

Intelligent Construction Assistance System

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Abstract—The construction and interior planning industry faces several challenges in project coordination, resource allocation, and customer engagement due to a lack of digital integration and real-time management tools. Our proposed project aims to address these problems by developing a smart, AI powered platform that combines construction site management with interior planning and visualization features. For construction site managers, the system will offer modules for land registration, approval workflows, worker and engineer registrations, inventory management, labour allocation, and project progress tracking. Key features include automated alerts for low stock, assignment and transfer of labourers based on skill, and predictive analytics using machine learning to estimate project timelines based on input factors such as available workers, materials, site area, and equipment. Additionally, it incorporates outsourcing modules and customer registration to facilitate streamlined communication and resource sharing between stakeholders. On the interior planning front, the system will include an AI-based visualization tool (Interior Module) that considers room size, type, lighting conditions, customer preferences, and budget to generate optimal design suggestions. Other features include daily call site reports, loan and EMI tracking, appointment scheduling for admin interaction, and customer feedback collection. By integrating predictive intelligence, automated data handling, and real-time reporting, this solution not only reduces manual errors and delays but also improves customer satisfaction and decision-making for managers. Overall, the proposed application provides a comprehensive digital transformation platform tailored to modern construction and interior design workflows, ensuring transparency, efficiency,

and scalability in the industry.

Keywords— *Artificial Intelligence, Machine Learning, Project Scheduling, Labour Allocation, Inventory Management, Interior Design, Predictive Analytics, Resource Optimization, Decision Support System, Real-Time Monitoring, Automated Alerts, Customer Interaction, Project Tracking*

I. INTRODUCTION

Our project titled “Intelligent Construction Assistance System” is a complete digital solution designed to handle all aspects of construction site operations. It includes modules such as land registration and approval, worker/labour and engineer registration, outsourcing of workers, construction project tracking, inventory and material management, and AI-based prediction systems. It also offers a smart interior design planner, daily reporting, EMI and loan tracking, customer appointment handling, and yearly financial analysis. This system connects all key roles like Admin, Landowner, Civil Engineer, Workers, and Customers to ensure smooth communication and project execution from start to finish. Construction projects often face challenges such as labour shortages, material mismanagement, delayed approvals, and lack of proper reporting. As students with a passion for solving real-life problems using technology, we identified the construction industry as a space needing smarter digital solutions. Our motivation came from observing how manual processes create confusion and delays on real construction sites. By choosing this topic, we aim to bring automation, transparency, and AI-powered decision-making into construction site management, ultimately reducing cost, saving time, and improving safety and quality. There are some applications in the market for construction tracking and interior design (like Co-Construct, Buildertrend, or

SketchUp), but they often focus on limited features such as task tracking or designing only. Our system is multi-functional and integrated, combining land and labour registration, real-time inventory alerts, inter-company labour outsourcing, AI-driven material and labour predictions, and daily reporting — all in one platform.

Unlike other tools, we provide a centralized system that supports both field workers and decision-makers with user friendly dashboards, real-time updates, and intelligent suggestions, making our solution more practical, affordable, and impactful.

II. LITERATURE REVIEW

Research on intelligent construction systems primarily spans three major dimensions: **resource optimization, AI-driven decision-making, and workflow integration**. Early studies focused on improving specific construction activities, while recent work explores the integration of advanced technologies such as Artificial Intelligence (AI), cloud computing, and machine learning.

H. Lu et al. (2018) proposed a simulation-based optimization approach using discrete-event simulation combined with genetic algorithms to enhance material allocation and reduce project costs. Their work demonstrated that optimization techniques can significantly improve efficiency in construction planning. However, the study was limited to material management and did not address other critical aspects such as scheduling, stakeholder interaction, or design integration.

With the advancement of intelligent technologies, Changhao Wang (2023) explored the application of AI, cloud computing, and big data in smart construction environments. The study highlighted improvements in real-time monitoring, project scheduling, and resource utilization. Despite these advancements, the system primarily focused on site-level operations and lacked integration with customer-facing services and interior design modules, which are essential for a comprehensive construction solution. Further extending the role of AI, Abdul Raheman Mohammed (2024) applied machine learning and computer vision techniques for predictive scheduling and construction monitoring.

His findings indicated that AI-driven prediction models can reduce delays and improve workflow efficiency. However, similar to earlier approaches, the system addressed only specific components of construction management and did not provide a unified platform that combines planning, execution, and visualization.

Overall, the existing literature reveals that while significant progress has been made in applying advanced technologies to construction management, most solutions remain **fragmented and domain-specific**.

There is a lack of integrated systems that combine **resource management, predictive analytics, customer interaction, and design visualization** into a single platform.

The proposed **Intelligent Construction Assistance System** addresses this research gap by offering a unified solution that integrates construction planning, AI-based prediction, and design assistance.

By combining these features, the system aims to improve overall efficiency, enhance decision-making, and provide a more holistic approach to modern construction management.

TABLE I
 TECHNOLOGY STACK USED IN THE PROPOSED SYSTEM

Layer	Technology And Propose
Frontend	HTML, CSS, Javascript
Backend	Java, SpringBoot for RESTful API services
Database	MySQL for scalable and flexible data
AI/ML	Python, TensorFlow, Pandas for prediction and data analysis
Communication	Twilio API for automated SMS Notification
Payment-Integration	Razorpay for payment-Integration
Security	JWT for secure user authentication and authorization

III. PROBLEM STATEMENT

The construction industry faces several operational challenges due to inefficient management systems and lack of intelligent decision-making tools. One of the major problems is manual data handling, where project details, labour records, and material information are stored in separate files or systems. This leads to data inconsistency, duplication, and difficulty in tracking project progress. Manual processes also increase the chances of human errors, resulting in delays and poor project management.

Project planning and execution is another critical challenge. Traditional methods involve manual scheduling and resource allocation, which are time-consuming and often inaccurate. Without proper planning tools, construction projects may face delays due to poor labour management, material shortages, or improper coordination among stakeholders. This directly affects project timelines, cost efficiency, and overall productivity.

Another problem is the lack of predictive analytics in traditional systems. Most systems store financial data but do not analyze it to identify patterns or trends. Without predictive analysis, institutions cannot forecast loan defaults, customer repayment behavior, or financial risks. This limits their ability to make informed decisions.

In addition, many institutions do not have integrated systems for employee management, EMI calculation, investment planning, and audit reporting. These tasks are Existing construction systems lack predictive analytics, making it difficult to estimate project timelines and manage resources efficiently. Interior design tools also have poor visualization, causing confusion for clients. Additionally, using separate tools for construction, labour, inventory, and finance increases complexity.

The proposed Intelligent Construction Assistance System solves these issues by providing a unified platform with better prediction, visualization, and efficient management

IV. PROPOSED SYSTEM OVERVIEW

The **Intelligent Construction Assistance System** is a role-based, AI-enabled web platform accessible through modern browsers. The system is designed to streamline construction management by integrating planning, monitoring, and design

support into a unified environment. It recognises four primary actor classes: **Customers (clients who request and track construction projects)**, **Admins (system controllers responsible for overall management and data integrity)**, **Managers (project supervisors who handle planning, scheduling, and resource allocation)**, and **Labour (workers responsible for executing on-site tasks)**.

Customers authenticate through a secure login system and can provide project requirements such as budget, location, and design preferences. They can track project progress, view updates, and interact with the system for design visualization and cost estimation. Admins manage user roles, monitor system activities, and maintain data consistency and security across the platform. Managers access a dedicated dashboard to plan projects, assign tasks, monitor timelines, and optimize resource usage. Labour users are provided with task-specific access, enabling them to view assigned work, update task status, and communicate progress in real time.

The system includes an AI-powered assistant that supports intelligent decision-making by providing recommendations for scheduling, cost optimization, and design selection. Core functionalities include **project planning and scheduling, resource allocation, cost estimation, AI-based delay prediction, and real-time progress tracking**. Additionally, the platform supports **design visualization**, allowing customers to preview construction layouts before execution.

The admin and manager dashboards provide features such as **task management, resource tracking, analytics dashboards, and report generation**, along with a complete audit trail to ensure transparency and accountability. By integrating all stakeholders and functionalities into a single platform, the Intelligent Construction Assistance System improves efficiency, enhances communication, and supports better decision-making throughout the construction lifecycle.

V. SYSTEM ARCHITECTURE

The diagram represents a **Layered Architecture of the Intelligent Construction Assistance System**, designed to ensure scalability, modularity, and efficient communication between different components. It is divided into four main layers: Users, Presentation Layer, Application Layer, Data Layer, and External Services.

1. Users Layer

This is the topmost layer consisting of three types of users:

- Manager – Handles project planning, labour allocation, and monitoring
- Admin – Manages users, approvals, finance, and system control
- Customer – Views projects, books appointments, and tracks progress

Each user interacts with the system based on their role.

2. Presentation Layer (React.js)

This layer represents the frontend UI, built using React.js.

- Manager Dashboard
 - Project overview, labour allocation, inventory, reports, predictions
- Admin Dashboard
 - User & role management, approvals, inventory, finance, analytics
- Customer Dashboard
 - View designs, appointments, offers, feedback, notifications

This layer is responsible for user interaction and displaying data.

3. Application Layer (Spring Boot – REST API)

This is the backend logic layer where all processing happens.

Authentication Middleware

- Uses Firebase Authentication + JWT
- Validates user identity and assigns roles (Manager, Admin, Customer)

Controllers (Core Modules)

Each controller handles a specific functionality:

- AuthController → Login, logout, token generation
- UserController → User & role management
- ProjectController → Project creation & tracking

- LabourController → Labour allocation & transfer
- InventoryController → Stock management & alerts
- AppointmentController → Scheduling meetings
- FinanceController → Loans, EMI, offers
- FeedbackController → Reviews & ratings
- PredictionController → Project completion prediction
- InteriorController → AI-based interior planning
- LandController → Property registration & approvals

This layer acts as a bridge between frontend and database.

4. Data Layer

This layer stores all system data using Firebase databases:

- Users DB
- Projects DB
- Inventory DB
- Appointments DB
- Finance & Offers DB
- Land & Property DB
- Feedback DB

Machine Learning Microservice (Python Flask)

- Uses **Linear Regression** to predict project completion time
- Provides a Priority API for smart decision-making

This layer ensures data storage and intelligent analysis.

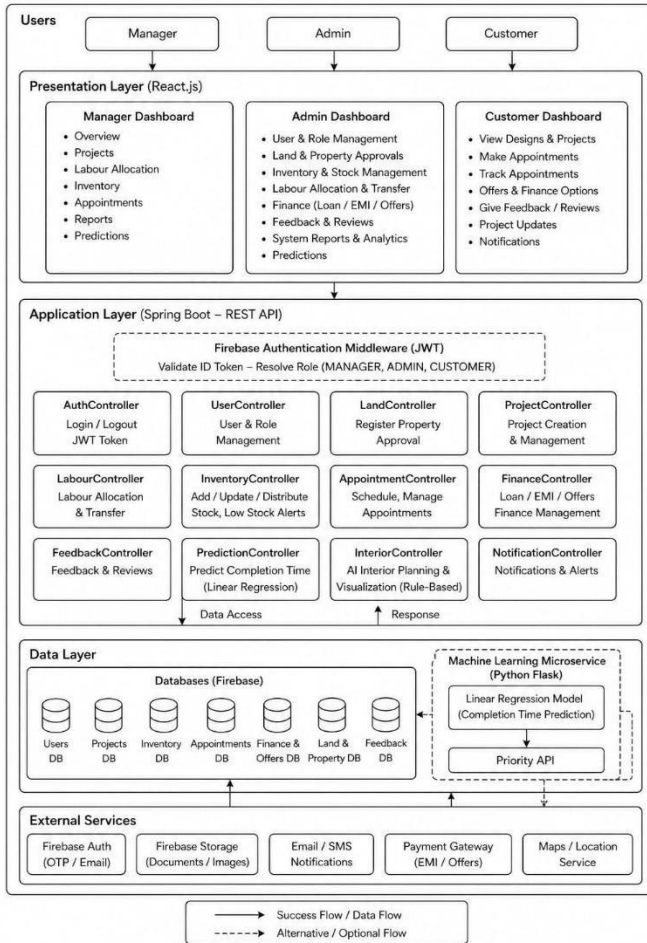


Fig. 1. Layered System Architecture of AI-Driven Construction Assistance Platform with Manager, Admin & Customer Dashboards (Linear Regression for Project Completion Prediction)

Fig. 1. Layered System Architecture of Intelligent Construction Assistance System

5. External Services

The system integrates with external tools:

- **Auth** → Login (OTP/Email)
- **Storage** → Store images/documents
- **SMS** → Notifications
- **Payment Gateway** → EMI & payments
- **Maps API** → Location services

6. Data Flow

- **Solid arrows** → Normal data flow (request & response)
- **Dotted arrows** → Optional/alternative flow (ML predictions, external APIs)

This layered architecture separates concerns into different modules, making the system **scalable, secure, and easy to maintain**. It integrates **AI, cloud services, and real-time processing** to improve construction management efficiency.

VI. METHODOLOGY

A. Data Flow Diagram

The **Level-0 DFD** shows the system as one process interacting with **Customers, Admins, Managers, and Labour**, generating outputs like updates, approvals, and notifications.

The **Level-1 DFD** divides it into modules such as **Project, Labour, Inventory, Finance, and Prediction**, connected to databases and external services.

3. Data Flow diagrams

i. DFD Level 0 :

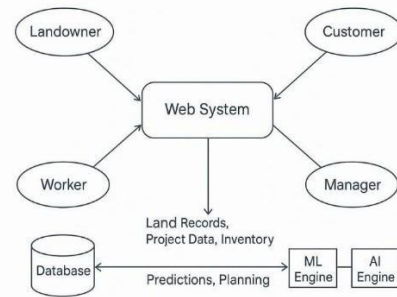


Fig. 2. DFD Level-0

DFD Level 1 – AI-Driven Construction Management Platform (Manager, Admin & Customer Dashboards)

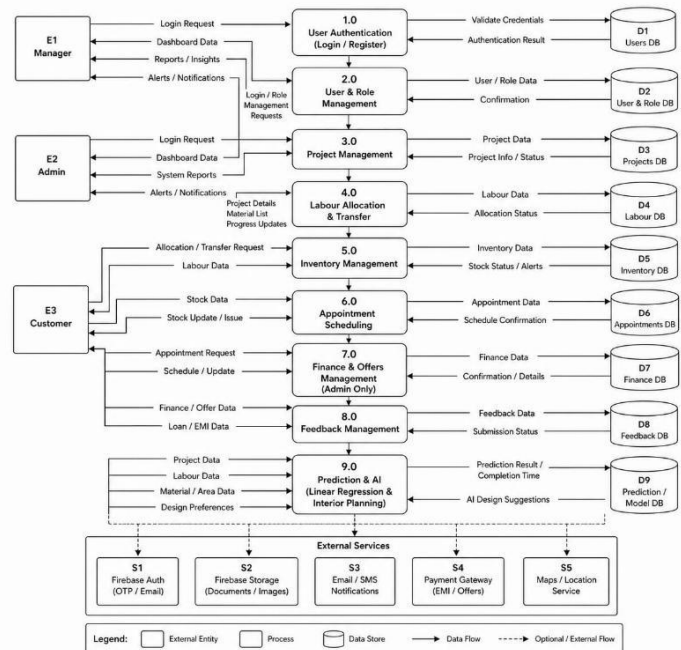


Figure 3. DFD Level-1

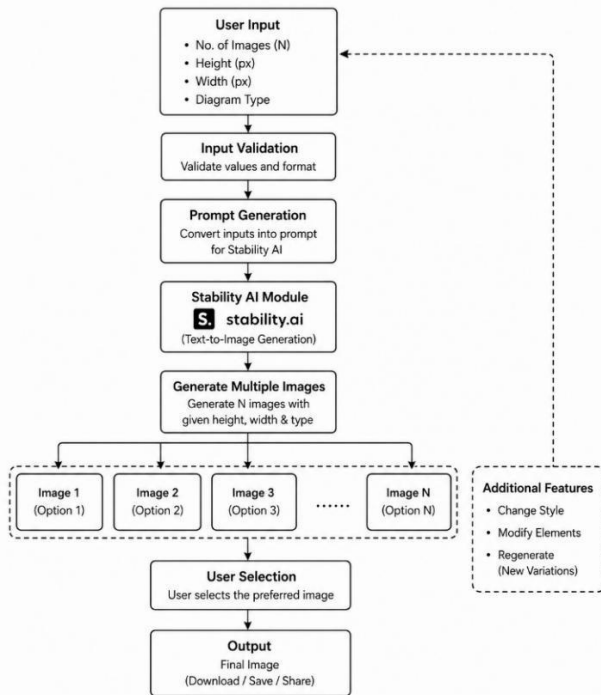


Figure 4. Interior Design

The diagram represents the workflow of an **AI-based interior design generation module** using Stability AI.

1. User Input

The process starts when the user provides inputs such as:

- Number of images to generate
- Height and width of the image
- Diagram type (general design preference)

2. Input Validation

The system checks whether the entered values are correct and in proper format.

3. Prompt Generation

The validated inputs are converted into a detailed **text prompt**, which is required by the AI model.

4. Stability AI Module

The prompt is sent to the Stability AI model, which performs **text-to-image generation**.

5. Generate Multiple Images

The system generates multiple design images based on user input (N images with given size).

6. Image Options

Several design options (Image 1, Image 2, ... Image N) are displayed to the user.

7. User Selection

The user selects the most suitable design from the generated options.

8. Output

The final selected image is provided, which can be downloaded, saved, or shared.

VII. IMPLEMENTATION DETAILS

1. Frontend Architecture

The frontend of the system is developed using Thymeleaf as the server-side templating engine, along with HTML, CSS, and JavaScript for designing user interfaces. The application follows a structured UI approach where separate dashboards are provided for Admin, Manager, and Customer roles.

Communication between frontend and backend is handled using REST APIs via the Fetch API, enabling smooth data exchange and dynamic content rendering.

2. Public Chatbot

A public chatbot feature is integrated into the system specifically for Customer users. The chatbot assists users in resolving queries related to services, projects, and general platform information. It is implemented using rule-based logic for predefined responses and can be extended in the future using AI-based APIs for more intelligent interactions.

3. Backend Modules

The backend of the system is implemented using Spring Boot, following a RESTful architecture. The application is modularized into different functional components to ensure scalability and maintainability.

Main Backend Modules:

Authentication Module: Handles login and registration using secure mechanisms

User & Role Management: Manages Admin, Manager, and Customer roles

Project Management: Handles project creation, updates, and progress tracking

Labour Allocation Module: Assigns and manages labour across projects

Inventory Management: Maintains stock details and alerts for low inventory

Appointment Scheduling Module: Manages booking and scheduling of appointments

Finance & Feedback Module: Handles loan/EMI options and collects user feedback (Admin controlled)

AI Modules: Linear Regression for project

completion prediction Stability AI integration for Interior Image Generation.

VIII. Results

A. Homepage

The above screenshot shows the **home page of the Smart Construction System**. This interface provides an overview of the system and its main functionalities related to construction management and interior planning. It acts as the entry point for users to access different modules such as project management, labour allocation, inventory management, and customer interaction.

The design is clean, simple, and user-friendly, allowing users to easily navigate through different features of the system. It highlights the concept of smart and efficient construction by integrating modern technologies into a single platform.

This module ensures easy access to system functionalities and improves user experience by providing a well-organized and interactive interface.

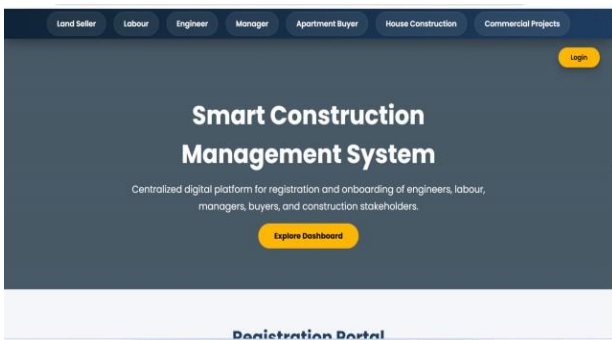


Fig. 1: Homepage

B. Admin-Panel

The above screenshot shows the **Admin Panel of the Smart Construction Management System**. This module allows the administrator to manage and monitor all activities within the system from a centralized interface. It provides access to various categories such as engineers, managers, labourers, land sellers, and apartment buyers, enabling efficient user management.

The admin can view and control construction-related operations such as land and house builders, own land construction, and project details. It also

includes features like adding apartments, handling site visit requests, managing bookings, and viewing all projects. Additionally, the finance/loan module and feedback module help in managing financial services and user feedback.



Fig.2: Adminpanel

C. Unassigned-Workers

The above screenshot shows the **Unassigned Workers module in the Admin Panel of the Smart Construction Management System**. This module allows the administrator to view workers and engineers who are currently not assigned to any project. It helps in identifying available resources for efficient allocation.

The interface is divided into two sections: **Unassigned Engineers** and **Unassigned Labours**. Each section displays important details such as name, experience, and expertise or skills of the workers. This information helps the admin to assign the right person to the right project based on their qualifications and experience.

The design is simple and well-structured, making it easy to view and manage available workforce. This module plays an important role in improving resource utilization and ensuring proper workforce management within the system.

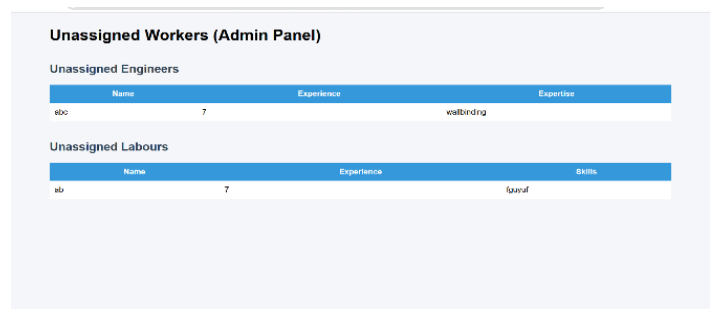


Fig 3: Unassigned-Workers

D. List of Manager

The above screenshot shows the **Managers Module in the Admin Panel of the Smart Construction Management System**. This module allows the administrator to view and manage the list of registered managers in the system. It displays detailed information such as serial number, name, email, mobile number, experience, previous project, and expected salary.

The admin can perform important actions like **approving, allocating, or rejecting** managers based on project requirements. Approved managers are marked accordingly, while others can be assigned to projects using the allocate option.

The interface is structured in a tabular format, making it easy to read and manage records efficiently. This module helps in selecting suitable managers for projects, improving resource allocation and overall project management.



Serial Number	Name	Email	Mobile Number	Experience	Previous Project	Expected Salary	Actions
1	abod	abod@gmail.com	9511269323	2	construction	7854.0	Approve Reject
2	Sanika Patil	sankap60@gmail.com	9511269323	7	construction	250000.0	Allocate Approve Reject
3	Namrata	ny5445@gmail.com	9511269323	7	construction	785200.0	Approve Reject
4	Shweta	sr@gmail.com	9511269323	2	construction	74000.0	Allocate Approve Reject

Fig 4: List of Manager

E. Interior module

The above screenshot shows the **Interior Design AI Image Generator module**. It allows users to enter a design prompt (e.g., “Kitchen”) and select the number of images to generate.

After clicking the **Generate** button, the system creates multiple interior design variations based on the input. The generated images section displays different kitchen styles with varied layouts, colors, and lighting.

This user-friendly interface helps users quickly explore design ideas and choose suitable interior concepts.

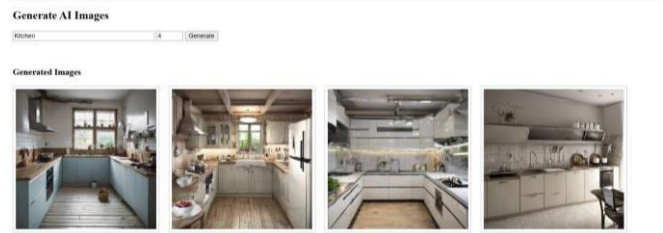
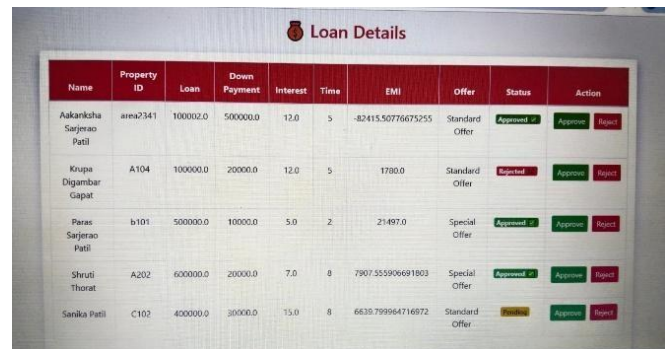


Fig 5: Interior Module

f. Loan Details

The **Loan Module** in the *Smart Construction Management System* provides financial support options to customers for construction and interior design projects. This module allows users to apply for loans or EMI-based payment plans based on their budget and requirements.



Name	Property ID	Loan	Down Payment	Interest	Time	EMI	Offer	Status	Action
Aakanksha Sarjeraso Patil	area2341	100000.0	500000.0	12.0	5	82415.50776675255	Standard Offer	Approved	Approve Reject
Krupa Digambar Gapat	A104	100000.0	20000.0	12.0	5	1700.0	Standard Offer	Rejected	Approve Reject
Paras Sarjeraso Patil	b101	500000.0	100000.0	5.0	2	21497.0	Special Offer	Approved	Approve Reject
Shruti Thorat	A202	600000.0	200000.0	7.0	8	7907.555906691803	Special Offer	Approved	Approve Reject
Sanika Patil	C102	400000.0	300000.0	15.0	8	6639.799964716972	Standard Offer	Rejected	Approve Reject

Fig 6: Loan Module

G. Phases For project management

The proposed **Project Phase Management Module** provides an efficient way to organize and monitor different stages of a construction project. It enables managers to define phases with timelines, budgets, and track progress in a structured manner.

By integrating cost tracking features such as material, expense, and total cost, the system helps in maintaining financial control and avoiding budget overruns. The centralized platform improves coordination, reduces manual effort, and enhances transparency.

Overall, the module simplifies project phase management and contributes to better planning, resource utilization, and timely project completion.

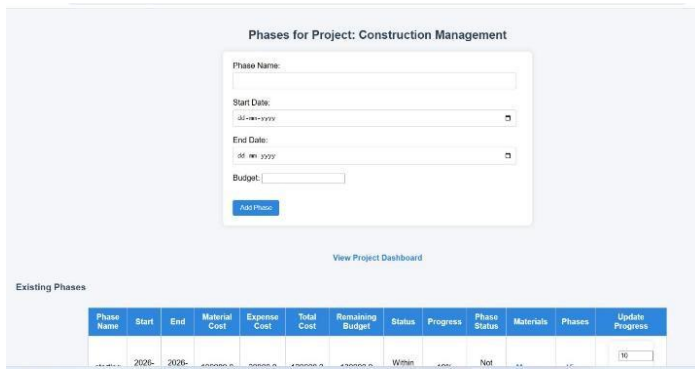


Fig 7: Phases for project management

H. Worker and Engineer Assignment Module

The proposed **Worker and Engineer Assignment Module** provides an efficient solution for allocating human resources in construction projects. It enables managers to assign engineers and labourers to specific project phases based on their experience, expertise, and skills.

By incorporating features such as salary input and phase selection, the system ensures proper workforce planning and cost management. The module also prevents duplicate assignments by indicating already assigned engineers, thereby maintaining data consistency.

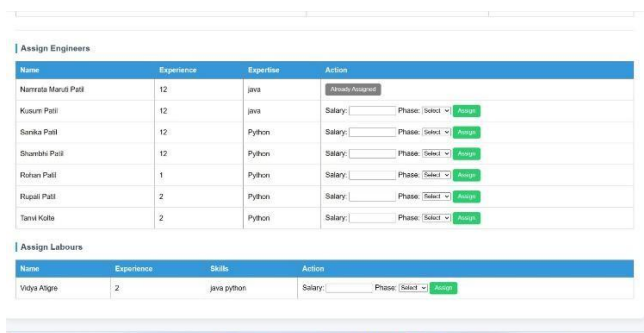


Fig 8: Worker and Engineer Assignment Module

I. Company-Requests

This screen displays the **Registered Company Requirements** in the system. It shows a list of companies that need labour and engineers for projects. Each record includes details like company name, required labour, and engineers. The **Status** column indicates whether the requirement is pending or completed. If the requirement is not fulfilled, it shows **Pending**. Once resources are assigned, the status changes to **Completed**.



Fig.9: Company Requests

This screen displays the Registered Company Requirements in the system.

It shows a list of companies that need labour and engineers for projects.

Each record includes details like company name, required labour, and engineers.

The Status column indicates whether the requirement is pending or completed.

If the requirement is not fulfilled, it shows Pending. Once resources are assigned, the status changes to Completed.

The Assign button allows Admin or Manager to allocate labour and engineers.

After assignment, the action changes to Assign Completed.

This module helps in efficient resource management and tracking.

IX. CONCLUSION AND FUTURE WORK

The proposed *Intelligent Construction Assistance System* provides a comprehensive and efficient solution for managing construction projects and interior design processes. By integrating multiple modules such as project management, labour allocation, inventory management, customer interaction, and financial services into a single platform, the system overcomes the limitations of traditional construction methods.

The use of machine learning techniques for project completion prediction enables better planning and reduces delays. Additionally, the AI-based interior design module improves visualization and enhances user decision-making. The centralized system ensures better coordination among stakeholders, reduces manual effort, and improves overall efficiency and resource utilization.

Overall, the system demonstrates how the integration of modern technologies such as web applications and artificial intelligence can transform construction management into a smarter, more reliable, and user-friendly process.

X. REFERENCE

In the future, the system can be enhanced by integrating advanced technologies and additional features to further improve its capabilities. One major improvement could be the integration of IoT-based sensors for real-time monitoring of construction sites, including material usage, worker activity, and safety conditions.

The system can also be extended by developing a mobile application to provide easier access and real-time updates for users. Advanced machine learning and deep learning models can be implemented to improve prediction accuracy and support more complex decision-making tasks.

In addition, features such as real-time analytics dashboards, automated report generation, and integration with government approval systems can further enhance system functionality. The interior design module can be upgraded using augmented reality (AR) or virtual reality (VR) to provide a more immersive user experience.

Overall, these enhancements can make the system more intelligent, scalable, and suitable for real-world large-scale construction applications.

XII. ACKNOWLEDGMENT

The authors would also like to acknowledge the support of industry professionals and users who provided valuable insights into construction workflows, labour management, and real-world challenges, which helped in shaping the system design and implementation.

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