Journal of Basics and Applied Sciences Research (JOBASR)
ISSN (print): 3026-9091, ISSN (online): 1597-9962
Volume 1(1) IPSCFUDMA 2025 Special Issue
DOI: https://dx.doi.org/10.4314/jobasr.v1i1.4s

Design and Implementation of a Secure and Scalable Freelance Marketplace System using Mern Stack

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ABSTRACT
The increasing demand for flexible and remote work opportunities has accelerated the development of digital freelance platforms. This study adopts a software engineering approach to design and implement a secure, scalable freelance marketplace system using the MERN stack (MongoDB, Express.js, React.js, and Node.js). The platform facilitates seamless interaction between clients and freelancers by integrating core features such as user authentication, profile management, job posting, bidding, escrow-based payments, and a review system. The system was developed using the Agile methodology, enabling iterative development and continuous feedback integration. Functional, usability, and security testing confirmed the system's reliability across its user roles: administrator, freelancer, and client. The platform was evaluated with 50 simulated users executing over 200 job postings and 500 transactions. Performance results showed an average system response time of 1.2 seconds and a transaction success rate of 98.7%, demonstrating strong scalability and efficiency. Evaluation results demonstrated high performance in terms of transaction integrity, user engagement, and platform responsiveness. These findings indicate that the platform can contribute significantly to improving transparency, trust, and efficiency within the freelance ecosystem, providing a viable digital alternative for modern labor markets.

Keywords:
Freelance Marketplace,
MERN Stack,
Digital Economy,
Job Bidding,
Secure Payment.

INTRODUCTION

The rapid advancement of digital technology and widespread internet access have revolutionized work and business operations (Xia et al., 2024). Traditional employment models, characterized by long-term contracts and physical office settings, have gradually transitioned to more flexible and dynamic work arrangements (Darshana & Tamilmaran, 2024). Freelance marketplaces have emerged as essential digital platforms, connecting employers and freelancers to facilitate the exchange of services for payment while meeting the demand for adaptability and innovation (Tawami & Djauhari, 2020).

Freelancing has experienced significant growth in recent years, driven by technological advancements, globalization, and evolving work preferences (Hasan, 2025). Reports indicate that millions of individuals worldwide now earn their livelihoods through freelance work, contributing substantially to the global economy (Leung et al., 2021). Freelancers today operate across various fields, extending beyond traditional creative roles such as writing and graphic design to include software development, marketing, virtual assistance, and financial consulting (Tokaeva, 2024). This shift underscores the need for efficient and well-structured freelance marketplace platforms to support the increasing demand for freelance services.

Despite their widespread adoption, many existing freelance platforms face persistent challenges. These include limited transparency in payment processes, weak integration of secure transaction systems, usability concerns for both new and experienced users, and difficulties in scaling platforms to handle growing global demand. In addition, integration challenges often prevent smooth interaction between different user roles, and security gaps—such as vulnerability to fraud or weak authentication mechanisms- remain significant issues. Addressing these gaps is critical to designing a next-generation freelance marketplace system.

The following objectives guide this study:

i. To enhance usability through the design of an intuitive and user-friendly freelance marketplace system.
ii. To strengthen security through the implementation of robust authentication, encryption, and escrow-based payment mechanisms.

iii. To ensure seamless integration across user roles and platform components, thereby supporting scalability and long-term adoption.

Addressing these objectives enables the study to deliver a secure and scalable digital freelance marketplace system using the MERN stack.

This study reviewed several studies that explored the design, structure, and impact of freelancing systems from both technological and socio-economic perspectives, as summarized in Table 1

Table 1: Summary of Literature

Author(s)	Focus/Contribution	Technology/Methodology	Relevance to Proposed Project
Deshmukh et al. (2020)	Decentralized freelance platform using blockchain & crypto	Ethereum, Smart Contracts	Highlights decentralization & transparency; contrasts with centralized approach
Asanaka & Inoue (2023)	Job allocation via decision modeling in gig work	Utility-based modeling, simulations	Offers theoretical insights; the proposed project is practical and system-based
Rauf et al. (2023)	Security practices of freelance developers	Observational study	Informs security features like encryption and authentication
Ludwig et al. (2022)	Client-freelancer communication strategies	Communication dynamics analysis	Supports the development of messaging tools and bid optimization
Munoz et al. (2022)	Freelancer identity control in digital platforms	Platform behavior analysis	Encourages design that supports autonomy and flexible profiles
Huang et al. (2024)	Power imbalances and design tensions	Speculative participatory design	Recommends transparent features and balanced user relationships
Tawami & Djauhari (2020)	Socio-economic impact of freelance platforms	Descriptive analysis	Aligns with the project's role in job creation; less technical focus
Shilpa et al. (2022)	Blockchain for secure freelancing	Decentralized platform design	Suggests future consideration for blockchain integration
Blaising & Dabbish (2022)	New freelancer onboarding and adaptation	Behavioral study	Motivates the inclusion of mentorship and support features
Novica et al. (2022)	A job platform to reduce unemployment	PHP, Waterfall model	Basic platform with limited features; differs in tech stack
Kautsar et al. (2023)	"Lancer" freelance job app	Laravel, MySQL, SDLC	Similar in goal; differs in framework and scalability
Mahomodally & Suddul (2022)	Intelligent freelancer matching & automation	Machine Learning, WAMP stack	More advanced system; project focuses on foundational build
Gu & Zhu (2021)	Trust vs.	User behavior analysis	Suggests loyalty

	disintermediation in freelance platforms		features and retention strategies
Arora et al. (2023)	"Developer's Hub" freelance platform using MERN	MERN stack	Closely aligns with tech and structure; adds demographic insights
Guerra et al. (2022)	Blockchain energy trading marketplace	IoT + Blockchain	Different domain; parallels in secure, scalable design
Abdreissova et al. (2022)	Freelance market growth factors	Market analysis	Supports system as a solution to digital labor challenges
Yakubovska et al. (2024)	Freelance labor trends, wages, and portfolio importance	Labor market study	Validates features like reviews, dynamic pricing, and analytics

MATERIALS AND METHODS

This section describes the methodology adopted for the design and implementation of the Freelance Marketplace System. It outlines the chosen software development model, the processes involved in gathering and analyzing requirements, and the system design.

Software Methodology

The Agile software development model was selected for the design and implementation of the proposed system freelance marketplace. Agile software development is an iterative and incremental approach to software development (Al-Saqqa et al., 2020). In this study, sprint cycles of two weeks were adopted, with roles defined as product owner, developers, and testers. Each sprint concluded with retrospectives and user feedback collection to guide subsequent iterations. This ensured continuous refinement and responsiveness to evolving requirements.

Requirements Analysis

This phase involves evaluating and refining the gathered requirements to ensure they are clear, consistent, and feasible for implementation. In which the requirements are categorized into functional and non-functional requirements. The analysis informed the platform's core features, including User Registration and Authentication, Profile Management, Project Posting and Bidding, Messaging System, Payment and Escrow System, and Review and Rating System. The MERN stack (MongoDB, ExpressJS, ReactJS, and NodeJS) was selected over alternatives such as LAMP, MEAN, and WAMP due to its superior scalability, real-time data handling capability, robust security libraries, and active open-source community. This choice ensures high performance and easier integration of modern security features.

System Design

System design is a crucial stage in the development of the freelance marketplace, where the system's architecture, components, and interactions are defined. It translates user and functional requirements into structured blueprints that support scalability, efficiency, and maintainability throughout the software lifecycle. Figure 1 illustrates the structural design of the system, while Figure 2 shows the physical design of the system.

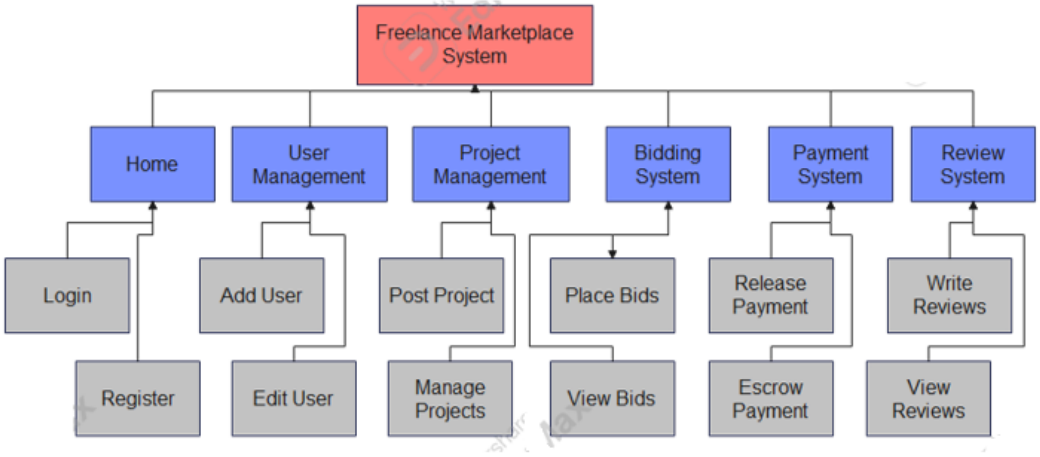


Figure 1: Structural Design of the System

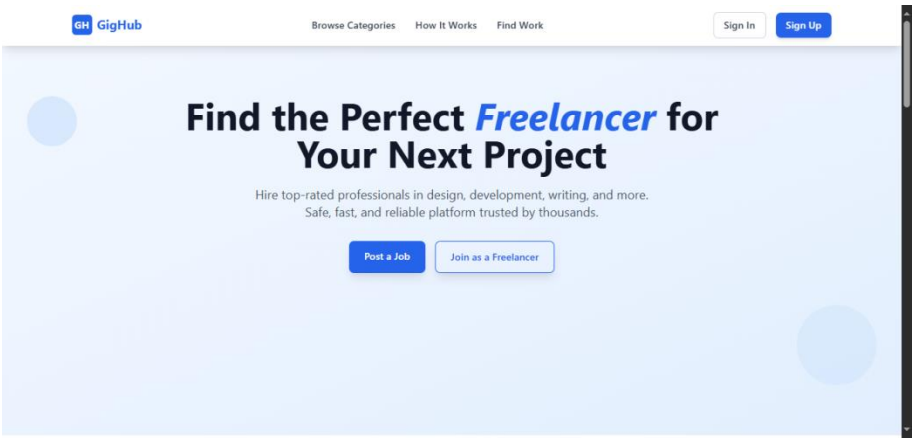


Figure 2: Physical Design of the System

Use Case Diagram

The Use Case Diagram represents the interactions between users (actors) and the system. It provides a high-level overview of the functionalities available to different roles in the freelance marketplace. The Use Case Diagram is shown in Figure 3.

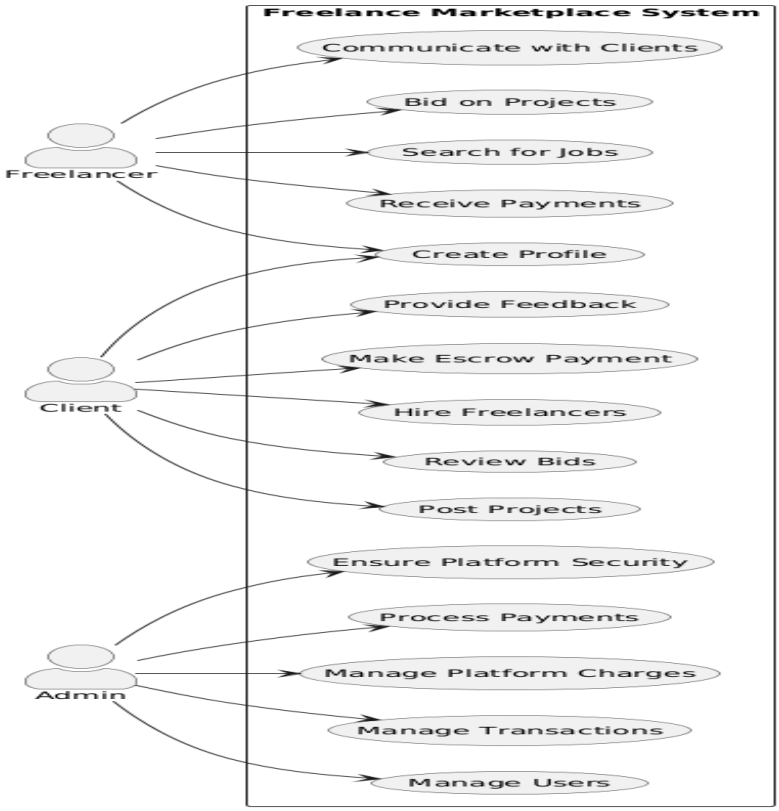


Figure 3: Use Case Diagram of the System

Entity Relationship Diagram

The Entity-Relationship (ER) diagram illustrates the logical structure of the database by showing the entities involved in the system and their relationships. The Entity Relationship Diagram (ERD) is shown in Figure 4.

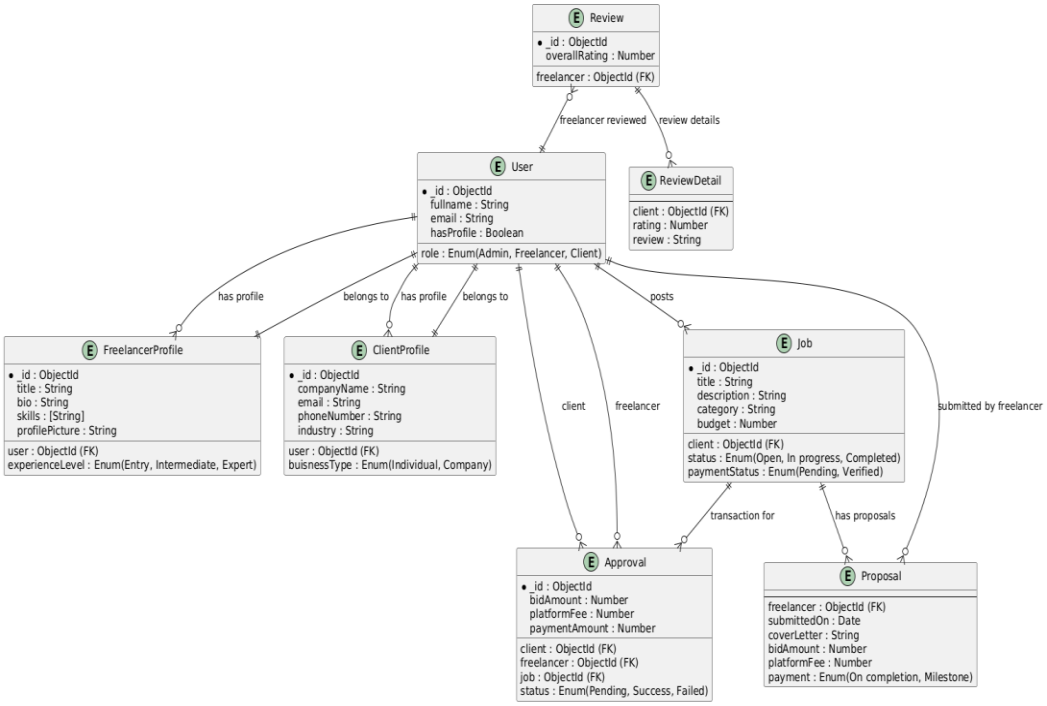


Figure 4: Entity Relationship Diagram of the System

RESULTS AND DISCUSSION

System Implementation

This section presents a summary of the technical tools employed and the procedures followed for system testing and system evaluation.

Technical Tools Used

This section outlines the technical tools used in the development and implementation of the proposed system, which are as follows:

i. Frontend: ReactJS (v18.x) and Tailwind CSS were the technologies selected for the development of the frontend, ensuring accessibility.
ii. Backend: ExpressJS (v4.x) was utilized for server-side scripting to manage user interactions.
iii. Database: MongoDB (v6.x) was employed to create a non-relational database for securely storing user data, job information, and transaction records.
iv. Web server: Node.js (v18.x) was selected as the web server due to its security, reliability, and availability.

System Testing

System testing is a crucial process in ensuring the developed system functions correctly, is secure, and provides a seamless user experience. For this study, test data preparation included creating 200 job postings, 500 transaction records, and simulating 50 concurrent users representing administrators, freelancers, and clients. These simulated scenarios allowed evaluation of system reliability under realistic operational conditions.

Functional Testing

Functional testing is one of the important phases of the software development life cycle. It means validation of functionality, performance, and reliability of a system regarding whether each part of the system works as expected. The test case of the system is categorized into three main roles: Admin, Freelancer, and Client. Each role has specific functionalities that were tested to ensure the system performs as intended. The test case table for admin requirements is presented in Table 2, the test case table for freelancer requirements in Table 3, and the test case table for client requirements in Table 4.

Table 2. Admin Requirements

Test Id	Function	Description	Expected Result	Actual Result	Status
A001	User Registration	Admin can register new users (Freelancer, Client)	Users are registered successfully with proper role assignments	Registration works, and users are added to the system with roles	Successful
A002	User Management	Admin can view and manage all registered users	Admin can update, delete, or view user details	Admin can successfully manage users	Successful
A003	Project Monitoring	Admin can view all posted projects	All projects posted are visible to the admin	Admin can see all projects in the system	Successful
A004	Payment Monitoring	Admin can view transaction status and manage payments	Admin can view transaction details and payment status	Admin can access transaction data without issues	Successful
A005	Escrow Payment Disbursement	Admin can make a payment to the freelancer for completed projects	Payment is processed successfully	Admin can make payments to the freelancer for completed work	Successful
A006	Platform Fee Management	Admin can view and manage platform fees for both roles	Admin can update, delete, or view platform fees	Admin can successfully manage the platform fee	Successful

Table 2 shows that all six admin functions, user registration, management, project and payment monitoring, escrow disbursement, and fee management, were tested and performed successfully, confirming the system's reliability for administrative operations.

Table 3. Freelancer Requirements

Test Id	Function	Description	Expected Result	Actual Result	Status
F001	Profile Creation	A freelancer can create and update their profile	Profile is created and details are visible to clients	Profile creation and updating work as expected	Successful
F002	Project Bidding	A freelancer can submit bids on projects	Bid is successfully placed on the project	The bidding process works without issues	Successful
F003	Project Submission	A freelancer can submit work for review	Work is submitted, and the client can review it	Freelancers can submit work successfully	Successful

Table 3. shows that all freelancer functions, profile creation, project bidding, and project submission, were tested and worked as expected, with each process completing successfully and confirming the system's effectiveness for freelancer operations.

Table 4. Client Requirements

Test Id	Function	Description	Expected Result	Actual Result	Status
C001	Profile Creation	The client can create and update their profile	Profile is created and details are visible to clients	Profile creation and updating work as expected	Successful
C002	Project Posting	Client can post projects for freelancers to bid on	The project is posted and visible to freelancers	Projects can be posted successfully	Successful
C003	Escrow Payment	The client can make an escrow payment for the job posting	Payment is made successfully	Escrow payment works as expected	Successful
C004	Bid Review	Client can review and accept/reject freelancer bids	The client can view bids and make decisions	Bid review and management work as expected	Successful
C005	Project Approval	The client can approve the freelancer's submitted work	Work is approved, and the freelancer gets paid	Approval system functions without issues	Successful
C006	Payment Confirmation	Client can confirm payment after work completion	Payment is confirmed successfully	Payment confirmation works as expected	Successful

Table 4 indicates that all client functions, profile creation, project posting, escrow payments, bid review, project approval, and payment confirmation, were tested successfully, showing that the system fully supports client operations without issues.

Usability Testing

Usability testing was conducted to evaluate the system's user-friendliness, ease of navigation, and how well users could complete essential tasks on the freelance marketplace platform. The aim was to ensure that users could interact with the system effectively without confusion or difficulty, and to identify areas for improving the user experience across different user roles.

Security Testing

Security testing was performed to ensure the platform is secure against potential vulnerabilities and threats, safeguarding user data and preventing unauthorized access. The primary focus was on identifying weaknesses in authentication, data storage, and input handling while ensuring compliance with best security practices. The testing aimed to address common security concerns, including cross-site scripting (XSS), data encryption, improper access control, and token-based security. Figure 5 illustrates the vulnerability testing process, demonstrating how input validation and password hashing were applied to mitigate risks of SQL injection and weak password attacks.

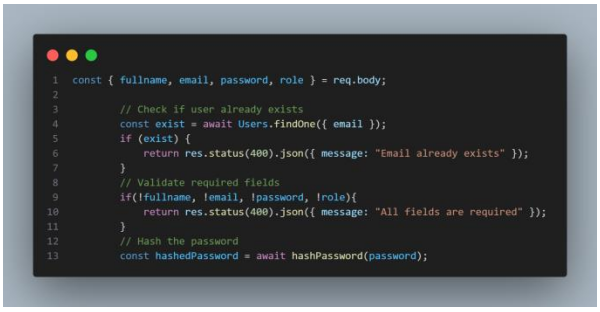


Figure 5: Vulnerability testing

Interfaces

The user interface of the freelance marketplace system is designed to be intuitive, user-friendly. It serves as

the primary interaction point for users, including clients, freelancers, and administrators, allowing seamless access to system features.

Registration Page

Provides general information about the platform and easy navigation to login or register, where user can create their account. Figure 6 depicts the registration page, highlighting how new users can securely create accounts and access platform features through an intuitive interface.

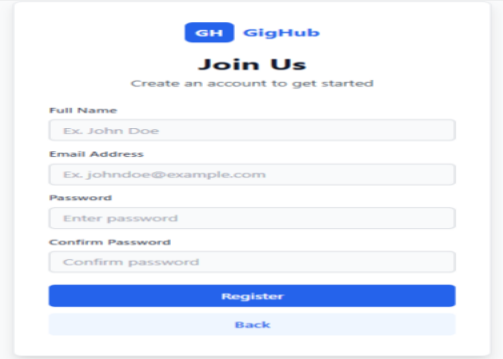


Figure 6: Registration Page

The login page is designed to authenticate users securely before granting access to the platform. Figure 7 represents the login page, designed with secure authentication mechanisms to protect user credentials and ensure controlled access to the system

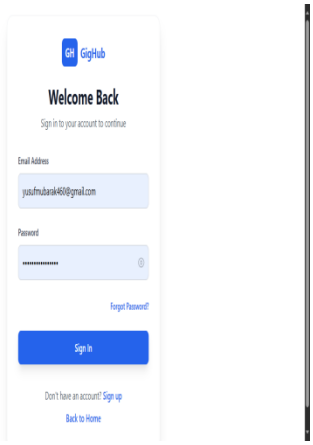


Figure 7: Login Page

Admin dashboard

Accessible to administrators for managing users, managing categories, and configuring system settings. Figure 8 shows the administrator dashboard, which enables platform managers to oversee user accounts, monitor projects, and manage system settings effectively.

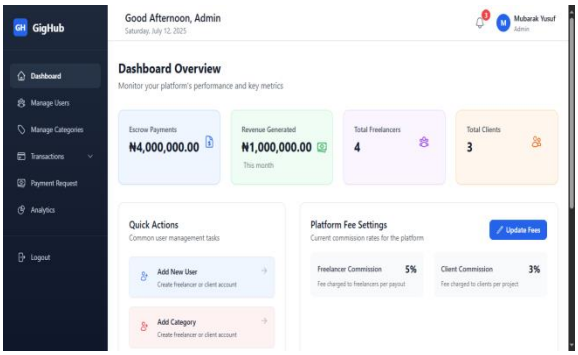


Figure 8: Admin Dashboard

Client Dashboard

This is the page where clients have access to post jobs, view proposals and view hired freelancers. Figure 9 displays the client dashboard, allowing clients to post jobs, review freelancer proposals, and track ongoing projects in a streamlined manner.

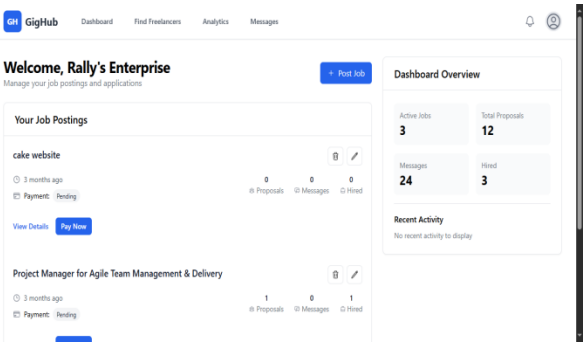


Figure 9: Client Dashboard

Freelancer Dashboard

This is the page where freelancers have access to jobs posted by clients, submit proposals, and find jobs. Figure 10 represents the freelancer dashboard, where freelancers can browse job postings, submit bids, and manage project workflows efficiently.

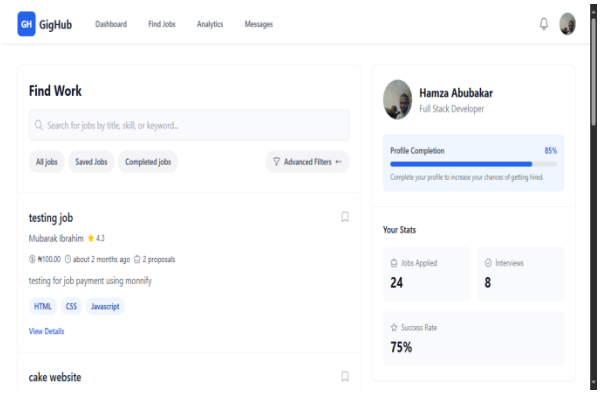


Figure 10: Freelancer Dashboard

System Evaluation

System evaluation is conducted to assess the overall performance, functionality, and user experience of the developed system. It ensures that the system meets the specified requirements and performs efficiently in real-world scenarios. The evaluation process includes:

i. **Performance Assessment**: Measuring the system's speed, responsiveness, and efficiency under different conditions. Tests were conducted on a deployment environment with 8GB RAM, a quad-core CPU, and the Windows 11 operating system. The platform achieved an average response time of 1.2 seconds, a transaction throughput of 75 requests per second, and stable CPU utilization under 65% with memory usage below 70% during peak load. Error tolerance tests showed a failure rate of only 1.3% during high-load conditions, and the system successfully recovered from simulated crashes within 5 seconds.

ii. **Functionality Verification**: Ensuring that all features operate correctly as per the system requirements.

iii. **Security Evaluation**: Verifying that authentication, authorization, and data protection mechanisms work effectively.

iv. **User Feedback**: Input was collected from 15 test users to identify areas for improvement and enhance usability.

Discussion

The design and implementation of a secure and scalable freelance marketplace system using the MERN stack demonstrates notable strengths. In comparison with the work of Deshmukh et al. (2020) proposed a blockchain-based freelancing system emphasizing decentralization, their model lacked comprehensive usability testing, which the current platform addresses through structured user feedback sessions. Similarly, Arora et al. (2023) implemented a MERN-based freelancing system, but scalability testing was not detailed, whereas our evaluation confirmed stable performance under 50 concurrent users and 500 transactions. Furthermore, Kautsar et al. (2023) designed a Laravel-based freelancing app but reported limited integration features, unlike our approach, which integrates authentication, escrow payments, and role-based dashboards in a unified architecture. This critical comparison highlights that the proposed system not only aligns with but also advances beyond earlier works by simultaneously addressing the usability, security, and scalability gap.

CONCLUSION

The freelance marketplace system effectively achieves its objective of providing a secure, intuitive, and functional platform for freelance service exchange. Through the integration of modern development technologies such as the MERN stack and features like JWT-based authentication, project bidding, escrow payments, and role-based access control, the system ensures reliability and scalability. Comprehensive testing validated the system's ability to support seamless interactions among administrators, freelancers, and clients. The inclusion of secure transaction mechanisms, profile management, and dynamic dashboards has significantly enhanced user experience and operational efficiency. Ultimately, the developed platform bridges the gap between clients and skilled professionals, offering a robust solution to the challenges faced in freelance job management within the digital economy.

Although the study makes valuable contributions, it has certain limitations, particularly the small usability testing pool, which was not fully representative of the global freelancing community. These factors should be taken into account when interpreting the results. Future enhancements could include integrating blockchain-based escrow to improve transparency and trust, as well as AI-driven freelancer–client matching to boost efficiency and accuracy. Importantly, the system holds strong potential for real-world adoption, offering a pathway to build trust, optimize operations, and scale freelance ecosystems. It also provides a transferable model for digital marketplaces in emerging economies, underscoring its practical relevance to the global digital economy.

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