Innovative AI Solutions for Smart Construction

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Fall 2021

A Dissertation Submitted To

Faculty of Computing,

Riphah International University, Islamabad

As a Partial Fulfillment of the Requirement for the Award of the

Degree of

Bachelors of Science in Computer Science

Faculty of Computing
Riphah International University, Islamabad

Date: [date of final presentation]

Final Approval

This is to certify that we have read the report submitted by ***Mir Allahyar Khan Talpur (36527), Syed Touqeer Hussain Shah (32161), Haider Ali (32404)*** for the partial fulfillment of the requirements for the degree of the Bachelors of Science in Computer Science (BSCS). It is our judgment that this report is of sufficient standard to warrant its acceptance by Riphah International University, Islamabad for the degree of Bachelors of Science in Computer Science (BSCS).

Committee:

1 ______________________________

[Name Supervisor]
(Supervisor)

2 ______________________________

[Name of HOD/chairman]
(Head of Department/chairman)

Declaration

We hereby declare that this document "**Innovative AI Solutions for Smart Construction**" neither as a whole nor as a part has been copied out from any source. It is further declared that we have done this project with the accompanied report entirely on the basis of our personal efforts, under the proficient guidance of our teachers, especially our supervisor **Mubariz Rehman**. If any part of the system is proved to be copied out from any source or found to be reproduction of any project from anywhere else, we shall stand by the consequences.

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Dedication

Our project is dedicated to our parents, seniors, friends and our supervisor "Mubariz Rehman" whose unwavering support, guidance and inspiration have been instrumental to its success. We are deeply grateful for their love and encouragement throughout this journey. Their belief in us has fueled our determination to overcome challenges and achieve our goals. This achievement stands as a testament to their continuous care and mentorship and we dedicate every millstone to them.

Acknowledgement

First of all, we are obliged to Allah Almighty the Merciful, the Beneficent and the source of all Knowledge, for granting us the courage and knowledge to complete this Project.

We would like to express our sincere gratitude to our project supervisor “Mubariz Rehman” whose invaluable guidance, advice, and constant support have played a key role in the successful completion of this project. Without his expertise and encouragement this work would not have been possible.

We are also deeply thankful to our parents and family whose unwavering support and belief in us have been a constant source of strength. They have instilled in us the values of honesty, hard work and perseverance which have been instrumental in the completion of this project.

Our heartfelt thanks go to our teachers, classmates and friends for their encouragement and assistance throughout this journey. Their collective support has helped us stay motivated and focused making this achievement even more meaningful.

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Abstract

As technology continues to reshape industries, AI is opening up exciting possibilities in construction, making complex tasks easier and more accessible for everyone involved. Our project, **Innovative AI Solutions for Smart Construction**, introduces a user-friendly platform designed to simplify the construction process, especially for homeowners and contractors. With this platform, users can generate front elevation designs for their homes by simply entering details like plot size, making professional design accessible at their fingertips.

Beyond design, the platform also provides detailed cost estimates, factoring in current market rates with material and without material, so users have a clear understanding of their budget right from the start. Additionally, the platform fosters community by offering a chat feature where users, contractors, and service providers can interact, ask questions, and share insights. For added convenience, a bidding system allows contractors to submit project proposals, enabling users to make informed choices that suit both their vision and budget. This blend of AI-driven design, cost transparency, real-time interaction, and competitive bidding aims to transform residential construction into a more seamless, efficient, and personalized experience for everyone involved.

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Abstract

A web-based platform called **Innovative AI Solutions for Smart Construction** is created with the goal of streamlining the home construction planning process. This application is developed with the **MERN** (*MongoDB*, *Express*, *React*, *Node.js*) **Stack**, uses generative AI to automatically generate front elevation designs so that users can easily visualize the front of their home. Additionally, the platform offers a **cost calculation tool** that provides customers with clear financial insights for their projects by estimating expected construction prices based on current labor and material market rates. For seamless communication, a **community chatbot** facilitates real-time interaction, allowing users, contractors and service providers to connect and collaborate effortlessly. Additionally, a **bidding featu**re enables user to submit competitive proposals, giving users the flexibility to choose the best fit for their project. With its unique combination of AI-driven design, budget clarity, interactive community support and a streamlined bidding process, this platform offers a complete solution that simplifies construction planning for house.

Chapter 1: Introduction

The real estate construction industry has always faced challenges with using modern technology. This has led to inefficiencies, poor coordination and major delays in projects. Even though platforms like Houzz and Thumbtack help with specific tasks such as design and managing vendors, they don't cover the entire construction process. This makes things harder for homeowners, contractors and others involved in building houses. As a result, there are many problems like inaccurate cost estimates, project delays and communication issues among various stakeholders.

To solve these problems, this project proposes a web-based platform that uses artificial intelligence (AI) to make the construction process smoother. The idea is to use AI for house design, estimating costs and improving communication between everyone involved. This platform will make the whole process more efficient, reduce the need for in-person meetings and speed up decision-making. The goal is to create a seamless, integrated solution that improves coordination, cuts down on delays and ensures more accurate cost estimates. This will lead to construction projects being completed in a more efficient and cost-effective way.

The proposed platform will use Deep learning, specifically a DCGAN (Deep Convolutional Generative Adversarial Network) model, to generate house designs based on user preferences. Users can input their plot dimension and the AI will create realistic front elevation designs for houses. It will also provide accurate cost estimates based on current market prices. In addition, the platform will include a community chat feature to allow homeowners, contractors and service providers to communicate easily and work together throughout the construction process. With a dataset of 500-600 images of house designs, the AI model will be able to create detailed and realistic house plans for standard plot sizes.

This chapter introduces the key issues in the real estate construction industry, explains why using AI is important for improving the construction process, and outlines the goals of the project. The next sections will go into more detail about the specific objectives and the scope of the project, offering a clear plan for developing and implementing the platform.

1.1 Goals and Objectives

Goals:

- To provide an AI-powered platform that integrates design, cost estimation and vendor communication in the real estate construction industry.
- To streamline the house construction process by automating design generation and providing accurate cost estimates.
- To improve communication and collaboration between stakeholders, reducing the need for in-person meetings and accelerating project decision-making.

Objectives:

- To develop a system that uses Deep learning algorithms (DCGAN) to generate front elevation designs.
- To implement a cost estimation tool that calculates construction costs using current market rates and material costs.
- To facilitate collaboration between contractors, service provider and homeowners through an integrated community chat feature.
- To address the issues of poor coordination, inaccurate cost estimates and delays commonly experienced in the traditional construction process.

1.2 Scope of the Project

The scope of this project includes the development of a web-based platform built on AI technologies, with the following key features:

- **AI-Based Design Generation**: The platform will allow users to generate customized front elevation designs of houses using Deep Learning algorithm (DCGAN).
- **Cost Estimation**: The system will provide accurate cost estimates for house construction based on current market rates, material costs and user-specific preferences.
- **Community Chat**: A feature that enables communication and collaboration among different stakeholders, including homeowners, contractors, service provider and other parties involved in the construction process.
- **Bidding System**: It allows users to submit their project proposal, which are then displayed to all contractors. This ensures contractor can review various projects, understand the requirements and make informed decisions based on their expertise, vision and budget alignment.
- **Contractor and service provider**: It allow user to find contractor and service provider.
- **Data Set**: The platform will use a dataset of 500-600 images of front house elevations, collected from various architectural sources, to train the AI model.

The project will focus on integrating the main elements Design, cost estimation, Bidding system, find contractor, find service provider and communication—into a single platform, with the goal of improving overall efficiency, reducing delays and minimizing errors in cost Calculation. The platform will be accessible online, providing an easy-to-use interface for homeowners and contractors to interact and collaborate efficiently. Future versions of the platform may expand to include additional features or support a wider range of architectural designs.

Chapter 2: Literature Review

2.1 Introduction

The advent of artificial intelligence (AI) and deep learning has revolutionized various fields, including the construction and architecture domains, where traditional practices are increasingly augmented by computational methods. One significant breakthrough in AI is the development of Generative Adversarial Networks (GANs), first introduced by Goodfellow et al. in 2014. GANs employ a unique adversarial framework, consisting of two neural networks—the generator and the discriminator—that work together to produce synthetic data that closely mimics real-world datasets. Over the years, the capabilities of GANs have been extended to various applications, such as image synthesis, design generation, and data augmentation, driving innovations across diverse industries.

In architectural design, particularly in generating house elevations, GANs offer an unprecedented opportunity to enhance creative processes, enabling designers to explore numerous aesthetic possibilities while adhering to structural and spatial constraints. The challenge of manually designing front elevations is not only time-consuming but also constrained by the creativity and experience of individual designers. GANs address these challenges by automating the generation of diverse and innovative designs based on learned patterns, reducing human effort and increasing efficiency.

The motivation for this research lies in addressing the practical needs of architects and construction professionals by leveraging GANs to automate and optimize the design process for house front elevations. With the growing interest in generative models, the focus has shifted toward harnessing the potential of GANs for high-quality, realistic design outputs that cater to aesthetic preferences and functional requirements.

This literature review aims to explore the evolution, applications, and challenges of GANs in related fields, analyzing their potential to innovate front elevation design. Five significant research papers are reviewed in detail, each contributing unique insights into the implementation of GANs for generative modeling. This review sets the foundation for understanding the state-of-the-art technologies and identifying gaps that guide the scope of this research.

The subsequent sections will elaborate on the historical background, existing challenges, and technological advancements that have shaped the development of GANs, followed by a detailed analysis of related research, definitions, and a consolidated summary of findings to establish the groundwork for developing a GAN-based approach to generate house front elevations.

2.2 Background and Problem Elaboration

The field of architectural design and construction has long relied on manual methods and rule-based systems to create building designs, including house front elevations. These traditional methods, while effective, are often labor-intensive, time-consuming, and limited by human creativity. As demands for personalized, aesthetically pleasing, and structurally sound designs increase, there is a need for innovative solutions that can automate the design process while maintaining high-quality outputs.

Generative Adversarial Networks (GANs) have emerged as a promising solution in the domain of generative modeling. Introduced by Goodfellow et al. in 2014, GANs utilize a dual-network structure—a generator that creates synthetic data and a discriminator that evaluates its authenticity. This adversarial training approach enables GANs to learn complex data distributions and produce high-quality outputs, making them ideal for applications such as image synthesis, data augmentation, and creative design generation.

Despite their potential, GANs face several challenges, particularly when applied to the construction and architectural sectors. Training GANs is computationally intensive and requires substantial data, which is often scarce in the construction domain. Additionally, issues such as training instability, mode collapse, and vanishing gradients can hinder their performance. For architectural applications, GANs must generate designs that are not only visually appealing but also adhere to structural and spatial constraints—a complex task requiring a balance between aesthetic and functional considerations.

In the context of generating house front elevations, traditional methods often struggle to address the diverse stylistic preferences of homeowners while maintaining practical feasibility. Designers must account for numerous variables, including cultural influences, environmental factors, and material constraints, making the manual design process both intricate and repetitive. Existing automated systems, such as rule-based or parametric design tools, lack the creative adaptability needed to produce novel and diverse designs.

The problem is further compounded by the lack of comprehensive datasets that capture the diversity of architectural styles and elements necessary for training robust generative models. This scarcity of data often leads to overfitting or limited generalization in GAN-based models, reducing their effectiveness in real-world applications. Additionally, integrating GAN-generated designs into existing workflows remains a challenge, as the outputs must meet industry standards for safety, durability, and sustainability.

This research seeks to address these challenges by leveraging GANs to automate the generation of house front elevations. By exploring advancements in GAN architectures and training methodologies, this study aims to develop a solution that combines creativity with practicality, enabling the generation of diverse and high-quality designs that cater to both aesthetic and structural requirements. The review of related works will provide insights into existing approaches, highlight their limitations, and identify opportunities for innovation in this field.

2.3 Detailed Literature Review

The literature review aims to provide a comprehensive understanding of the advancements, applications, and challenges of Generative Adversarial Networks (GANs) in various domains, with a particular focus on their potential for generating house front elevations.

2.3.1 Definitions

I. **Generative Adversarial Networks (GANs):** Introduced by Goodfellow et al. (2014), GANs consist of a generator that produces synthetic data and a discriminator that evaluates its authenticity. The adversarial process between these networks enables GANs to learn data distributions and generate realistic outputs.

II. **Conditional GANs (cGANs):** A GAN variant where the generator is conditioned on auxiliary information (e.g., labels or images), allowing controlled data generation for specific applications such as labeled house elevations.

III. **Deep Convolutional GANs (DCGANs):** A GAN architecture leveraging convolutional layers to generate high-resolution images. It improves the stability of GAN training and is widely used for image synthesis tasks.

IV. **Least Squares GANs (LSGANs):** A GAN variant that replaces the traditional cross-entropy loss with a least-squares loss to address vanishing gradients and enhance training stability, producing higher-quality outputs.

V. **U-Net Architecture:** Originally designed for biomedical segmentation, U-Net has been adapted for GAN frameworks due to its ability to capture both contextual and localization features. It is particularly effective in tasks requiring high spatial resolution.

VI. **Mode Collapse:** A common issue in GANs where the generator produces limited diversity, failing to capture the full range of the target data distribution.

VII. **f-Divergence:** A statistical measure related to GANs, including the Pearson χ^2 divergence minimized in LSGANs, influencing the model's ability to generate realistic outputs.

2.3.2 Related Research Work 1

Goodfellow et al. (2014) [1] introduced Generative Adversarial Networks (GANs), marking a transformative advancement in generative modeling. The framework involves two neural networks, a generator and a discriminator, competing in a zero-sum game to improve each other's performance. GANs can learn complex data distributions, enabling the creation of synthetic data that closely resembles real-world datasets. However, the initial GAN model faced challenges like training instability and mode collapse, necessitating further architectural improvements. This foundational work established the groundwork for subsequent GAN variants and applications, including image synthesis and design generation.

GAN Architecture to generate the new images.

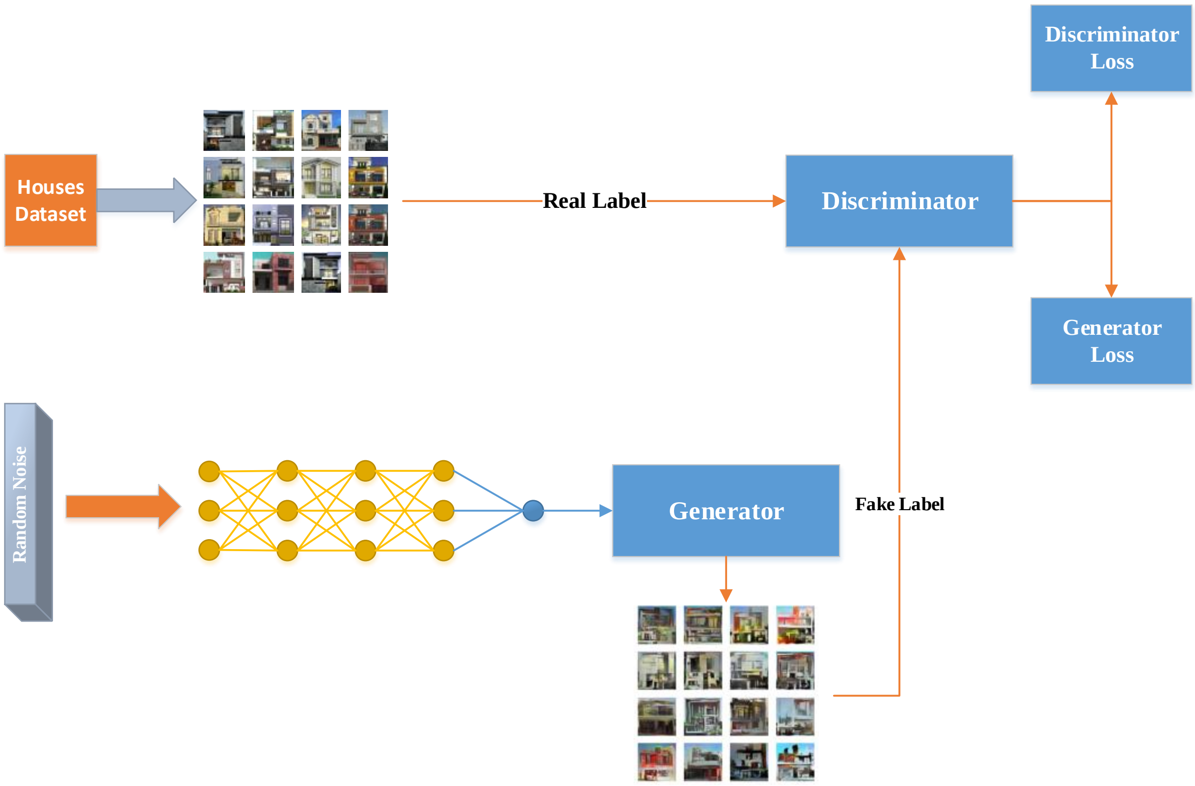


Figure 1 : Gan Architecture

2.3.3 Related Research Work 2

Radford et al. (2015) [2] proposed Deep Convolutional GANs (DCGANs), an architectural enhancement of GANs that replaced fully connected layers with convolutional layers. This modification improved the stability and quality of GAN outputs, enabling the generation of high-resolution synthetic images. DCGANs demonstrated their effectiveness in unsupervised representation learning, making them highly suitable for visual domains such as architectural design. By leveraging convolutional features, DCGANs set a benchmark for applying GANs in tasks requiring high-quality and detailed visual outputs, such as generating house elevations.

2.3.4 Related Research Work 3

Mao et al. (2017) [3] introduced Least Squares GANs (LSGANs) to address the vanishing gradient problem associated with traditional GANs. By adopting a least-squares loss function for the discriminator, LSGANs achieved greater training stability and generated higher-quality outputs. Experimental evaluations demonstrated LSGANs' effectiveness in image generation tasks, making them suitable for structured data applications, such as architectural designs. The improvement in stability and output quality addressed some of the critical limitations of earlier GAN models, paving the way for their adoption in domains requiring precise and reliable generative modeling.

2.3.5 Related Research Work 4

Ronneberger et al. (2015) [4] developed the U-Net architecture, primarily for biomedical image segmentation. Featuring a contracting path to capture context and an expanding path for precise localization, U-Net excelled in tasks requiring spatial accuracy and detail preservation. Its ability to produce segmented outputs from limited training data made it adaptable for architectural applications, including elevation design. U-Net's integration with GANs enables the generation of designs that are both aesthetically and structurally consistent, highlighting its potential in automating house front elevation generation.

2.3.6 Related Research Work 5

Zhu et al. (2017) [5] introduced CycleGAN, a GAN variant for image-to-image translation tasks without the need for paired training data. CycleGAN utilizes a cycle-consistency loss to ensure that translations preserve the essential features of the input images. This architecture is particularly useful for converting architectural sketches or floor plans into realistic house elevations. By eliminating the dependency on paired datasets, CycleGAN broadens the applicability of GANs in design automation, enabling creative exploration of diverse styles and layouts for house front elevations.

2.4 Literature Review Summary Table

The columns in the table depend upon your problem and should be specific to your project.

Table 1: Literature Review

No.	Reference	Inventor	Year	Input	Output	Description
1.	[1]	Ian Goodfellow et al.	2014	Random noise vector	Synthetic data resembling real data	Introduced the concept of GANs, forming the basis for generative modeling.
2	[2]	Alec Radford et al.	2015	Random noise vector	High-resolution synthetic images	Enhanced GAN training stability and quality using convolutional layers.
3	[3]	Xudong Mao et al.	2017	Random noise vector	High-quality and stable synthetic images	Addressed vanishing gradient issue with least squares loss for improved outputs.
4	[4]	Olaf Ronneberger et al.	2015	Biomedical images	Segmented images	Used for biomedical segmentation; adaptable to architectural tasks.

5	[5]	Jun-Yan Zhu et al.	2017	Unpaired image datasets	Image-to-image translations	Enabled image-to-image translations without paired datasets.

2.5 Research Gap

I. Generative Adversarial Networks (GANs)
Gap: The original GAN framework by Goodfellow et al. (2014) introduced the concept of adversarial training but faced critical challenges, including training instability, mode collapse, and vanishing gradients. These issues hinder the scalability and reliability of GANs for complex, high-resolution applications such as house elevation generation.

II. Deep Convolutional GANs (DCGANs)
Gap: While DCGANs (Radford et al., 2015) improved training stability and quality through convolutional layers, they still struggled with issues like limited diversity in generated outputs (mode collapse) and difficulties in integrating architectural constraints. The lack of mechanisms to incorporate structural guidelines or design standards into the generation process limits their applicability in architecture.

III. Least Squares GANs (LSGANs)
Gap: LSGANs (Mao et al., 2017) addressed vanishing gradients with a least-squares loss function, improving output stability and quality. However, the framework lacks exploration in generating outputs that adhere to real-world constraints, such as structural feasibility, material limitations, and aesthetic consistency for architectural designs like house elevations.

IV. U-Net Architecture
Gap: Although U-Net (Ronneberger et al., 2015) excelled in biomedical image segmentation and demonstrated potential for tasks requiring high spatial accuracy, its integration into GAN frameworks for architectural design remains underexplored. Additionally, U-Net's adaptation to handle complex and diverse styles in house elevations, while maintaining structural integrity, is an area that requires further research.

V. CycleGAN
Gap: CycleGAN (Zhu et al., 2017) introduced the ability to perform unpaired image-to-image translations, which is promising for converting sketches into realistic elevations. However, it lacks mechanisms to incorporate architectural constraints or user-defined preferences, limiting its practicality in real-world design workflows. Moreover, the focus on unstructured data prevents it from fully addressing the precision needed for architectural outputs.

2.6 Problem Statement

The construction industry suffers from delays, poor coordination and inaccurate cost estimations due to fragmented design, communication and budgeting processes.

Homeowners struggle to get specific designs understanding accurate cost estimates and coordinate with different stakeholders which leads them to delays, miscommunication, and unexpected expenses. The present options frequently force users to switch between different tools since they don’t take a single approach that covers all these features. In addition to increasing inefficiencies this fragmented approach reduces accessibility for both contractors and homeowners. The present situation of issues requires the creation of a single platform that makes construction project management easier while giving all stakeholders accurate and effective tools.

Chapter 3: Requirements and Design

In this chapter, we have developed the functional requirements for the main actors of our platform, i.e., Users, Contractors, Service Providers, and Admin. These requirements are specifically designed for the Innovative AI Solutions for Smart Construction platform, which aims to streamline the construction process by integrating design, cost estimation, and collaboration into a single web-based solution.

The platform is user-friendly, easy to navigate, and provides a convenient and efficient way for all stakeholders to connect, interact, and manage their construction projects. It incorporates AI-driven features to generate house elevation designs, cost estimation tools for budgeting, and communication systems for collaboration.

We have created detailed use cases for each functional requirement and illustrated them with diagrams such as use case diagrams and system architecture. These artifacts ensure clarity and provide a foundation for the development and implementation of the platform.

3.1 Requirements

3.1.1 Functional Requirements

- **User**

REQUIREMENT NO.	REQUIREMENT DESCRIPTION
FR-1.1	Users can register by providing their name, email, and password.
FR-1.2	Users can log in to the system using their credentials.
FR-1.3	Users can view available Contractors and Service Providers with filters.
FR-1.4	Users can search for Contractors or Service Providers using a search bar.
FR-1.5	Users can filter results by location, rating, and expertise.
FR-1.6	Users can sort results based on predefined criteria (e.g., highest rated).
FR-1.7	Users can view detailed profiles of Contractors and Service Providers.
FR-1.8	Users can send service requests to selected Contractors or Service Providers.
FR-1.9	Users can manage their profile by updating personal information.
FR-1.10	Users can view the history of interactions and service requests.

- **Contractor**

REQUIREMENT NO.	REQUIREMENT DESCRIPTION
FR-2.1	Contractors can register by providing their name, email, and password.
FR-2.2	Contractors must create a profile during the first login with details like expertise.
FR-2.3	Contractors can log in using their credentials.
FR-2.4	Contractors can list the services they provide, specifying expertise areas.
FR-2.5	Contractors can view and respond to service requests sent by Users.
FR-2.6	Contractors can manage their schedule and mark availability for new requests.
FR-2.7	Contractors can edit and update their profile anytime.
FR-2.8	Contractors can view feedback and ratings from Users.

- **Service Provider**

REQUIREMENT NO.	REQUIREMENT DESCRIPTION
FR-3.1	Service Providers can register by providing their name, email, and password.
FR-3.2	Service Providers must create a profile during the first login, including services offered.
FR-3.3	Service Providers can log in using their credentials.
FR-3.4	Service Providers can list services and tools they provide, specifying pricing.
FR-3.5	Service Providers can view requests sent by Users and respond accordingly.
FR-3.6	Service Providers can edit and update their profile anytime.
FR-3.7	Service Providers can view feedback and ratings provided by Users.

➢ **Admin**

REQUIREMENT NO.	**REQUIREMENT DESCRIPTION**
FR-4.1	Admin can access a dashboard to monitor and manage system activities.
FR-4.2	Admin can view and manage User accounts.
FR-4.3	Admin can deactivate or delete User accounts if necessary.
FR-4.4	Admin can view and manage Contractor profiles and their services.
FR-4.5	Admin can approve or reject new Contractors or their services.
FR-4.6	Admin can view and manage Service Provider profiles and services/tools.
FR-4.7	Admin can approve or reject new Service Provider registrations or service listings.
FR-4.8	Admin can monitor feedback and ratings to ensure no offensive content is published.
FR-4.9	Admin can remove inappropriate feedback or ban abusive users.
FR-4.10	Admin can generate reports on platform activity (e.g., active Users, feedback trends).
FR-4.11	Admin can resolve disputes between Users, Contractors, and Service Providers.
FR-4.12	Admin can manage platform-wide settings like service categories and pricing policies.

3.1.2 Non-Functional Requirements

- **User-Friendly Interface:** The platform is designed with a simple and intuitive user interface to ensure ease of use for all stakeholders, including homeowners, contractors, and service providers. Navigation is straightforward, with clearly labeled menus and logically structured workflows that minimize confusion. Users can quickly access key features such as generating front elevations, calculating costs, and finding contractors or service providers. The interface is responsive, providing a seamless experience across desktop and mobile devices, ensuring accessibility for users on the go.
- **Performance**: Key operations, such as design generation and cost estimation, are designed to execute in under 3 seconds, maintaining a smooth user experience.
- **Compatibility**: The platform is compatible with major web browsers and operating systems, offering a consistent experience across devices such as desktops, tablets, and smartphones.

3.1.3 Hardware and Software Requirements

To ensure that users can effectively utilize the Innovative AI Solutions for Smart Construction platform, the following hardware and software requirements are specified:

- **Hardware Requirements**

  - **Device Compatibility:**
    The platform can be accessed using the following devices:
    - **Desktop/Laptop:** A device with at least 4GB of RAM and a dual-core processor for smooth browsing.
    - **Smartphone/Tablet:** A modern smartphone or tablet with at least 2GB of RAM and a 1.5 GHz processor.

  - **Display Resolution:**
    A minimum screen resolution of 1024x768 pixels is recommended for optimal interface display.
  - **Internet Connection:**
    A stable internet connection with a minimum speed of 2 Mbps is required to access real-time features like design generation, cost calculation, and community chat.

- **Software Requirements**

  - **Operating Systems:**
    The platform supports the following operating systems:
    - **Desktop:** Windows 8 or later, macOS 10.13 or later, and Linux distributions with modern browsers.
    - **Mobile:** Android 8.0 or later and iOS 12.0 or later.

  - **Web Browsers:**
    The platform is optimized for the latest versions of major browsers, including:
    - Google Chrome
    - Mozilla Firefox
    - Safari
    - Microsoft Edge
  - **Applications and Tools:**
    - No additional applications are required; the platform is entirely web-based and runs in the browser.
  - **Security:**
    - The browser must support HTTPS to ensure secure communication.

3.2 Proposed Methodology

The Innovative AI Solutions for Smart Construction platform follows a systematic methodology to achieve its objectives of streamlining the home construction planning process. The proposed methodology is divided into several stages, ensuring that all functionalities are implemented efficiently and effectively.

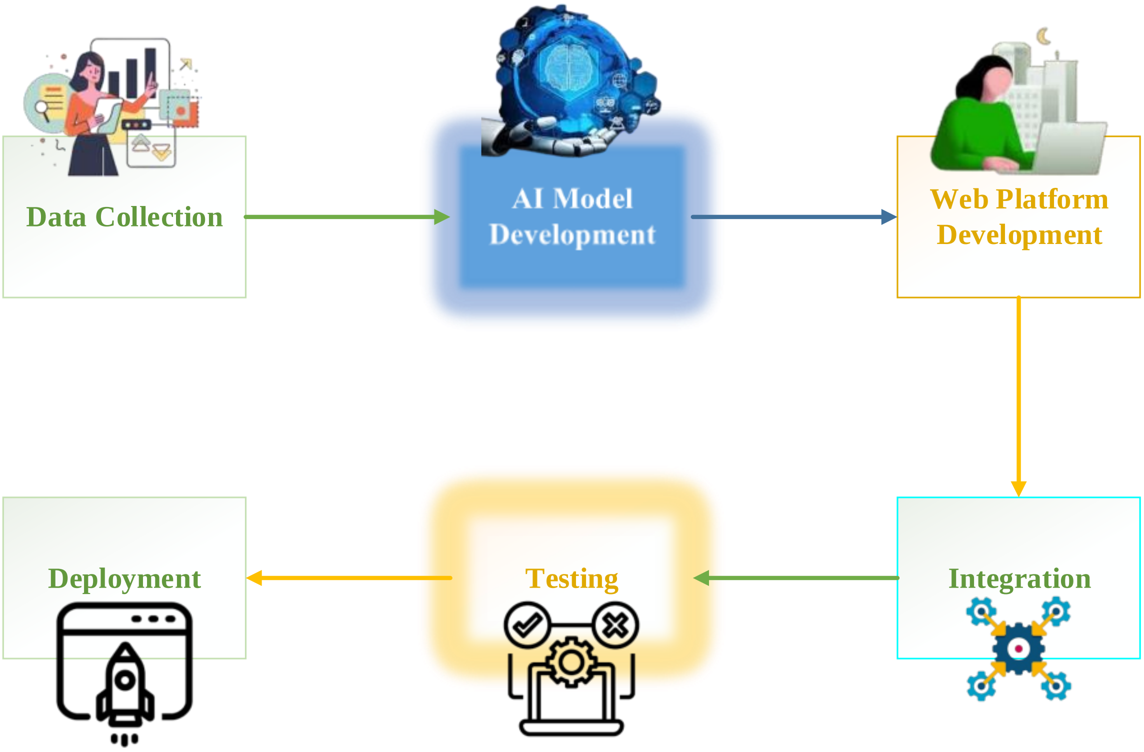


Figure 1: Proposed Methodology

I. **Data Collection**

The foundation of the platform's AI-powered features is a dataset of 500–600 images of house front elevations collected from architectural sources. This dataset is used to train the DCGAN model for generating realistic and customized designs.

II. **AI Model Development**

- A Deep Convolutional Generative Adversarial Network (DCGAN) is used to generate front elevation designs based on user-provided inputs like plot dimensions and style preferences.
- The model is trained on the collected dataset to produce diverse and high-quality designs that align with structural and aesthetic requirements.

III. **Web Platform Development**

The platform is developed using the MERN stack for its scalability, flexibility, and robust support for modern web applications:

- **Front-End:**

- ➢ Built using React.js to create a responsive and user-friendly interface for interacting with platform features.
- ➢ Key components include design generation forms, cost calculators, and communication tools.
- **Back-End**:
- ➢ Developed using Node.js and Express.js to handle server-side logic, API integration, and secure user authentication.
- **Database:**
- ➢ MongoDB is used to store user data, project details, and design history securely.

VI. Integration of Key Features

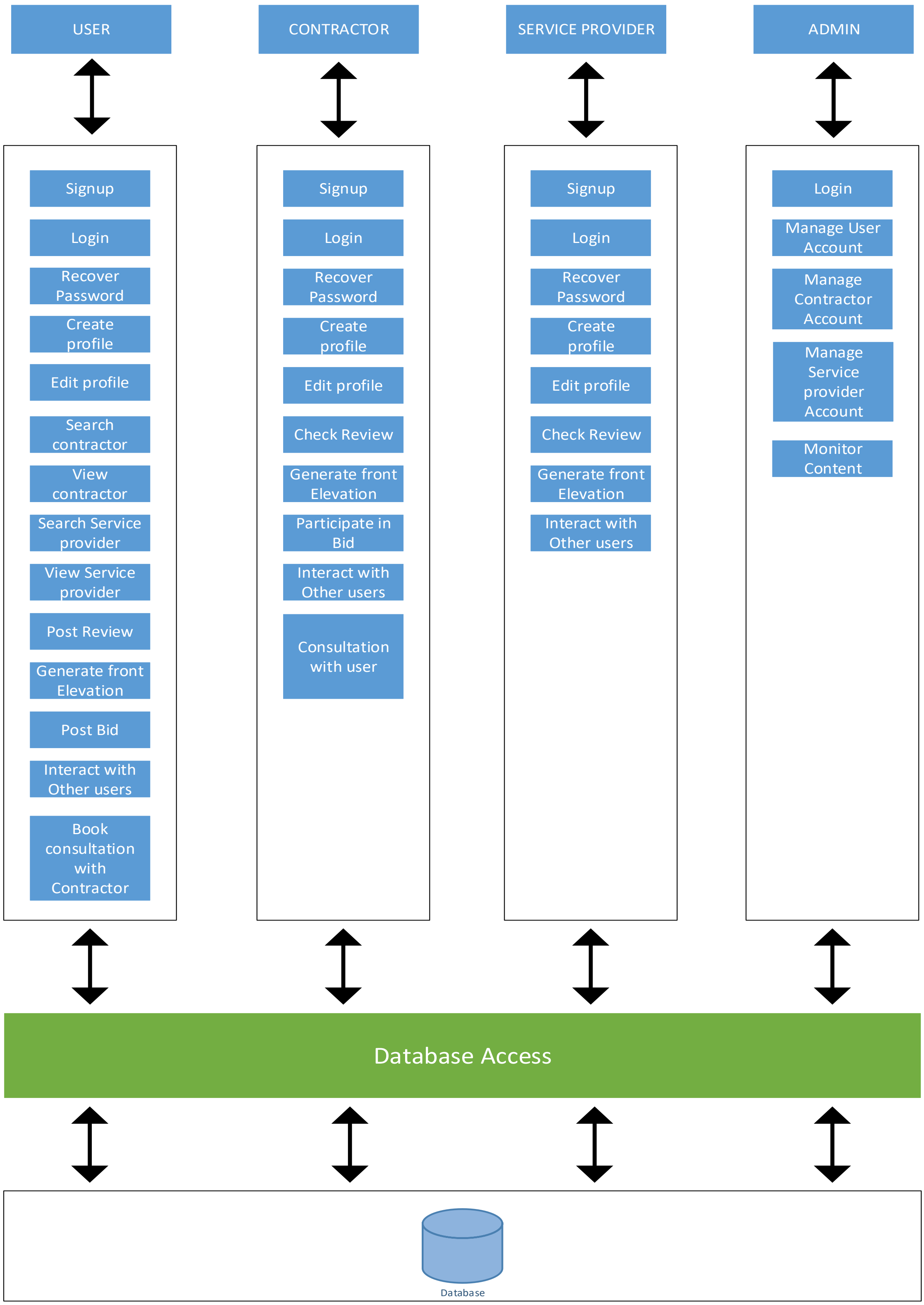
- **Design Generation:** The trained DCGAN model is integrated to produce realistic house front elevations based on user inputs.
- **Cost Estimation Tool:** Algorithms are implemented to calculate project costs based on real-time labor and material rates.
- **Bidding System:** A module is created for contractors to submit proposals for user projects, allowing competitive pricing.
- **Community Chat:** A real-time chat system is developed to enable communication between users, contractors, and service providers.
- **Search and Filter Tools:** Advanced filters and sorting mechanisms are implemented to help users find contractors or service providers efficiently.

VII. Testing

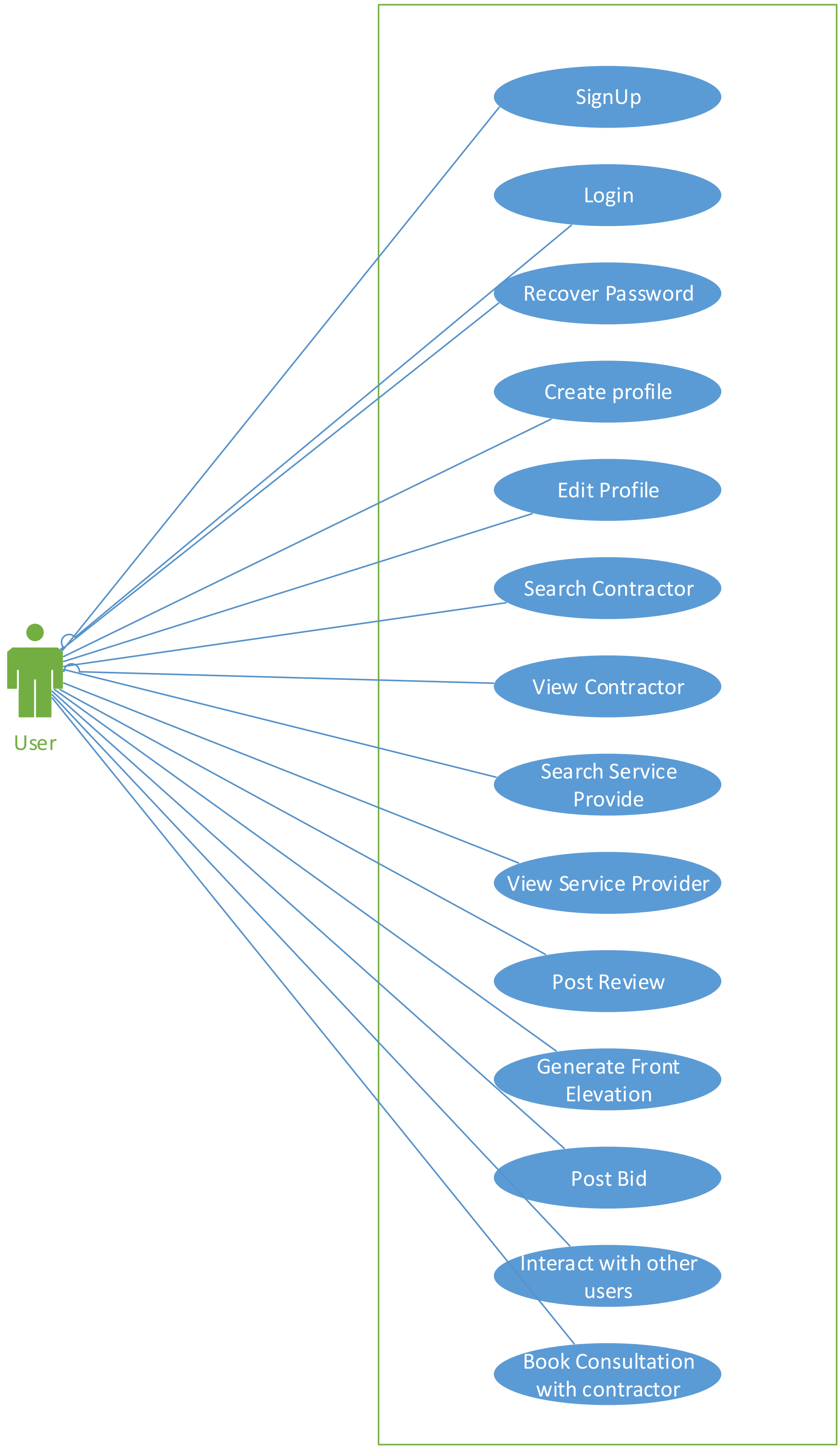
Comprehensive testing is conducted to ensure that all features work seamlessly:

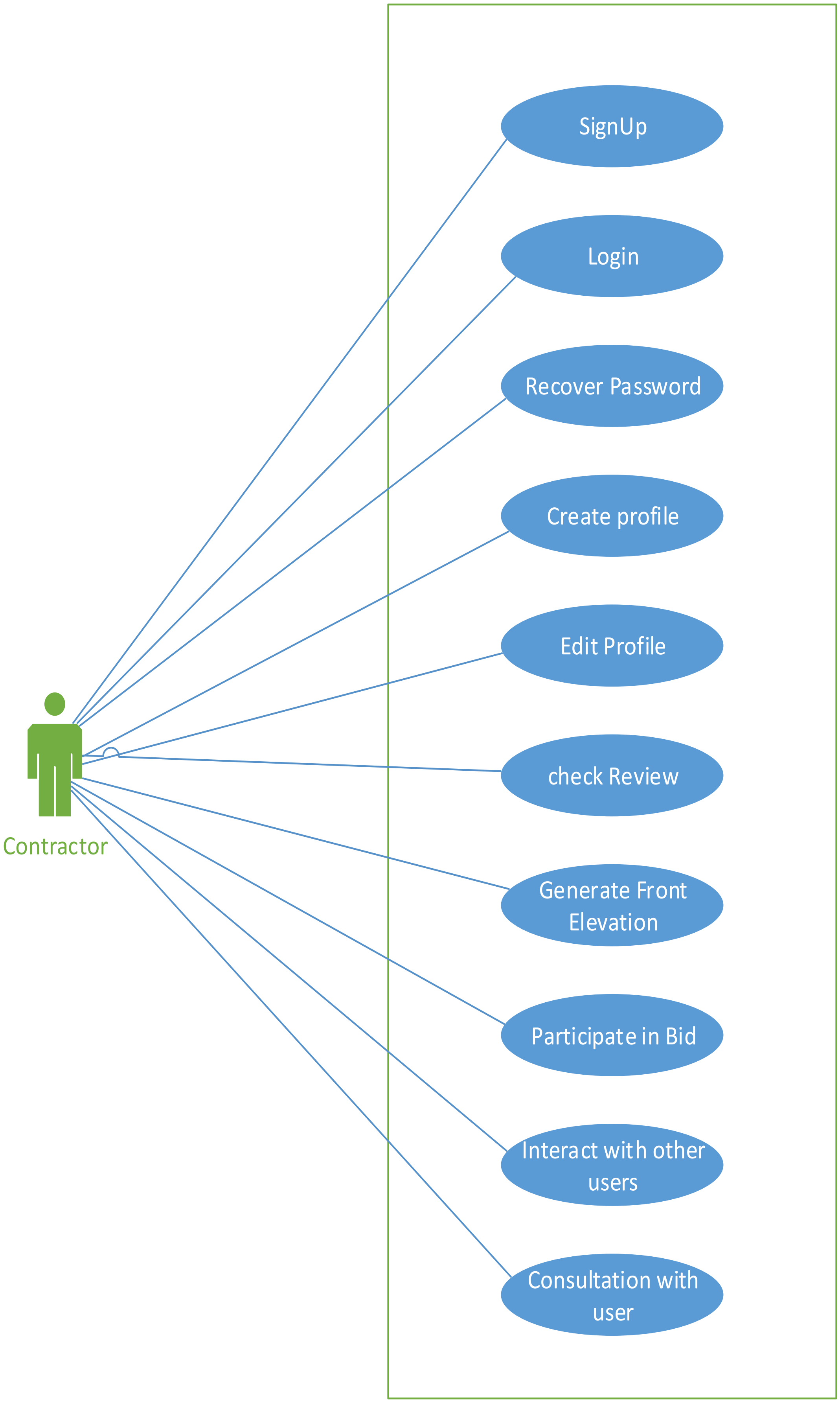
- **Unit Testing:** Individual modules like design generation and cost estimation are tested for accuracy and reliability.
- **Integration Testing:** Ensures smooth interaction between various components like AI design generation and the user interface.
- **Usability Testing:** Real-world scenarios are simulated to test the platform’s ease of use and responsiveness.

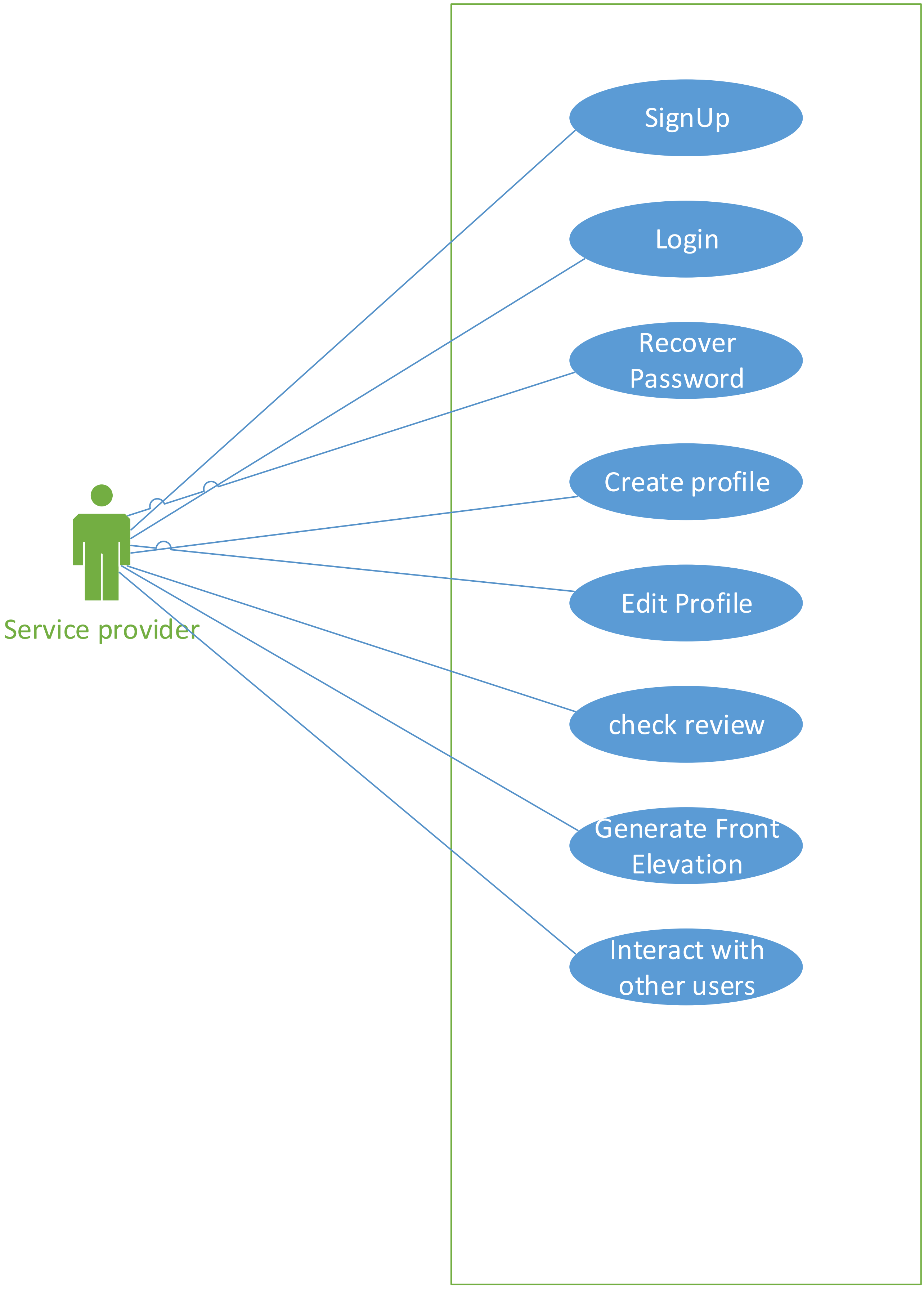
3.3 System Architecture

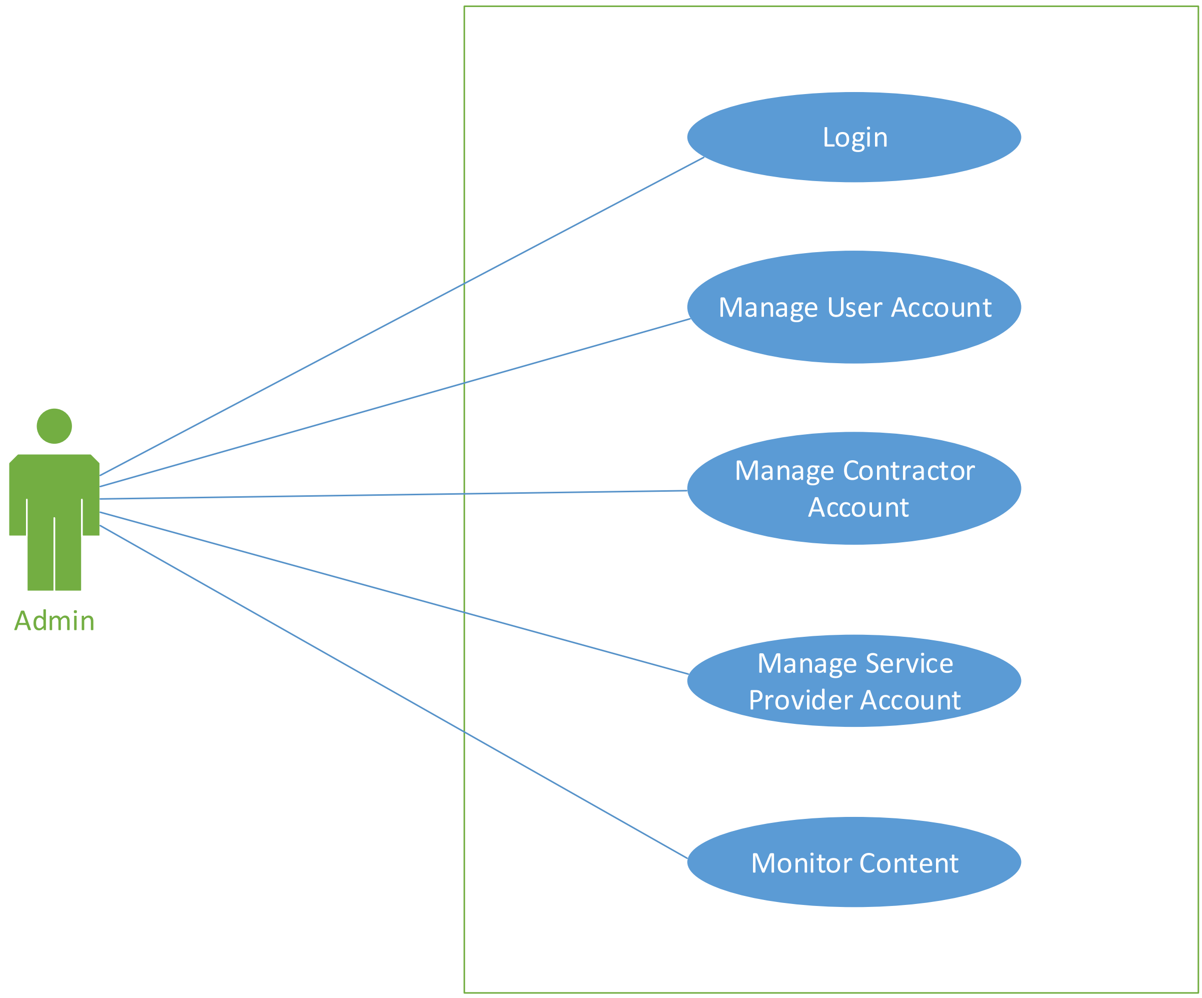


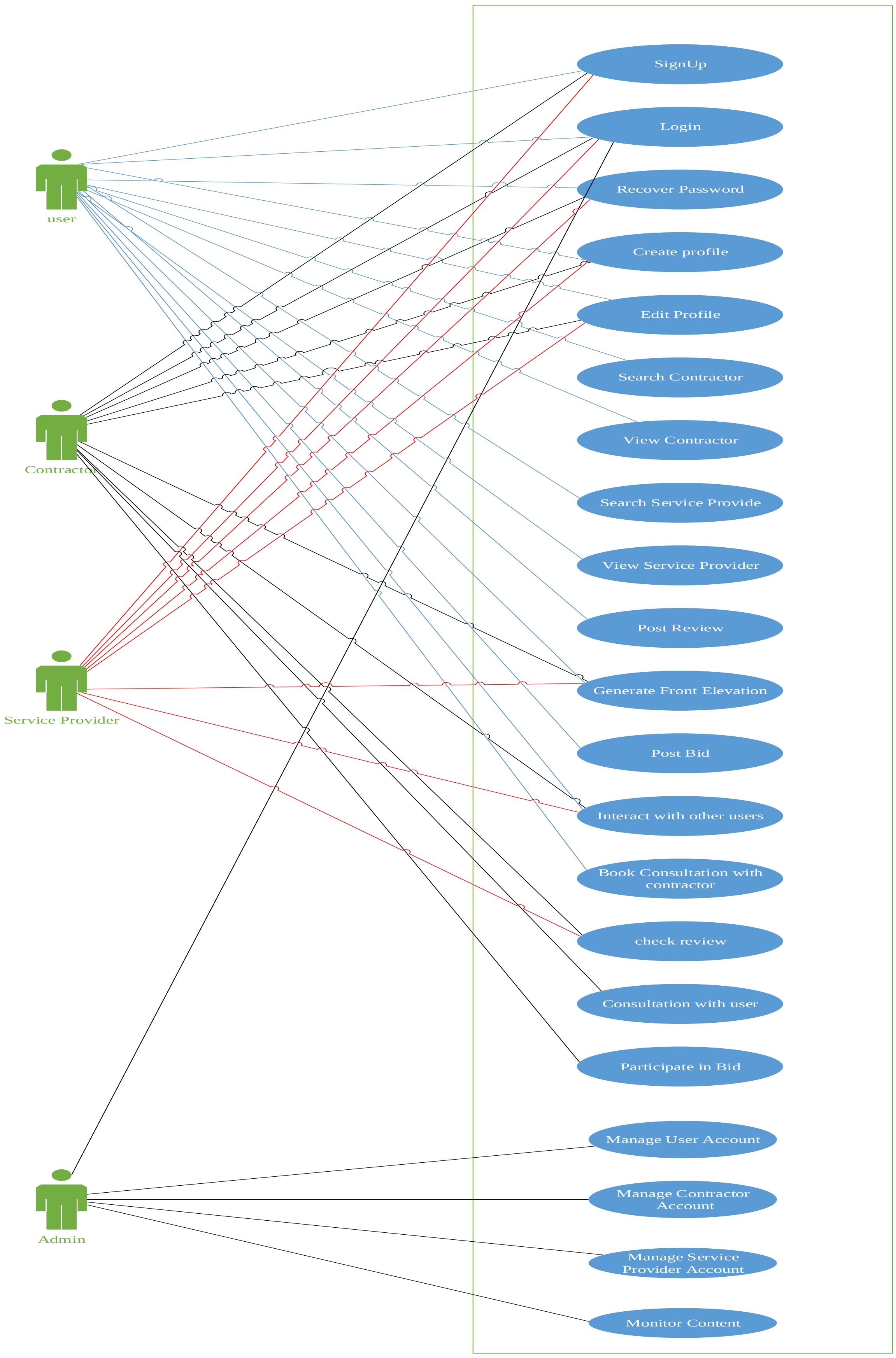
3.4 Use Cases


SignUp
Login
Recover Password
Create profile
Edit Profile
Search Contractor
View Contractor
Search Service Provide
View Service Provider
Post Review
Generate Front Elevation
Post Bid
Interact with other users
Book Consultation with contractor
User


SignUp
Login
Recover Password
Create profile
Edit Profile
check Review
Generate Front Elevation
Participate in Bid
Interact with other users
Consultation with user
Contractor


SignUp
Login
Recover Password
Create profile
Edit Profile
check review
Generate Front Elevation
Interact with other users
Service provider


Login
Manage User Account
Manage Contractor Account
Manage Service Provider Account
Monitor Content
Admin


user
Contractor
Service Provider
Admin
SignUp
Login
Recover Password
Create profile
Edit Profile
Search Contractor
View Contractor
Search Service Provide
View Service Provider
Post Review
Generate Front Elevation
Post Bid
Interact with other users
Book Consultation with contractor
check review
Consultation with user
Participate in Bid
Manage User Account
Manage Contractor Account
Manage Service Provider Account
Monitor Content

Fully-Dressed Use Cases Diagram

3.4.1 User Login

<table>
<tr><td>Name</td><td colspan="3">User Login</td></tr>
<tr><td>Actors</td><td colspan="3">User (Admin, Contractor, Service Provider)</td></tr>
<tr><td>Summary</td><td colspan="3">The system allows users to log in by providing their email and password. Upon successful verification, the user is redirected to their dashboard.</td></tr>
<tr><td>Pre-Conditions</td><td colspan="3">The user must have an existing account.</td></tr>
<tr><td>Post-Conditions</td><td colspan="3">The user is authenticated and redirected to their respective dashboard, and a session is established and maintained.</td></tr>
<tr><td>Special Requirements</td><td colspan="3">None</td></tr>
<tr><td colspan="4">Basic Flow</td></tr>
<tr><td colspan="2">Actor Action</td><td colspan="2">System Response</td></tr>
<tr><td>1</td><td>The user navigates to the login page.</td><td>2</td><td>The login page is displayed, requesting email and password.</td></tr>
<tr><td>3</td><td>The user enters valid credentials.</td><td>4</td><td>The system verifies the credentials, establishes a session, and redirects them.</td></tr>
<tr><td colspan="4">Alternative Flow</td></tr>
<tr><td>3</td><td>The user enters invalid email or password.</td><td>4-A</td><td>The system displays an error message: "Incorrect email or password entered."</td></tr>
</table>

3.4.2 User Signup

<table>
<tr><td>Name</td><td colspan="3">User Signup</td></tr>
<tr><td>Actors</td><td colspan="3">User (Admin, Contractor, Service Provider)</td></tr>
<tr><td>Summary</td><td colspan="3">The system allows users to create a new account by providing required details such as name, email, and password.</td></tr>
<tr><td>Pre-Conditions</td><td colspan="3">None</td></tr>
<tr><td>Post-Conditions</td><td colspan="3">A new account is created, and the user can log in.</td></tr>
<tr><td>Special Requirements</td><td colspan="3">Input validation must ensure data integrity.</td></tr>
<tr><td colspan="4">Basic Flow</td></tr>
<tr><td colspan="2">Actor Action</td><td colspan="2">System Response</td></tr>
<tr><td>1</td><td>The user navigates to the sign-up page.</td><td>2</td><td>The system displays the sign-up form, requesting name, email, and password.</td></tr>
<tr><td>3</td><td>The user enters their details and submits.</td><td>4</td><td>The system validates the input and creates the account.</td></tr>
<tr><td></td><td></td><td>5</td><td>A success message is displayed, and the user is redirected to the login page.</td></tr>
</table>

Alternative Flow			
3.1	The user enters invalid or duplicate data.	3.2	The system displays an error message indicating the issue (e.g., "Email already exists").

3.4.3 Forgot Password

Name	Forgot Password
Actors	User (Admin, Contractor, Service Provider)
Summary	The system allows users to reset their password securely via an email-based reset link.
Pre-Conditions	The user must have a registered account.
Post-Conditions	A reset link is sent, and the user's password is updated successfully upon completion.
Special Requirements	Reset links must expire after a specific time.

Basic Flow			
Actor Action		**System Response**	
1	The user clicks "Forgot Password" on the login page.	2	The system displays a form requesting the registered email.
3	The user submits their email.	4	The system validates the email and sends a reset link.
5	The user clicks the link, sets a new password.	6	The system updates the password and confirms the reset.
Alternative Flow			
3.1	The user enters an unregistered email.	3.2	The system displays an error message: "No account found with this email."
5.1	The user clicks an expired link.	5.2	The system displays an error: "This link has expired. Request a new one."s

3.4.4 Manage User Profile

Name	Manage User Profile
Actors	User (Admin, Contractor, Service Provider)
Summary	The system allows users to update their profile details, such as name, email, phone, or password.
Pre-Conditions	The user must be logged in.
Post-Conditions	The user's updated information is saved and reflected in the system.
Special Requirements	Password changes must require the current password for validation.
Basic Flow	

Actor Action		System Response	
1	The user navigates to the profile page.	2	The system displays the current profile details.
3	The user edits their information and submits.	4	The system validates and updates the profile.
		5	A success message is displayed.
Alternative Flow			
3.1	The user enters invalid data (e.g., weak password).	3.2	The system displays an error message indicating the issue.

3.4.5 View User Dashboards

Name	View User Dashboard		
Actors	User (Admin, Contractor, Service Provider)		
Summary	The system displays a dashboard tailored to the user's role, showing relevant information and actionable insights.		
Pre-Conditions	The user must be logged in.		
Post-Conditions	The dashboard displays relevant data and navigation links.		
Special Requirements	The dashboard must load data quickly and adapt to the user's role dynamically.		
Basic Flow			
Actor Action		**System Response**	
1	The user logs in and navigates to the dashboard.	2	The system fetches and displays the user’s role-specific data (e.g., requests, activities).
3	The user interacts with elements (e.g., notifications, profile management links).	4	The system responds to user actions with the corresponding pages or data.
Alternative Flow			
3.1	The user has no data (e.g., no pending requests or interactions).	4.1	The system displays a message: "No recent activity" and suggests actions.

3.4.6 Explore Contractors

Name	Explore Contractors		
Actors	User (Admin, Regular User)		
Summary	The system allows users to search for contractors using criteria like location, expertise, and ratings, and view detailed profiles.		
Pre-Conditions	Contractors must have completed profiles in the system.		
Post-Conditions	The user can view a list of contractors matching the search criteria and navigate to detailed profiles.		
Special Requirements	The search must provide accurate results and be responsive.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the "Explore Contractors" page.	2	The system displays search and filtering options.
3	The user enters search criteria (e.g., location) and submits.	4	The system fetches and displays a list of matching contractors.
5	The user clicks a contractor profile.	6	The system displays detailed contractor information, including ratings and reviews.
Alternative Flow			
3.1	The user enters search criteria yielding no results.	6.1	The system displays a message: "No contractors found matching your criteria."

3.4.7 Explore Service Providers

Name	Explore Service Providers		
Actors	User (Admin, Regular User)		
Summary	The system allows users to search for service providers offering tools or services, using criteria like pricing, availability, and location.		
Pre-Conditions	Service providers must have completed profiles and listings in the system.		
Post-Conditions	The user can view service providers matching the criteria and navigate to detailed profiles.		
Special Requirements	Results must include clear pricing, availability, and ratings information.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the "Explore Service Providers" page.	2	The system displays search and filtering options.
3	The user enters search criteria and submits.	4	The system fetches and displays a list of matching providers.
5	The user clicks a provider profile.	6	The system displays detailed information, including available tools/services and pricing.

Alternative Flow			
3.1	The user enters criteria yielding no results.	6.1	The system displays a message: "No providers found matching your criteria."

3.4.8 Search and Filter Contractors/Service Providers

Name	Search and Filter Contractors/Service Providers		
Actors	User (Admin, Regular User)		
Summary	The system allows users to perform detailed searches using filters such as location, rating, and expertise, and view matching results.		
Pre-Conditions	Contractors and service providers must have relevant profile details populated.		
Post-Conditions	The user can view a list of results matching the search criteria.		
Special Requirements	Filtering and search must be accurate and fast.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the search section.	2	The system displays a search bar and filter options (e.g., expertise, location).
3	The user applies filters or enters search terms.	4	The system dynamically updates the results based on the criteria.
Alternative Flow			
3.1	The user enters search criteria that yield no results.	3.2	The system displays a message: "No contractors or service providers found matching your criteria."
3.3	The user modifies the search criteria.	4.1	The system reprocesses the search and displays updated results (if any).

3.4.9 View Contractor Profile

Name	View Contractor Profile		
Actors	User (Admin, Regular User)		
Summary	The system allows users to view detailed contractor profiles, including expertise, ratings, reviews, and availability.		
Pre-Conditions	Contractors must have completed profiles.		
Post-Conditions	The user views detailed information about a contractor.		
Special Requirements	Profile details must be displayed in an intuitive and user-friendly format.		
Basic Flow			
Actor Action		**System Response**	

1	The user selects a contractor from the search results.	2	The system displays the contractor's detailed profile, including expertise, availability, and ratings.
Alternative Flow			
1.1	The user selects an inactive or unavailable contractor.	1.2	The system displays a message: "This profile is currently unavailable."

3.4.10 View Service Provider Profile

Name	View Service Provider Profile		
Actors	User (Admin, Regular User)		
Summary	The system allows users to view detailed profiles of service providers, including offered tools/services, pricing, and reviews.		
Pre-Conditions	Service providers must have completed profiles.		
Post-Conditions	The user views detailed information about a service provider.		
Special Requirements	Profiles must include ratings, pricing, and availability.		
Basic Flow			
Actor Action		**System Response**	
1	The user selects a service provider from the search results.	2	The system displays the service provider's detailed profile, including services, pricing, and ratings.
Alternative Flow			
1.1	The user selects an inactive or unavailable service provider.	1.2	The system displays a message: "This profile is currently unavailable."

3.4.11 Send Service Requests

Name	Send Service Requests		
Actors	Regular User		
Summary	The system allows users to send service requests to contractors or service providers after exploring profiles.		
Pre-Conditions	The user must be logged in, and contractors/providers must have active profiles.		
Post-Conditions	The service request is sent, and the contractor/provider is notified.		
Special Requirements	Requests must be logged for tracking purposes.		
Basic Flow			
Actor Action		**System Response**	

1	The user selects a contractor or service provider.	2	The system displays the profile with a "Send Request" button.
3	The user clicks "Send Request" and fills in request details.	4	The system validates the input and sends the request.
Alternative Flow			
4.1	The user enters incomplete or invalid details.	4.2	The system prompts the user to correct the input.

3.4.12 Provide Feedback and Ratings

Name	Provide Feedback and Ratings		
Actors	User (Contractor, Regular User, service provider)		
Summary	The system allows users to provide feedback and rate contractors or service providers based on their interactions or services rendered. This feedback is stored and displayed publicly on the contractor's or service provider's profile.		
Pre-Conditions	The user must have interacted with the contractor or service provider (e.g., completed a service request).		
Post-Conditions	Feedback and ratings are saved in the database and displayed on the relevant profile.		
Special Requirements	Feedback must be moderated to prevent inappropriate content.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the contractor or service provider's profile.	2	The system displays the profile with an option to provide feedback and a rating.
3	The user clicks on the "Provide Feedback" button.	4	The system displays a form for entering feedback and selecting a rating
Alternative Flow			
2.1	The user submits feedback that violates content guidelines (e.g., inappropriate language).	4.1	The system detects and rejects the feedback, displaying an error message: "Your feedback contains inappropriate content."
3.1	The user attempts to provide feedback for a contractor or service provider they haven't interacted with.	4.2	The system displays an error message: "Feedback can only be provided for completed interactions."

3.4.13 Contractor Login

Name	Contractor Login
Actors	Contractor
Summary	The system allows contractors to log in by providing their email and password. Upon successful verification, the contractor is redirected to their dashboard.

Pre-Conditions	The contractor must have an existing account.		
Post-Conditions	The contractor is authenticated and redirected to their dashboard. A session is established and maintained.		
Special Requirements	Login information must be encrypted using HTTPS for secure transmission.		
Basic Flow			
Actor Action		**System Response**	
1	The contractor navigates to the login page.	2	The login page is displayed, requesting email and password.
3	The contractor enters valid credentials.	4	The system verifies the credentials, establishes a session, and redirects them.
Alternative Flow			
3.1	The contractor enters invalid credentials.	4.1	The system displays an error message: "Incorrect email or password entered."

3.4.14 Contractor Signup

Name	Contractor Signup		
Actors	Contractor		
Summary	The system allows contractors to create a new account by providing details such as name, email, password, and expertise.		
Pre-Conditions	None		
Post-Conditions	A new contractor account is created, and the contractor can log in.		
Special Requirements	Input validation must ensure data integrity.		
Basic Flow			
Actor Action		**System Response**	
1	The contractor navigates to the sign-up page.	2	The system displays the sign-up form, requesting name, email, password, and expertise.
3	The contractor enters their details and submits.	4	The system validates the input and creates the account.
		5	A success message is displayed, and the contractor is redirected to the login page.
Alternative Flow			
3.1	The contractor enters invalid or duplicate data.	3.2	The system displays an error message indicating the issue (e.g., "Email already exists").

3.4.15 Manage Contractor Profile

Name	Manage Contractor Profile		
Actors	Contractor		
Summary	The system allows contractors to update their profile details, such as name, contact information, and expertise.		
Pre-Conditions	The contractor must be logged in.		
Post-Conditions	The contractor's updated information is saved and reflected in the system.		
Special Requirements	Validation and secure storage of data.		
Basic Flow			
Actor Action		**System Response**	
1	The contractor navigates to the profile page.	2	The system displays the current profile details.
3	The contractor edits their information and submits.	4	The system validates and updates the profile.
		5	A success message is displayed.
Alternative Flow			
3.1	The contractor enters invalid data (e.g., invalid phone number).	4.1	The system displays an error message indicating the issue.

3.4.16 View Contractor Dashboard

Name	View Contractor Dashboard		
Actors	Contractor		
Summary	The contractor's dashboard provides an overview of their pending requests, scheduled tasks, and feedback ratings.		
Pre-Conditions	The contractor must be logged in.		
Post-Conditions	The contractor can view and interact with their role-specific data.		
Special Requirements	The dashboard must load relevant data dynamically.		
Basic Flow			
Actor Action		**System Response**	
1	The contractor logs in and navigates to the dashboard.	2	The system fetches and displays the contractor’s data (e.g., pending requests).
3	The contractor interacts with dashboard elements (e.g., notifications, schedule management).	4	The system responds to user actions appropriately.

Alternative Flow			
3.1	The contractor logs into their dashboard.	4.1	The system displays a message: "No pending service requests found."
2.1	The contractor navigates to other sections of the dashboard (e.g., profile, feedback).	2.2	The system allows access to other sections without showing request details.

3.4.17 View Feedback and Ratings

Name	View Feedback and Ratings		
Actors	Contractor		
Summary	The system allows contractors to view feedback and ratings provided by users for completed service requests.		
Pre-Conditions	The contractor must be logged in.		
Post-Conditions	Feedback and ratings are displayed, helping the contractor assess their performance.		
Special Requirements	Feedback must be presented in a clear, chronological format.		
Basic Flow			
Actor Action		**System Response**	
1	The contractor navigates to the "Feedback" section.	2	The system displays feedback and ratings left by users.
Alternative Flow			
2.1	There is no feedback available.	2.2	The system displays a message: "No feedback available yet."

3.4.18 Service Provider Login

Name	Service Provider Login
Actors	Service Provider
Summary	The system allows service providers to log in by providing their email and password. Upon successful verification, they are redirected to their dashboard.
Pre-Conditions	The service provider must have an existing account.
Post-Conditions	The service provider is authenticated and redirected to their dashboard. A session is established and maintained.
Special Requirements	Login information must be encrypted using HTTPS for secure transmission.

Basic Flow			
Actor Action		System Response	
1	The service provider navigates to the login page.	2	The login page is displayed, requesting email and password.
3	The service provider enters valid credentials.	4	The system verifies the credentials, establishes a session, and redirects them.
Alternative Flow			
3.1	The service provider enters invalid credentials.	4.1	The system displays an error message: "Incorrect email or password entered."

3.4.19 Service Provider Signup

Name	Service Provider Signup		
Actors	Service Provider		
Summary	The system allows service providers to create a new account by providing details such as name, email, password, and services offered.		
Pre-Conditions	None		
Post-Conditions	A new service provider account is created, and the provider can log in.		
Special Requirements	Input validation must ensure data integrity.		
Basic Flow			
Actor Action		**System Response**	
1	The service provider navigates to the sign-up page.	2	The system displays the sign-up form, requesting name, email, password, and services.
3	The service provider enters their details and submits.	4	The system validates the input and creates the account.
		5	A success message is displayed, and the service provider is redirected to the login page.
Alternative Flow			
3.1	The service provider enters invalid or duplicate data.	4.1	The system displays an error message indicating the issue (e.g., "Email already exists").

3.4.20 Manage Service Provider Profile

Name	Manage Service Provider Profile
Actors	Service Provider

Summary	The system allows service providers to update their profile details, such as name, contact information, and services offered.		
Pre-Conditions	The service provider must be logged in.		
Post-Conditions	The updated profile is saved and reflected in the system.		
Special Requirements	Validation and secure storage of data.		
Basic Flow			
Actor Action		**System Response**	
1	The service provider navigates to the profile page.	2	The system displays the current profile details.
3	The service provider edits their information and submits.	4	The system validates and updates the profile.
		5	A success message is displayed.
Alternative Flow			
4.1	The service provider enters invalid data (e.g., invalid phone number).	4.2	The system displays an error message indicating the issue.

3.4.21 View Service Provider Dashboard

Name	View Service Provider Dashboard		
Actors	Service Provider		
Summary	The service provider's dashboard provides an overview of pending requests, tools/services listed, and feedback.		
Pre-Conditions	The service provider must be logged in.		
Post-Conditions	The service provider can view and interact with role-specific data.		
Special Requirements	The dashboard must load relevant data dynamically.		
Basic Flow			
Actor Action		**System Response**	
1	The service provider logs in and navigates to the dashboard.	2	The system fetches and displays data such as pending requests and listed tools/services.
Alternative Flow			
1.1	The service provider logs into their dashboard.	2.1	The system displays a message: "No pending requests at the moment."
		2.2	The system displays an error message: "Unable to load data. Please try again later."
		2.3	The system displays a prompt: "Your

			service listing is incomplete. Please update your profile to proceed."

3.4.22 View Feedback and Ratings

Name	View Feedback and Ratings		
Actors	Service Provider		
Summary	The system allows service providers to view feedback and ratings provided by users for completed requests.		
Pre-Conditions	The service provider must be logged in.		
Post-Conditions	Feedback and ratings are displayed, helping the provider assess their performance.		
Special Requirements	Feedback must be presented in a clear, chronological format.		
Basic Flow			
Actor Action		**System Response**	
1	The service provider navigates to the "Feedback" section.	2	The system displays feedback and ratings left by users.
Alternative Flow			
2.1	There is no feedback available.	2.2	The system displays a message: "No feedback available yet."

3.4.23 Cost Calculator

Name	Cost Calculator		
Actors	User		
Summary	The system allows users to calculate estimated construction costs by inputting project details such as area, materials, and labor requirements.		
Pre-Conditions	None		
Post-Conditions	The system displays a cost estimate based on the user-provided data.		
Special Requirements	Ensure accurate calculation logic and user-friendly interface.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the cost calculator page.	2	The system displays a form for entering project details (e.g., area, materials).
3	The user inputs the required data and submits.	4	The system processes the inputs and calculates an estimated cost.

5	The system displays the calculated cost.		
Alternative Flow			
4.1	The user provides incomplete or invalid inputs.	4.2	The system prompts the user to correct the errors.

3.4.24 Generate Front Elevation Design

Name	Generate Front Elevation Design		
Actors	User		
Summary	The system uses a GAN model to generate a front elevation design based on user-provided preferences such as dimensions and style.		
Pre-Conditions	None		
Post-Conditions	The system generates and displays a front elevation design.		
Special Requirements	Ensure the generation process is efficient, and results are visually accurate and appealing.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the "Generate Front Elevation" page.	2	The system displays a form for inputting design preferences.
3	The user enters required details and submits.	4	The system processes the inputs using the GAN model and generates a design.
5	The system displays the generated design to the user.		
Alternative Flow			
3.1	The user provides incomplete or invalid data.	4.1	The system prompts the user to correct the inputs.

3.4.25 Explore Blogs and News

Name	Explore Blogs and News
Actors	User
Summary	The system allows users to browse blogs and news articles related to construction trends, technologies, and industry updates.
Pre-Conditions	Blogs and news must be available in the system.
Post-Conditions	The user views and navigates through relevant blogs or news articles.
Special Requirements	Ensure content is categorized and easy to navigate.

Basic Flow			
Actor Action		System Response	
1	The user navigates to the "Blogs and News" page.	2	The system displays a list of blogs and news articles.
3	The user selects a blog or news article to read.	4	The system displays the selected content in a readable format.
Alternative Flow			
4.1	There are no blogs or news articles available.	4.2	The system displays a message: "No blogs or news available at this time."

3.4.26 Search and Read News Articles

Name	Search and Read News Articles			
Actors	User			
Summary	The system allows users to search for specific news articles using keywords and filters.			
Pre-Conditions	News articles must be available in the system.			
Post-Conditions	The user views relevant news articles matching the search criteria.			
Special Requirements	Ensure search results are accurate and relevant.			
Basic Flow				
Actor Action			**System Response**	
1	The user navigates to the "Search News" section.		2	The system displays a search bar and filtering options.
3	The user enters keywords or applies filters (e.g., date, category) and submits.		4	The system displays a list of matching news articles.
5	The user selects a news article to read.		6	The system displays the selected article.
Alternative Flow				
5.1	The search criteria yield no results.		6.1	The system displays a message: "No articles found matching your search."

3.4.27 Book Consultation

Name	Book Consultation
Actors	User
Summary	The system allows users to book a consultation with contractors or service providers by specifying details like preferred date and time.

Pre-Conditions	The user must be logged in.		
Post-Conditions	The consultation request is sent to the contractor or service provider.		
Special Requirements	The system must check the contractor's or service provider's availability before confirming the booking.		
Basic Flow			
Actor Action		**System Response**	
1	The user navigates to the "Book Consultation" page.	2	The system displays a form for entering consultation details (e.g., date, time).
3	The user enters the details and submits the form.	4	The system checks availability and sends the request to the contractor/provider.
5	The system displays a confirmation message.		
Alternative Flow			
4.1	The selected date/time is unavailable.	2.1	The system prompts the user to select a different date/time.

3.4.28 Admin Login

Name	Admin Login		
Actors	Admin		
Summary	The system allows the admin to log in by providing their email and password. Upon successful verification, they are redirected to the admin dashboard.		
Pre-Conditions	The admin must have an existing account.		
Post-Conditions	The admin is authenticated and redirected to their dashboard. A session is established and maintained.		
Special Requirements	Login information must be encrypted using HTTPS for secure transmission.		
Basic Flow			
Actor Action		**System Response**	
1	The admin navigates to the login page.	2	The login page is displayed, requesting email and password.
3	The admin enters valid credentials.	4	The system verifies the credentials, establishes a session, and redirects them.
Alternative Flow			
3.1	The admin enters invalid credentials.	4.1	The system displays an error message: "Incorrect email or password entered."

3.4.29 Manage User Accounts (Approve/Deactivate)

Name	Manage User Accounts		
Actors	Admin		
Summary	The system allows the admin to view, approve, deactivate, or delete user accounts.		
Pre-Conditions	Users must have registered accounts.		
Post-Conditions	User account statuses are updated based on admin actions.		
Special Requirements	Ensure actions are logged for audit purposes.		
Basic Flow			
Actor Action		**System Response**	
1	The admin navigates to the "User Management" section.	2	The system displays a list of registered users with their statuses.
3	The admin selects a user to approve, deactivate, or delete.	4	The system updates the account status and displays a confirmation message.
Alternative Flow			
3.1	The admin selects an invalid user or tries to update a non-existent account.	4.1	The system displays an error message: "User account not found."

3.4.30 Manage Contractor Profiles and Services

Name	Manage Contractor Profiles and Services		
Actors	Admin		
Summary	The system allows the admin to review, approve, or deactivate contractor profiles and services.		
Pre-Conditions	Contractors must have registered and listed their services.		
Post-Conditions	Contractor profiles and services are updated based on admin actions.		
Special Requirements	Notifications must be sent to contractors about any changes to their profiles or services.		
Basic Flow			
Actor Action		**System Response**	
1	The admin navigates to the "Contractor Management" section.	2	The system displays a list of contractor profiles and services.
3	The admin reviews and approves or deactivates profiles or services.	4	The system updates the profile/service status and notifies the contractor.
Alternative Flow			

2.1	The admin attempts to approve a contractor profile with missing or invalid data.	2.2	The system displays an error: "Profile data is incomplete or invalid."
3.1	The admin attempts to deactivate an already deactivated contractor profile.	3.2	The system displays a message: "This profile is already deactivated."

3.4.31 Manage Service Provider Profiles and Listings

Name	Manage Service Provider Profiles and Listings		
Actors	Admin		
Summary	The system allows the admin to review, approve, or deactivate service provider profiles and tool/service listings.		
Pre-Conditions	Service providers must have registered and listed their tools/services.		
Post-Conditions	Service provider profiles and listings are updated based on admin actions.		
Special Requirements	Notifications must be sent to service providers about any changes to their profiles or listings.		
Basic Flow			
Actor Action		**System Response**	
1	The admin navigates to the "Service Provider Management" section.	2	The system displays a list of service provider profiles and listings.
3	The admin reviews and approves or deactivates profiles or listings.	4	The system updates the status and notifies the service provider.
Alternative Flow			
2.1	The admin attempts to approve a service provider listing with missing details.	2.2	The system displays an error: "Listing data is incomplete or invalid."
3.1	The admin attempts to deactivate an already deactivated listing.	3.2	The system displays a message: "This listing is already deactivated."

3.4.32 Moderate Feedback and Ratings

Name	Moderate Feedback and Ratings
Actors	Admin
Summary	The system allows the admin to monitor and remove inappropriate feedback or ratings left by users.
Pre-Conditions	Users must have submitted feedback or ratings.
Post-Conditions	Inappropriate feedback or ratings are removed, and relevant users are notified.

Special Requirements	Offensive content should be flagged for review automatically.		
Basic Flow			
Actor Action		**System Response**	
1	The admin navigates to the "Feedback Moderation" section.	2	The system displays a list of feedback and ratings flagged for review.
3	The admin reviews and removes inappropriate feedback or ratings.	4	The system updates the status and notifies the user who left the feedback.
Alternative Flow.			
2.1	The admin attempts to moderate a feedback entry that no longer exists.	2.2	The system displays an error: "Feedback not found."
3.1	The admin attempts to remove already moderated feedback.	4.1	The system displays a message: "Feedback has already been removed."

3.4.33 Configure Platform Settings (e.g., Categories, Pricing Policies)

Name	Configure Platform Settings		
Actors	Admin		
Summary	The system allows the admin to manage global platform settings, such as service categories, pricing policies, and platform-wide configurations.		
Pre-Conditions	None		
Post-Conditions	Platform settings are updated and applied system-wide.		
Special Requirements	Changes must be logged and take effect immediately.		
Basic Flow			
Actor Action		**System Response**	
1	The admin navigates to the "Settings" section.	2	The system displays options for managing platform configurations.
3	The admin updates settings (e.g., categories, pricing) and saves changes.	4	The system applies the updates and displays a success message.
Alternative Flow.			
3.1	The admin enters invalid or conflicting configuration settings.	4.1	The system displays an error: "Invalid input. Please review and correct the configuration."
3.2	The admin attempts to save changes, but the update fails.	4.2	The system displays an error: "Failed to update settings. Please try again later."

Chapter 4: Implementation and Test Cases

For FYP-1, we have successfully developed the initial prototype of the Innovative AI Solutions for Smart Construction platform. Below is a detailed description of the implemented components:

4.1 Implementation

I. Front Elevation Generation

We have implemented a Deep Convolutional Generative Adversarial Network (DCGAN) model trained on a curated dataset of 500–600 house front elevation images. The model generates realistic and customizable house designs based on user inputs, such as plot dimensions and architectural style preferences. This feature allows users to visualize potential designs tailored to their requirements. The integration of this trained model into the platform ensures users can generate and view designs directly through the web interface.

II. Cost Calculation

An algorithm for cost estimation has been developed to provide accurate and real-time project budgets. The cost calculator takes user-provided details, such as plot area, and combines them with up-to-date market data on labor and material costs. This tool equips users with detailed financial insights, enabling them to plan their projects effectively and avoid unexpected expenses.

III. Web Front-End

The platform's front-end has been developed using React.js to deliver a responsive, user-friendly, and visually appealing interface. Essential functionalities, such as AI design generation forms, cost estimation tools, and user authentication, have been integrated. The front-end interface ensures an intuitive and smooth user experience across various devices, including desktops and mobile phones.

IV. Model Integration

The trained DCGAN model has been successfully integrated with the platform's back-end to enable seamless interaction between the AI component and the user interface. APIs have been developed to handle design generation requests from the front-end, process them via the AI model, and return the generated designs for display. This integration bridges the gap between AI functionality and user interaction.

V. Partial Back-End Development

The back-end of the platform has been partially implemented using Node.js and Express.js. It currently supports core functionalities such as user registration, login, and handling requests for design generation. APIs have been developed and tested to ensure reliable communication between the front-end and the AI model. While some advanced features like the community chat and bidding system are pending implementation, the current back-end setup provides a solid foundation for future enhancements.

Implementation Summary

The progress achieved so far demonstrates the core functionalities of the platform, including AI-driven front elevation generation, cost calculation, and a working web interface. Subsequent efforts will focus on completing the back-end, refining user interaction features, and implementing additional modules like community chat and the bidding system.

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Figure 3: references