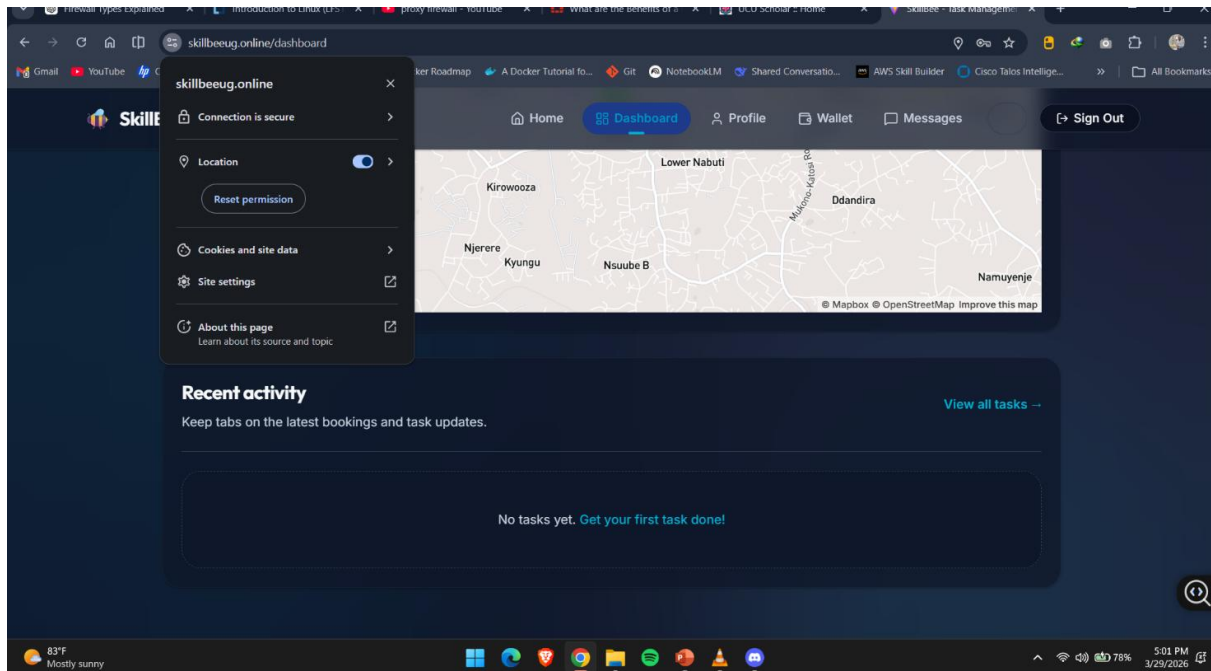


Figure 7: Location feature in browser

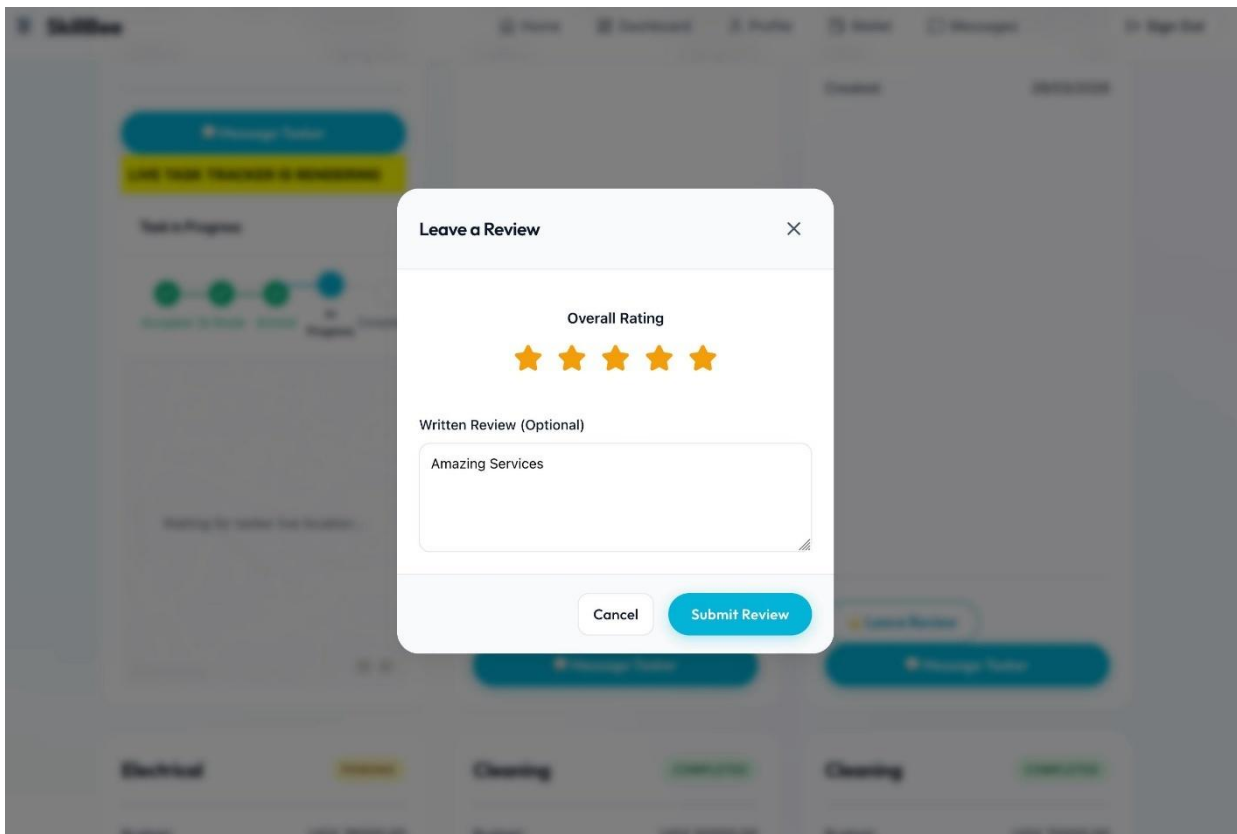


Figure 8: Review for clients

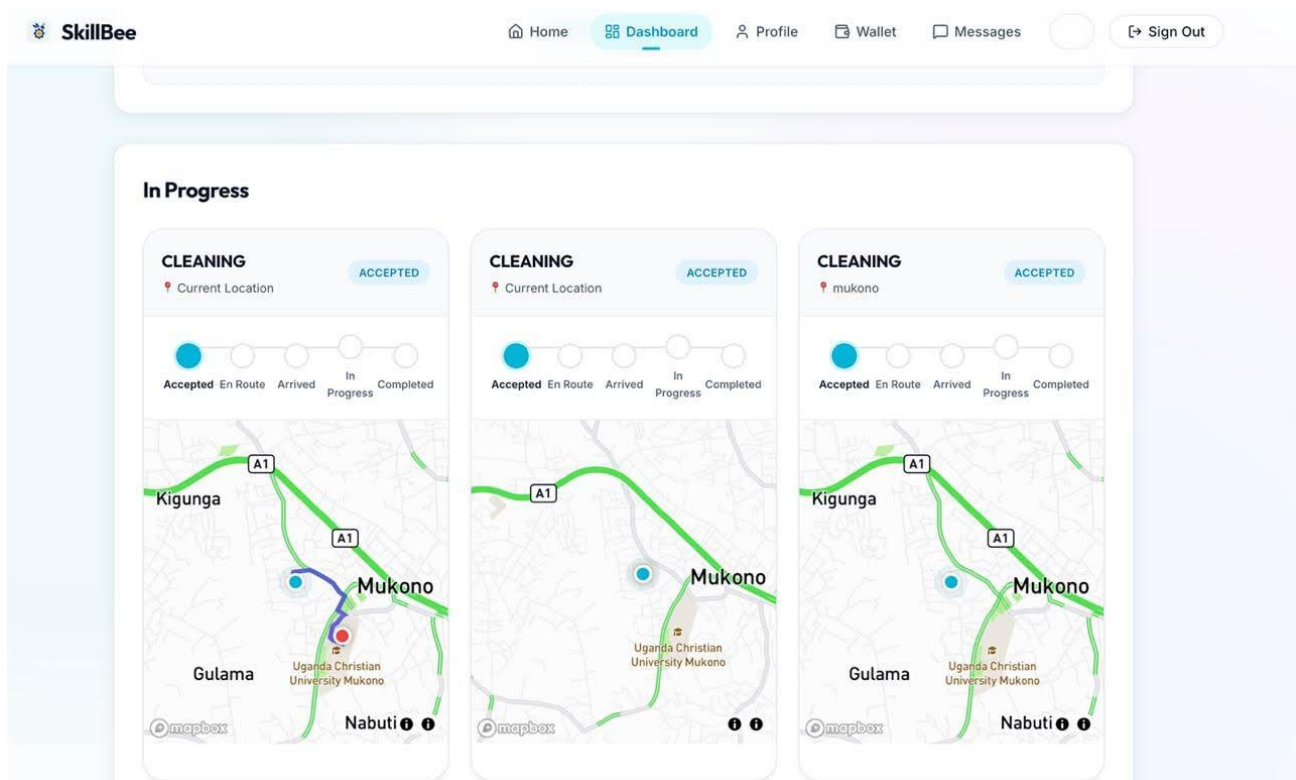


Figure 9: Tracking of progress of task

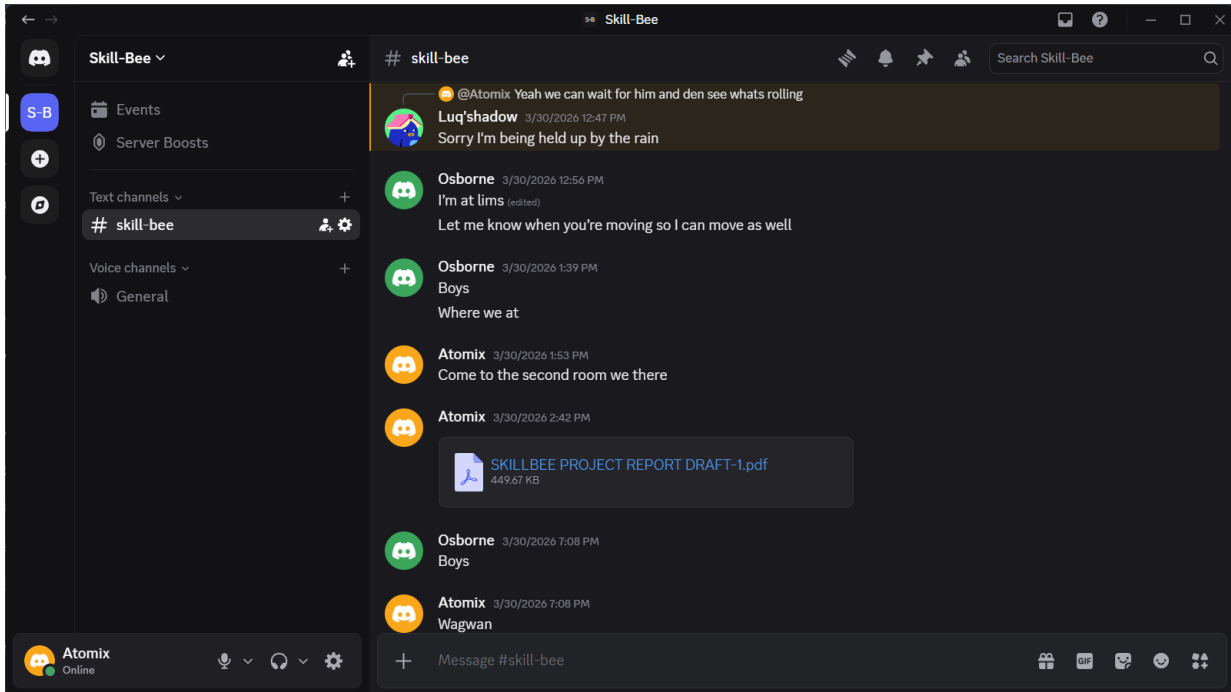


Figure 10: Discord for communication

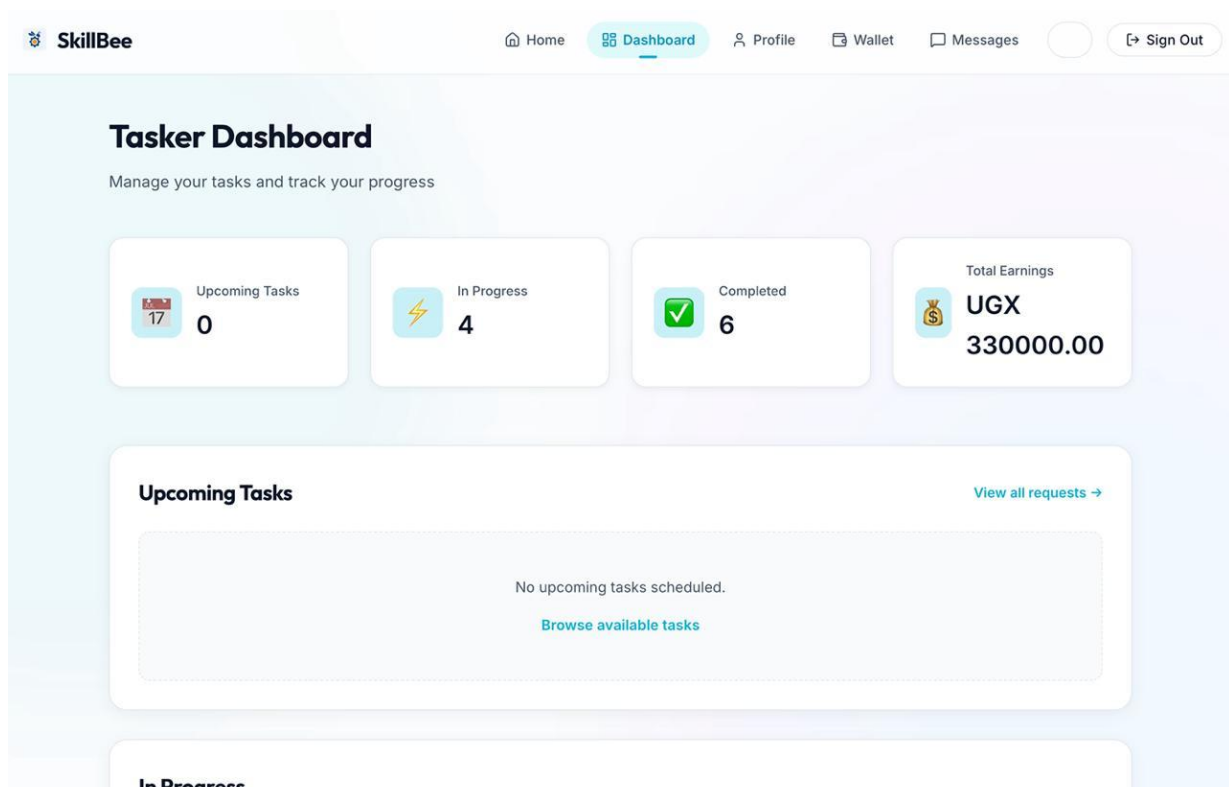


Figure 11: Taskers Dashboard



Meet Our Team



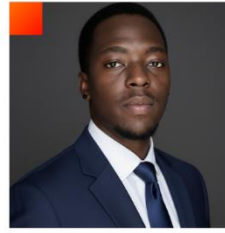
AKANKWASA TOM
S23B13/007

Role: Lead Researcher , Documentation
Coordinator, Assistant project
developer



KYEMBE LUQMAN
S23B13/028

Role: Technical & Framework
Developer, Pitcher



NIMARO OSBORNE
M23B13/025

Role: Lead Project developer and
Projector mobilizer

08

Figure 12: Group members