WORKEASE: BRIDGING DEMAND AND SUPPLY GAP OF EMPLOYMENT FOR LABOUR

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ABSTRACT

Technically sound and intelligent labour serves as a spinal cord of the nation. Efficient labour force makes proper use of the scarce natural resources of the country. Sincere, dedicated, devoted, hardworking and intelligent labour force helps the country to march on the path of development. The Labour shortage is a critical issue in our country and it is to be tackled for strengthening India's Economic growth. In general, some labour are unemployed as they cannot find work in a region. At the same time, in another region there is requirement of labour and the work needs to be done on time. So to curb this and to find work for labour and to decrease shortage of workers in a place we need a solution. The main objective of this prototype is to connect the places where there is shortage of workers and workers who are unemployed. So the workers will be benefitted. More over we can reduce unemployment. Consider the scenario of farming - Due to lack of labour, farmers are not able to harvest the crop on time. Even though there is more land for farmers to cultivate, due to shortage of labour, they are cultivating on small scale. So, using this website, farmer can find the labour easily and he can enhance the productivity in large scale. Connecting labour demand with available workers can certainly help address labour shortages, improve resource utilization, and enhance overall productivity. By providing a platform for farmers and other businesses to find and hire workers easily, we are facilitating a more efficient allocation of labour resources. Hence there is an increase in employment and the migration of workers to other sectors will be reduced.

Keywords: - Unemployment Solution, Labor Shortage, Economic Growth, Algorithms,Web Application,Optimization

1. INTRODUCTION

The functioning Indian working class stands as the economic base that directs progress through the three essential sectors of agriculture as well as building and services. The economy needs labor yet

its problems continue because of poor infrastructure and restricted digital networks and inadequate employee-employer communication systems. The vulnerabilities create both massive unemployment problems and inefficient resource distribution which triggers population relocations and generates a substantial employment mismatch.People working in rural and semi-urban regions face unfulfilling and inappropriate employment because proper timely opportunities remain inaccessible to them from nearby employment sources. Haryana faces high jobless rates because its seasonal agricultural cycle clashes with growing population growth and unbalanced resource distribution between different sections. People in this population segment cannot access the job market because of both digital disparities and poor digital abilities and insufficient economic resources.WorkEase develops an internet-based system to unite different workforce sources with the jobs currently available. The platform creates worker-job provider and worker-contractor matches by using advanced Geographic Information Systems technology in combination with real-time mapping and location-based services through skill and geographical match features. Through its platform WorkEase enables fair labor regulations that facilitate unlimited job opportunities between workers and employers without traditional job facilitation.Users can access WorkEase through mobile devices and authentication functions establish both security and interaction trust. Through WorkEase the recruitment process becomes more efficient with reduced workforce acquisition delays yet provides a chance for employees to stay immobile as it supports area development and generates local economic growth alongside improved quality of life for citizens throughout all parts of India.

2. LITERATURE SURVEY AND RELATED WORK

The problem of unemployment and inefficient labour distribution continues to challenge socio-economic development, particularly in countries like India where agriculture and informal sectors dominate. Traditional labour engagement methods—often relying on intermediaries or manual listings—lack scalability, transparency, and responsiveness to changing employment demands across regions. Consequently, research efforts have increasingly turned towards technology-driven platforms to bridge the demand-supply mismatch in the labour market.

Early work in this area, such as the study by Dr. Ashwani Kumar, identified unemployment as a systemic issue rooted in structural inefficiencies and the lack of modernisation in agriculture. Recommendations emphasized mechanisation, rural development, and improved infrastructure to address both rural and urban joblessness. Dr. Puspa Rani and Suman Devi further highlighted the cyclical nature of unemployment in Haryana, linking it to seasonal agriculture, limited land holdings, and insufficient diversification within the rural economy.

In response to these structural limitations, Prof. Arti Sharma examined the performance of agriculture and allied sectors in Haryana, emphasizing the role of agricultural diversification, technological adoption, and improved irrigation in job creation. However, the study also noted that without parallel improvements in labour allocation and mobility, agricultural growth alone would not solve the employment crisis.

Contemporary solutions have begun to explore digital platforms and mobile technologies. The concept of LabourGrid, as proposed by Vishal Dave et al., introduced a prototype leveraging

Interactive Voice Response Systems (IVRS), SMS alerts, and geo-location-based matching to improve communication between contractors and workers in rural areas. The system utilized distance-calculating algorithms such as the Haversine formula to match job seekers with nearby opportunities based on GPS coordinates. While promising, the solution faced challenges with brute force matching inefficiencies, limited dynamic scalability, and reliance on basic feature phones.
To address these challenges, newer approaches—such as the WorkEase platform proposed in this project—have embraced advanced spatial data structures (e.g., R-trees) and Geographic Information Systems (GIS) to enable precise and scalable contractor-labour matching. These technologies not only reduce the computational overhead of spatial queries but also enhance the responsiveness of the platform in high-demand scenarios. Moreover, integrating real-time identity verification, user ratings, and cross-platform mobile/web access has improved trust and usability among both job seekers and providers.

In summary, the evolution from traditional employment mechanisms to technologically enhanced labour matchmaking platforms demonstrates a critical shift in addressing unemployment. Solutions like WorkEase, built on contemporary web technologies and geospatial intelligence, offer a more dynamic, inclusive, and scalable approach to bridging the labour gap—particularly in underserved and rural regions of India.

3. Implementation Methodology

The implementation of WorkEase is grounded in contemporary research that emphasizes the power of digital platforms, spatial intelligence, and user-centric design in addressing systemic employment gaps. Drawing inspiration from earlier solutions such as LabourGrid, which employed IVRS and SMS communication for rural workforce matching, this project expands the technological frontier by integrating PostGIS-based spatial analysis, R-tree data structures, real-time authentication, and multi-platform deployment to optimize labour demand-supply alignment. The development process follows a structured pipeline, beginning with requirement analysis, where both functional and non-functional expectations are documented through stakeholder feedback and socio-economic research. This is followed by market research to analyze existing labour solutions, revealing critical gaps in accessibility, scalability, and data trust.
The conceptualization and planning phase outlines core modules—authentication, maps, notifications, and worker-contractor matching—along with system roles (owners, workers, heads), interaction workflows, and the use of Supabase for backend authentication and storage. Wireframes and prototypes are developed using design tools, with iterative feedback loops refining user experience across web and mobile interfaces. The development phase involves the integration of Next.js for front-end, PostgreSQL/PostGIS for geospatial databases, Redis for fast in-memory data access, and Leaflet.js for dynamic map visualizations. The labour-matching algorithm—a centerpiece of the platform—uses R-tree spatial indexing to narrow the search to relevant geographic rectangles, minimizing computational overhead and enabling rapid matching of contractors and workers within defined radii. The system incorporates both brute-force and optimized matching mechanisms, offering flexibility based on data volume.
In terms of authentication, Supabase manages traditional username-password logins, while Twilio APIs are used for OTP-based verifications and call-based notifications. Once registered, workers and

contractors can add, search, or apply for work, while ratings and feedback ensure platform accountability. Rigorous testing and quality assurance is conducted using both unit testing and black-box testing strategies. The experimental analysis reveals a significant performance gain with the R-tree-based matching system—achieving execution times of just 130 milliseconds for datasets exceeding 300,000 records, a marked improvement over the 13,000 milliseconds in brute-force methods.

Upon successful testing, the platform is deployed using Vercel (PaaS), supported by CDNs and load balancers to ensure global scalability and uptime. A continuous post-launch monitoring mechanism captures user insights for iterative improvements, while analytics dashboards track performance and job engagement trends. By combining geospatial precision, fast computation, and intuitive design, WorkEase transforms the traditional employment landscape—bridging the labour gap with a scalable, responsive, and human-centric digital solution that fosters both local empowerment and national productivity.

4. Proposed Methodology

In this study, we propose a geospatially intelligent, web-enabled platform named WorkEase to bridge the persistent mismatch between labour demand and supply, especially in economically diverse and geographically dispersed regions. The system is designed to minimize unnecessary migration, reduce unemployment, and enhance employment transparency by leveraging modern web technologies, geospatial analysis, and scalable backend infrastructure. Unlike traditional job-matching portals, our methodology incorporates location-aware matching algorithms, real-time updates, and interactive maps to provide both workers and employers with a responsive and reliable employment network.

The proposed methodology begins with user registration and authentication, implemented through Supabase, which supports both username-password and OTP-based verification via Twilio. This ensures a secure onboarding process and builds trust across the ecosystem. Once authenticated, users are categorized into distinct roles—owners, workers, or head workers—each with unique capabilities such as posting job requests, registering availability, or managing groups of labourers. The core of the system lies in its labour-matching algorithm, which utilizes PostGIS spatial queries and R-tree indexing to efficiently identify potential matches within a 20-kilometer radius of a job location, significantly reducing search overhead compared to brute-force methods.

To manage real-time data and enhance responsiveness, Redis is employed as an in-memory database for storing the most recently posted job entries, enabling instant retrieval and reducing backend load. Additionally, a layered map interface is built using Leaflet.js, displaying various types of available work (e.g., construction, farming) through intuitive icons, allowing users to filter and navigate opportunities based on geographic preference and job type.

The decision-making logic in the system ensures optimal matching by considering both head-level labour availability and individual worker preferences. The matching algorithm intelligently balances the load across multiple heads and individual workers, ensuring that each job request is fulfilled through the most efficient path. If a head cannot provide the total required workforce, the system dynamically falls back to individual workers nearby, maintaining fulfilment without delay.

To ensure continuous platform evolution and user-centric improvement, feedback loops are embedded throughout the application. Workers and employers can rate each other post-engagement, which influences their visibility and trust level on the platform. These insights are used to enhance future matching accuracy, discourage exploitation, and build a self-sustaining reputation system.

Overall, the proposed methodology represents a hybrid approach—combining geospatial intelligence, real-time data caching, secure identity protocols, and responsive user interfaces—to create an inclusive, scalable, and highly efficient digital employment solution. By uniting advanced mapping, algorithmic matching, and intuitive design, WorkEase not only solves the technical problem of labour imbalance but also delivers tangible social and economic benefits in underserved communities.

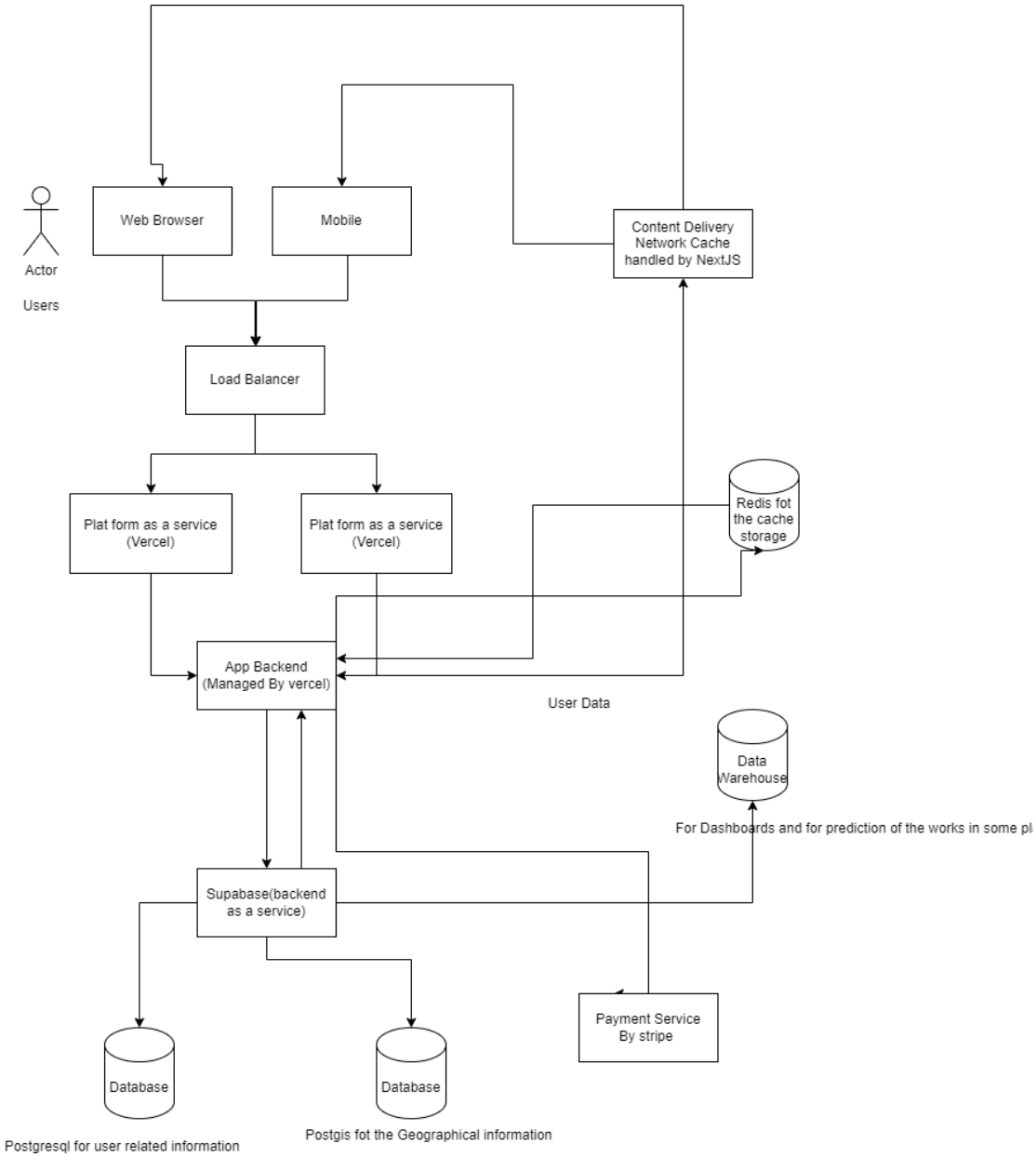


FIG1- SYSTEM ARCHITECTURE

5. System Requirement Analysis

The initial phase of the WorkEase project involves gathering detailed system requirements through stakeholder interviews, labour market studies, and technical feasibility assessments. Key user personas—workers, contractors, and head workers—were identified, and their needs were translated into both functional requirements (e.g., authentication, location-based search) and non-functional requirements (e.g., scalability, security, usability). This phase ensured that

the system was designed with a real-world labour ecosystem in mind.

5.2 Data Collection

WorkEase relies heavily on geolocation and user profile data to enable intelligent labour-contractor matchmaking. The data collected includes:

- User details (name, age, gender, work type, phone number)
- Location coordinates (latitude and longitude)
- Availability and work history
- Ratings and feedback from past engagements
- Job postings with required number of workers, work type, and deadline

All data is securely stored in a PostgreSQL database, with PostGIS extensions to support geospatial queries. In-memory data such as recent job listings is cached using Redis to ensure high-speed retrieval.

5.3 Data Preprocessing

Preprocessing is crucial for optimizing data integrity and enhancing system performance. It involves:

- Geolocation validation to ensure accurate mapping of users and job postings.
- Normalization of location data for spatial indexing using R-tree structures.
- Duplicate removal for users or job entries.
- Verification of user identities using Supabase authentication services.
- Handling real-time updates by syncing the Redis cache with the primary database to reflect new job postings and worker registrations immediately.

5.4 Feature Design & Matching Logic

The core logic of WorkEase lies in its labour-contractor matching algorithm. It is designed using a two-phase approach:

1. R-Tree Spatial Indexing: The system identifies geographic clusters and narrows down the matching process to rectangles (bounding boxes) where potential workers are most likely located.
2. Distance Calculation & Filtering: Within each R-tree leaf node, the Haversine formula is used to precisely calculate distance and filter candidates within a predefined radius (e.g., 20km).
3. Worker Allocation Strategy:
    - Preference is given to "head workers" who manage groups.
    - If heads do not meet the required count, individual workers are added.

- Workers are notified via Twilio SMS/IVRS, and upon acceptance, their status is updated in the database.

5.5 Platform Architecture and Modules

The system is built on a modular, microservices architecture with the following key components:

- Authentication Module: Handles registration and secure access using Supabase and OTP-based login.
- Notification Module: Delivers job offers via phone calls and messages using Twilio API.
- Map Module: Visualizes job locations and nearby workers using Leaflet.js integrated into a React-based frontend.
- Database Module: Combines PostgreSQL + PostGIS for structured and spatial data, and Redis for real-time performance.
- Backend Logic: Implemented with stored procedures and PL/pgSQL functions to manage matching, worker status, rating calculations, and worker-head-owner coordination.

5.6 Testing and Evaluation

To ensure system reliability and performance, a multi-stage testing process was conducted:

- Unit Testing of individual backend functions (e.g., matching algorithm, OTP authentication)
- Integration Testing of modules interacting across the system
- Performance Testing comparing brute-force and optimized algorithms (R-trees), where:
  - Brute-force approach: ~13,122 ms for 1,000 rows
  - Optimized approach: ~130 ms for 300,000 rows
- User Acceptance Testing (UAT) to validate the user experience for all types of users (workers, owners, heads)

5.7 Deployment Strategy

The final system is deployed using Vercel as a PaaS solution for frontend and backend hosting. Deployment steps include:

- Code bundling and CI/CD integration
- Secure environment variable management (API keys, database access)
- CDN caching using Nexus for rapid asset delivery
- Load balancing for traffic distribution

A feedback mechanism is embedded into the platform, allowing users to submit reviews and

suggestions for iterative improvement post-launch.

5.8 Post-Launch Support and Continuous Improvement

After deployment, the system is actively monitored for:

- Latency in matchmaking
- Job fulfillment rates
- System errors and real-time alerts

Weekly performance logs and monthly user feedback are used to deploy updates that enhance matching accuracy, usability, and feature depth—ensuring WorkEase remains adaptive to evolving labour market demands.

6.EXPERIMENTAL ANALYSIS AND RESULTS

This section discusses the results and their analysis regarding processing time to display output. Through rigorous optimization efforts, we achieved a remarkable reduction in the algorithm's runtime, with the optimized version completing the matching process in just 112 milliseconds. This represents a significant improvement over the initial runtime of 12 seconds meeting and surpassing the targeted performance threshold of under 200 milliseconds.

6.1Algorithm Analysis

Comparison of Brute Force Algorithm and Proposed Algorithm with R-trees for Contractor-Labor Matching

Aspect	Brute Force Algorithm	Proposed Algorithm(R-trees)
Test Sample Size	1000 Rows	300000 Rows
Run Time	13122 milliseconds	130 milliseconds
Methodology	Exhaustive search through all laborers within a certain distance threshold	Utilization of R- trees for spatial indexing and efficient nearest neighbor search
Computational Complexity	O(n)	O(logn)
Scalability	Limited Scalability	Scalable with logarithmic performance degradation as the laborers number increases
Spatial Indexing	No spatial Indexing, Linear search for proximity	Utilizes R-trees for efficient spatial indexing and retrieval
Performance Impact	Significant runtime overhead,	Minimal runtime overhead, even with large datasets
Accuracy	Dependent on distance threshold and search granularity	Maintains accuracy while improving efficiency
Resource Utilization	High computational andmemory resources due to exhaustive search	Optimal resource utilization with R-trees, minimizing computational and memory overhead
User Experience	Slow response times, potential frustration for users	Improved responsiveness, enhancing user satisfaction

Table – Algorithm Analysis

6.2.1Web pages

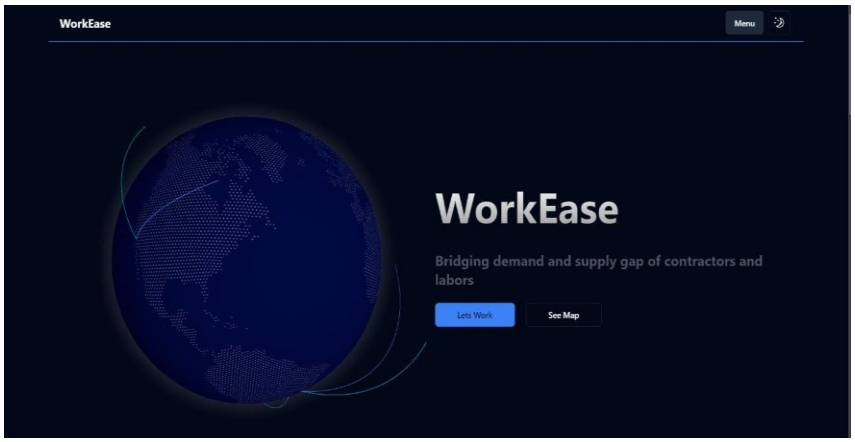


Figure 6.2.a Home Pag

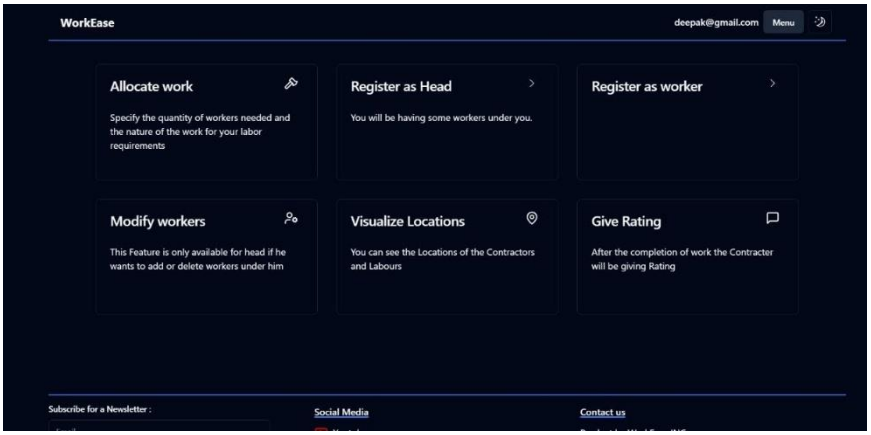


Figure 6.2.b Action page

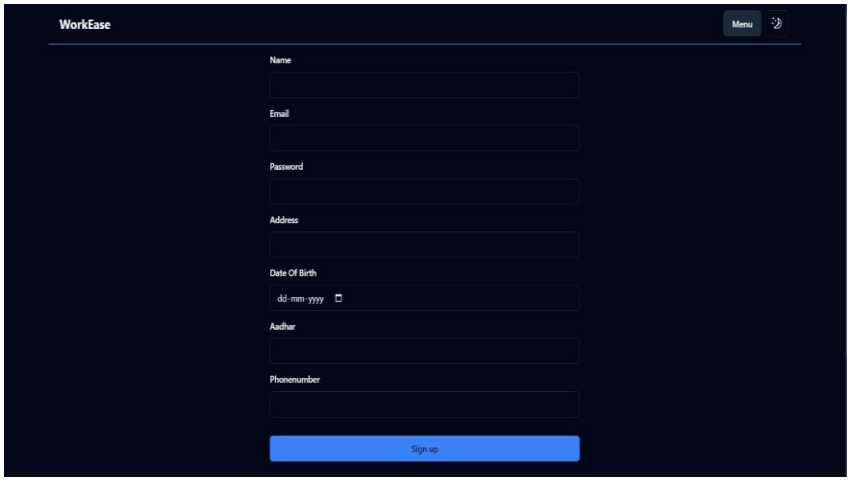
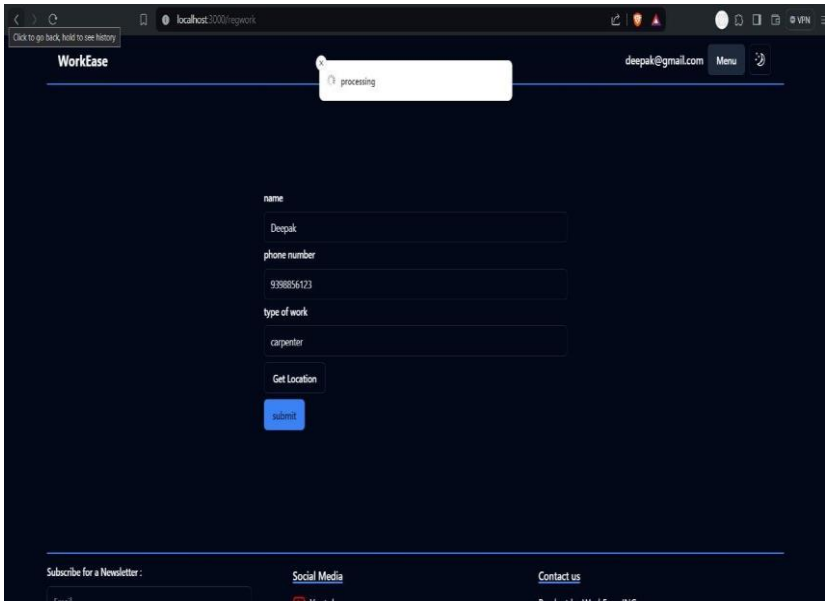
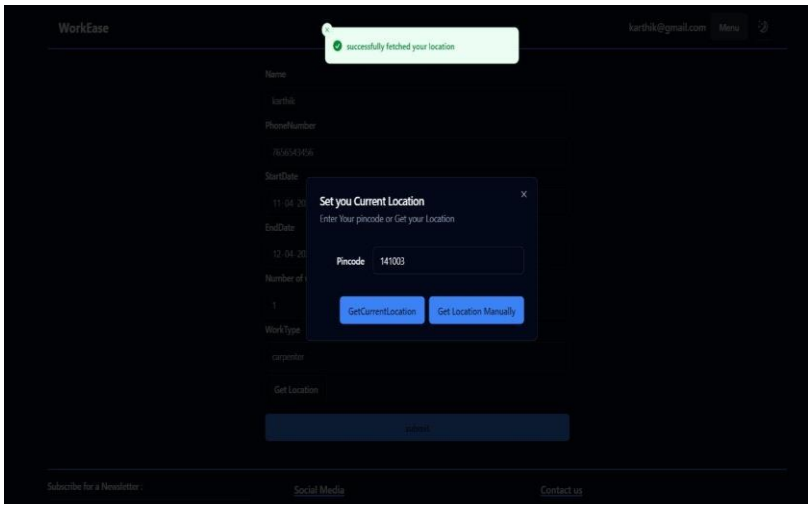
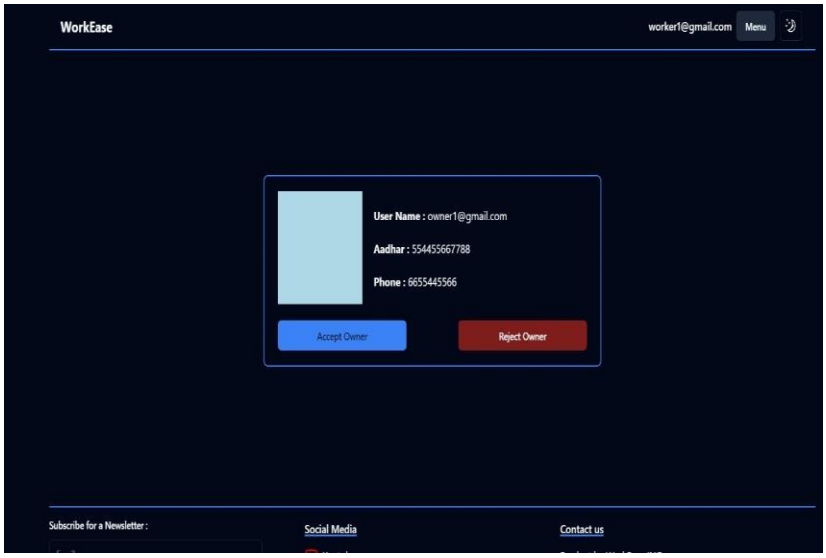


Figure 6.2.d Registration page



F igure 6.2.e Register for work page





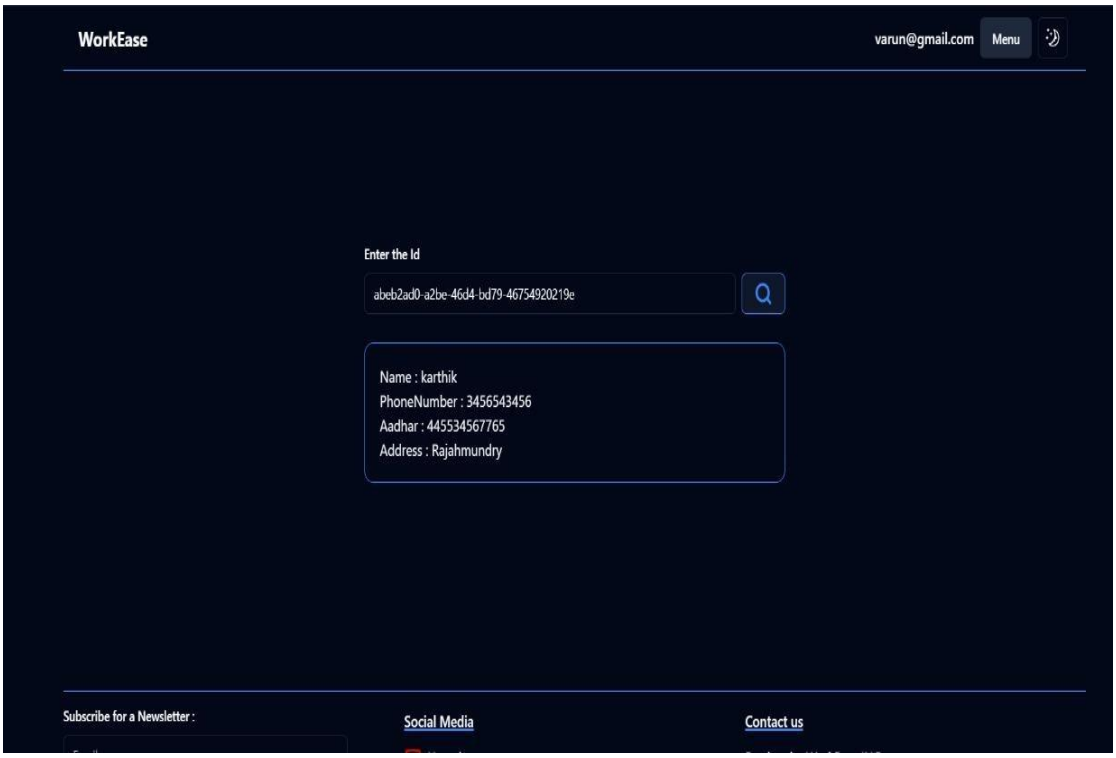


Figure 6.2.h User details page

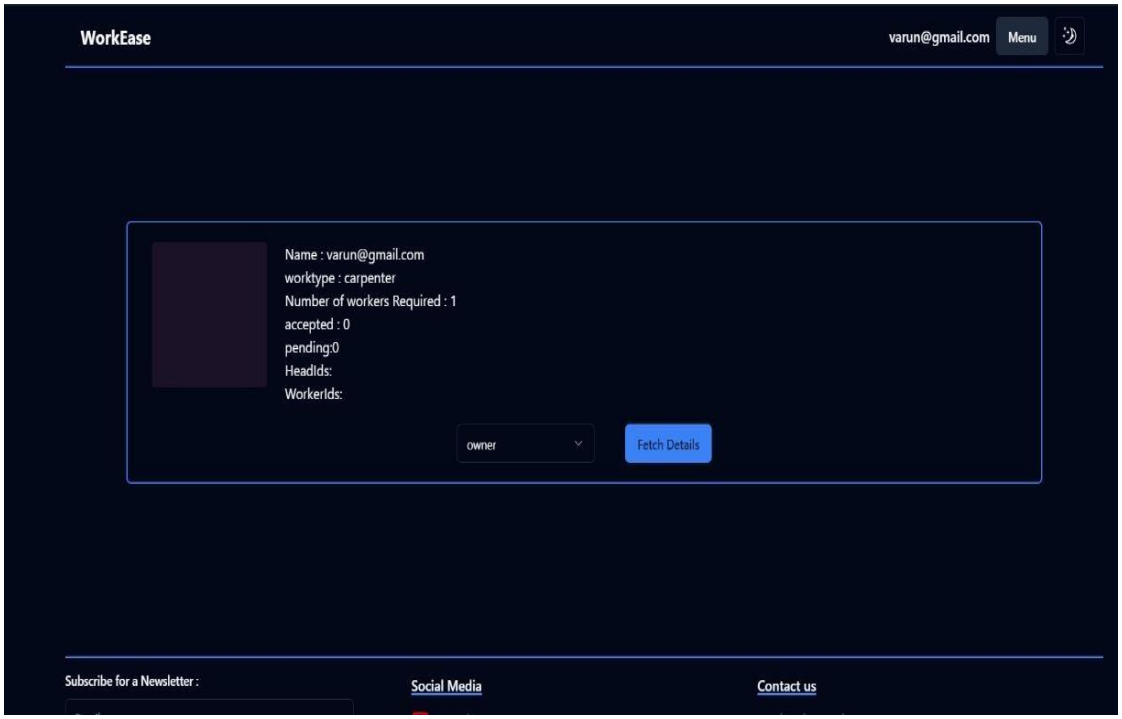


Figure 6.2.i Dashboard page

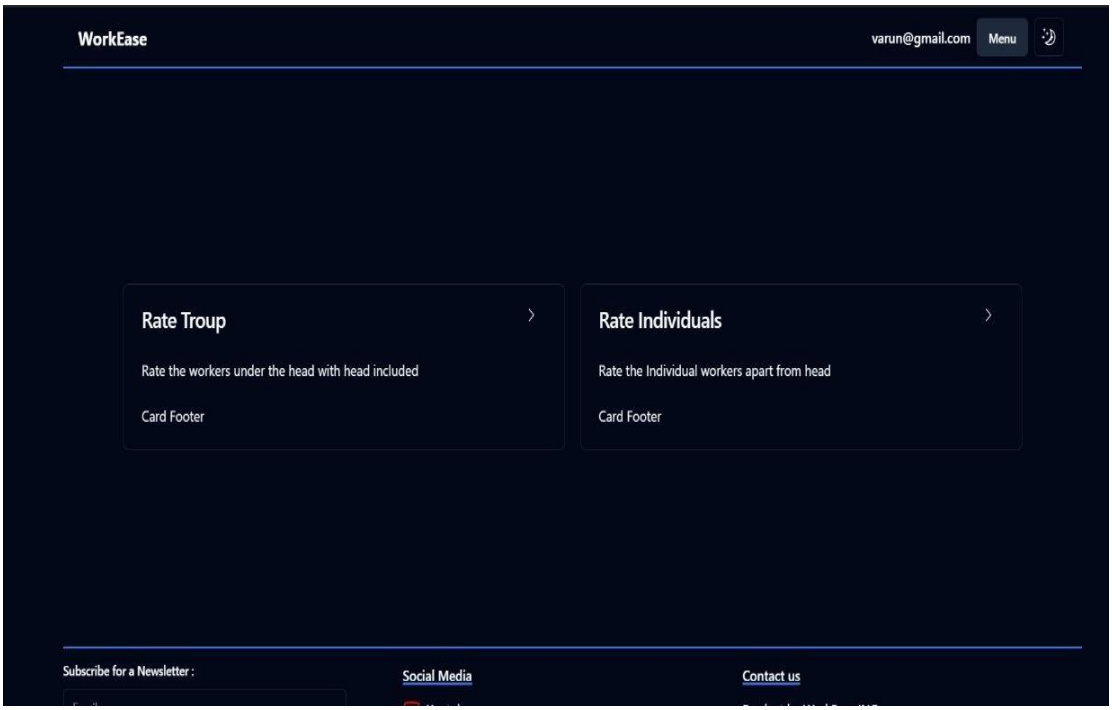


Figure 6.2.j Ratings Page

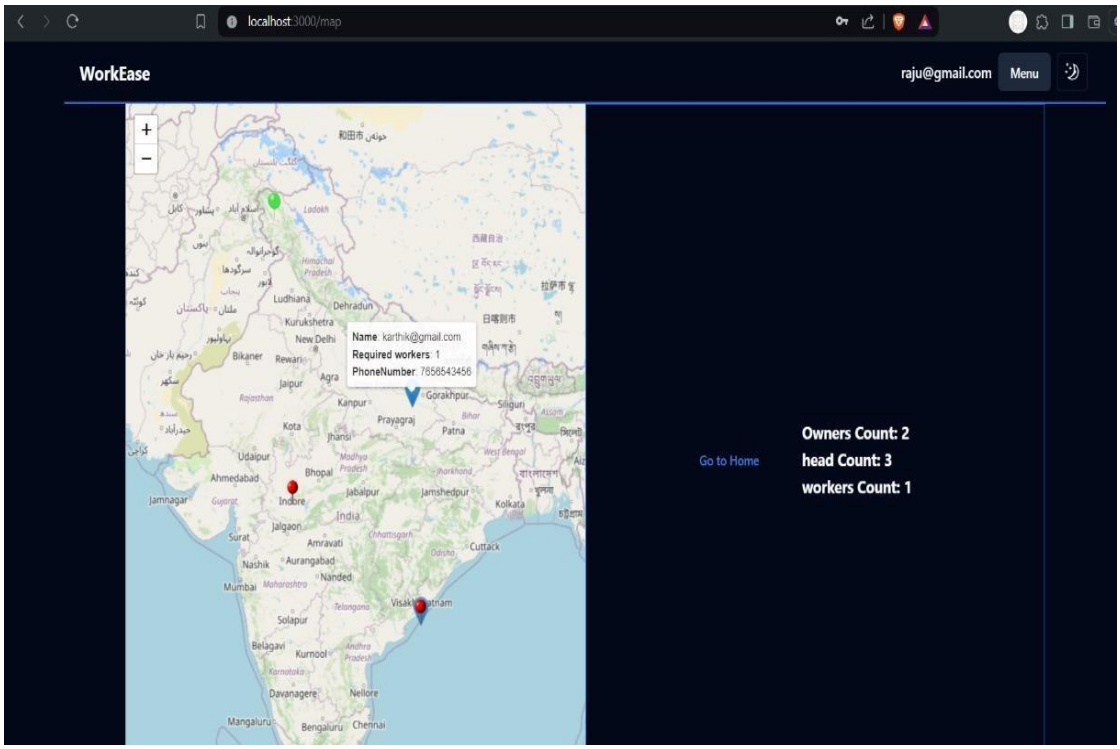


Figure 6.2.k Maps page

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

In conclusion, with its technological strength WorkEase provides an effective solution to India's pressing socio-economic labor market equilibrium solution. WorkEase applies geospatial intelligence and cloud-scalable software architecture and real-time communications standards to enable job matchability for job seekers and posters between industries with emphasis on rural and semi-urban job opportunities.

The system relies on PostGIS and R-tree spatial indexing for executing its location-aware matching algorithm by which it provides correct results prior to closing huge dataset transactions. WorkEase's labor model enables it to manage worker distribution to group heads and solo workers who provide fast responses to emergency assignments along with large-scale job requirements. Supabase authentication and Twilio notifications make the platform more usable and reliable so various user groups such as digitally disadvantaged users can access it easily.

Real-time interface with quick performance and cross-platform operation comes from utilizing the web components React, Leaflet.js and Redis. Digital innovation is a universal development driver that empowers labor and boosts productivity through reduced/unemployment and halting unnecessary labor migration to establish economic stability.

7.2 Future Scope

WorkEase holds immense potential for labor transformation but further research and studies must be performed to enhance its effects and operationality:

AI-Based Predictive Matching facilitates the use of machine learning algorithms such as logistic regression, XGBoost and KNN which predict worker preparedness and task acceptance likelihood so proactive job suggestion systems and smart job-worker matching can be implemented.

Future releases will provide voice interfaces and multi-language support with speech recognition and natural language processing for supporting users with low reading ability and older clients.

Blockchain technology's smart contracts allow secure payments along with transparent contracts that shield wages from middleman control.

The functionality of the app would be enhanced by progressive web app features and offline mode which offers local storage synchronization to work effectively in rural regions with poor internet connectivity.

The integration of government schemes like MGNREGA and Skill India and e-SHRAM with a portal will authenticate workers automatically and monitor their work history for policy-driven employment initiatives that are compliant.

The upcoming WorkEase updates will cover all industries of the economy through the addition of domestic employment and gig economy and logistics and microenterprises and this will make WorkEase a universal pan-sector employment facilitator.

Policy and decision-making beneficial employment planning decisions are made possible when

administrators and policymakers receive real-time dashboards with access to local labour market information.

WorkEase has the ability to grow as a digital job backbone in the country and tackle issues in both the job market and social and economic spheres as well as encouraging equal employment opportunities.

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