1. INTRODUCTION

1.1 Project Overview

Civil Engineering Insight Studio is an analytical and decision-support platform designed to assist civil engineers, urban planners, and infrastructure authorities in planning, designing, monitoring, and optimizing civil infrastructure projects. The studio integrates engineering data, analytical models, and visualization tools to provide actionable insights across domains such as transportation, structural health, water resources, and urban development.

Rapid urbanization, aging infrastructure, and increasing demand for sustainable development have made data-driven decision-making essential in civil engineering. Civil Engineering Insight Studio addresses these challenges by transforming raw engineering and environmental data into meaningful insights that support safer designs, efficient construction practices, and long-term infrastructure sustainability.

1.2 Objectives

1. **To develop a centralized analytics platform** for managing and visualizing civil engineering project data efficiently.
2. **To enable data-driven decision-making** by providing real-time insights into construction progress, resource usage, and project performance.
3. **To monitor infrastructure health and safety parameters** using structured data analysis and visual dashboards.
4. **To improve project planning and scheduling accuracy** by analyzing historical and real-time construction data.
5. **To track material usage and cost estimation** to reduce wastage and control project budgets.
6. **To enhance collaboration among stakeholders** (engineers, managers, and planners) through shared insights and reports.
7. **To identify risks and delays early** using predictive analytics and trend analysis.
8. **To support sustainable construction practices** by analyzing environmental impact and resource efficiency.

9. **To provide customizable dashboards and reports** tailored to different civil engineering domains such as roads, buildings, and bridges.
10. **To ensure scalability and reliability** of the system for handling large volumes of engineering data.

2. PROJECT INITIALIZATION AND PLANNING PHASE

2.1. Defining Problem Statement

Date	28 January 2026
Team ID	LTVIP2026TMIDS66183
Project Name	Civil Engineering Insight Studio
Maximum Marks	3 Marks

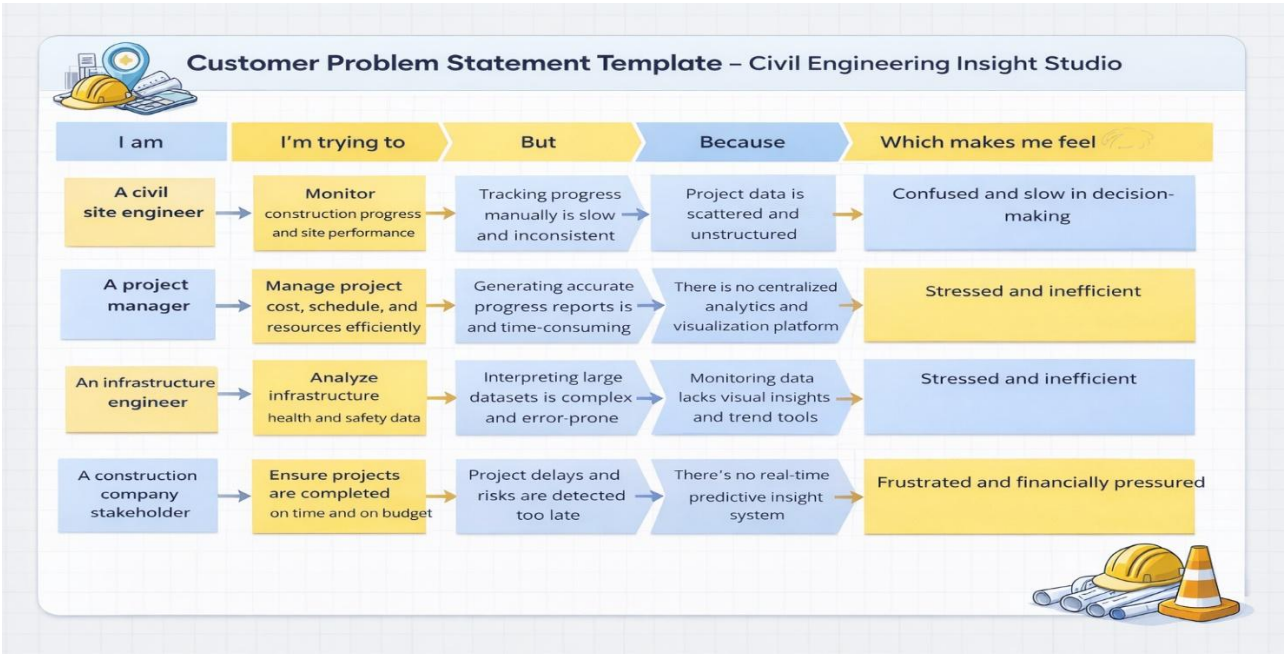
Define Problem Statements (Customer Problem Statement Template):

Civil engineering projects generate large volumes of data related to planning, design, construction progress, resource utilization, cost estimation, and infrastructure health. In traditional project management practices, this data is often stored in isolated systems, spreadsheets, or manual records, making it difficult to analyze, visualize, and utilize effectively. As a result, project stakeholders face challenges such as poor visibility into project status, delayed decision-making, cost overruns, inefficient resource allocation, and increased risk of project delays and safety issues.

Existing systems lack an integrated platform that can transform raw civil engineering data into meaningful insights through real-time monitoring and visualization. The absence of centralized analytics tools limits the ability to detect risks early, track performance efficiently, and support data-driven decision-making. Therefore, there is a need for a comprehensive and intelligent solution that consolidates civil engineering project data, provides actionable insights, and enhances planning, monitoring, and management processes.

The **Civil Engineering Insight Studio** aims to address these challenges by offering a unified analytics platform that enables efficient data management, visualization, and analysis to improve project efficiency, safety, cost control, and overall infrastructure management.

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	A civil site engineer	monitor construction progress and site performance	project data is scattered across reports, spreadsheets, and manual logs	there is no centralized system to visualize and analyze real-time project data	confused and unable to make quick decisions
PS-2	A structural or infrastructure engineer	assess infrastructure health and safety conditions	analyzing large volumes of inspection and monitoring data is difficult	data visualization and trend analysis tools are limited	uncertain and concerned about safety risks
PS-3	A construction company stakeholder	ensure timely project delivery within budget	delays and risks are identified too late	there is no predictive or insight-driven monitoring system	frustrated and financially pressured



Reference: https://miro.com/templates/customer-problem-statement/

2.2. Project Proposal (Proposed Solution)

Date	31 January 2026
Team ID	LTVIP2026TMIDS66183
Project Title	Civil Engineering Insight Studio
Maximum Marks	3 Marks

Project Proposal (Proposed Solution) template

Civil Engineering Insight Studio For Your Next Journey is a centralized data analytics and visualization platform designed to support efficient planning, monitoring, and management of civil engineering projects. The system transforms fragmented project data into meaningful insights that assist engineers, managers, and stakeholders in making informed decisions. The application is built using Streamlit and provides a simple interface for users to make decisions and assist work quickly.

Project Overview	
Objective	The objective of our Civil Engineering Insight Studio project is to develop a centralized analytics platform that provides real-time insights for effective planning, monitoring, and management of civil engineering projects.
Scope	This project focuses on the development of a data-driven analytics and visualization platform to support effective planning, monitoring, and management of civil engineering projects. The project primarily emphasizes data analysis, reporting, and decision support rather than physical construction activities.
Problem Statement	
Description	**Civil Engineering Insight Studio** is a data-driven analytics and visualization platform that helps monitor and manage civil engineering projects efficiently. It centralizes project data, provides clear insights on progress, cost, and resources, and supports informed decision-making through interactive dashboards.

Impact	It improves efficiency and decision-making in civil engineering projects by providing centralized data analytics and visualization. It reduces manual effort, enhances project transparency, enables early detection of delays and risks, improves cost and resource management, and supports better planning and infrastructure monitoring, leading to more reliable and timely project execution.
Proposed Solution	
Approach	Project requirements are first analyzed to identify key metrics and user needs. Relevant civil engineering data is then collected, cleaned, and stored in a centralized database. Analytical techniques are applied to process the data and extract meaningful insights. These insights are presented through interactive dashboards and reports, enabling stakeholders to monitor progress, manage resources, control costs, and make informed decisions effectively.
Key Features	• Centralized data management for civil engineering projects • Real-time monitoring of construction progress • Cost, schedule, and resource utilization analysis • Interactive dashboards and visual reports • Early identification of project delays and risks

Resource Requirements

Resource Type	**Description**	**Specification/Allocation**
Hardware		
Computing Resources	Standard personal computer	Windows 11 Home Single Language
Memory	Minimum 4 GB	16 GB
Storage	Minimum 20 GB free space	256 GB SSD
Software		
Frameworks	Python, Streamlit frameworks	Streamlit
Libraries	google-generativeai, streamlit	google-generativeai, streamlit

Development Environment	IDE, version control	Visual Studio Code, Git
Data		
Data	Resource data (labor, materials, equipment usage) Schedule data (planned vs actual dates)	User Input

2.3. Initial Project Planning

Date	02 February 2026
Team ID	LTVIP2026TMIDS66183
Project Name	Civil Engineering Insight Studio
Maximum Marks	4 Marks

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create a product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Project Setup & Infrastructure	USN-1	Configure the project environment by installing required software tools, libraries, and frameworks needed for developing the Civil Engineering Insight Studio.	1	Medium	Suhitha, Aswini

Sprint-1	Data Collection& Preprocessing	USN-2	As a developer, I want to collect and preprocess civil engineering project data (loads, materials, dimensions) so that it can be used for analysis and insight generation.	2	High	Gowtham, Niteesh
Sprint-2	Analysis Module Integration	USN-3	As a developer, I want to integrate structural safety, material optimization, and cost analysis modules into the web application to provide engineering insights.	2	High	Aswini, Suhitha
Sprint-2	Error Handling & Input Validation	USN-4	As a user, I want to receive proper error messages when incorrect or incomplete project data is entered so that I can correct it easily	2	High	Suhitha, Aswini, Niteeshwar Reddy, Gowtham
Sprint-3	Project Setup & Infrastructure	USN-1	Configure the project environment by installing required	1	Medium	Suhitha, Aswini

			software tools, libraries, and frameworks needed for developing the Civil Engineering Insight Studio.			
Sprint-3	Data Collection& Preprocessing	USN-2	As a developer, I want to collect and preprocess civil engineering project data (loads, materials, dimensions) so that it can be used for analysis and insight generation.	2	High	Gowtham, Niteesh
Sprint-4	Analysis Module Integration	USN-3	As a developer, I want to integrate structural safety, material optimization, and cost analysis modules into the web application to provide engineering insights.	2	High	Aswini, Suhitha

3. DATA COLLECTION AND PREPROCESSING PHASE

3.1. Data Collection plan and Raw Data Sources Identified

Date	05 February 2026
Team ID	LTVIP2026TMIDS66183
Project Title	Civil Engineering Insight Studio
Maximum Marks	2 Marks

Data Collection Plan & Raw Data Sources Identification

This phase data is collected from project planning documents, construction progress reports, cost and budget records, resource utilization logs, and infrastructure inspection reports, along with simulated and open-source datasets, which are cleaned, validated, and stored in a centralized database for analysis and visualization.

Data Collection Plan

Section	**Description**
Project Overview	*The **Civil Engineering Insight Studio** is a data-driven analytics and visualization platform designed to support efficient planning, monitoring, and management of civil engineering projects. It centralizes project-related data such as construction progress, cost, schedule, and resource usage, and converts it into actionable insights through analytical processing and interactive dashboards. The system helps engineers, project managers, and stakeholders track performance, identify risks early, and make informed decisions, ultimately improving project efficiency, transparency, and reliability.*
Data Collection Plan	**Civil Engineering Insight Studio** project is collected from project planning documents, construction progress reports, cost and budget records, resource utilization logs, and infrastructure inspection reports. Additional data is obtained from simulated academic datasets and open-source civil engineering sources. The collected data is

	cleaned, validated, and organized in a centralized database to support effective analysis, visualization, and decision-making.
RawDataSources Identified	The raw data for the **Civil Engineering Insight Studio** project consists of unprocessed project-related information collected from construction and infrastructure activities. This includes project details, daily and weekly construction progress reports, cost and expenditure records, resource utilization logs, schedules, and infrastructure inspection data. The raw data is initially available in formats such as spreadsheets, CSV files, and manual records, which are later cleaned and structured for analysis and visualization..

Raw Data Sources

Source Name	Description	Location / Source	Format	Size	Access Permissions
User Input – Project Details	Project information entered by the user (project name, location, type)	Web Interface / Application Form	Text	Small (per entry)	Public (User Provided)
User Input – Progress Data	Construction progress updates entered by site engineers	Web Interface / Data Entry Module	Numeric / Text	Small to Medium	Authorized Users
User Input – Cost Data	Budget and expenditure details entered by project managers	Web Interface / Data Entry Module	Numeric	Small to Medium	Authorized Users

3.2. Data Quality Report

Date	07 February 2026
Team ID	LTVIP2026TMIDS66183

Project Title	Civil Engineering Insight Studio
Maximum Marks	2 Marks

Data Quality Report

Quality is ensured for all content used in the **Civil Engineering Insight Studio** by maintaining accuracy, consistency, completeness, and reliability of the data. The collected project data is validated to remove errors, duplicates, and missing values before analysis. Standardized formats and units are used across all datasets to ensure consistency. Regular checks are performed to maintain data integrity, and only authorized users are allowed to enter or modify data, ensuring the overall quality and reliability of the project insights.

Data Source	Data Quality Issue	Severity	Resolution Plan
User Input (Project Details)	Missing or incorrect project information	High	Mandatory fields and input validation ensure complete and accurate project details.
User Input (Construction Progress)	Incomplete or inconsistent progress updates	High	Standardized data entry formats and validation checks are applied.
User Input (Cost & Budget Data)	Incorrect or unrealistic cost values	High	Numeric range validation and cross-checking with budget limits are enforced.
User Input (Resource Utilization)	Missing or inconsistent labor or material data	Moderate	Predefined templates and input constraints are used.
Inspection & Maintenance Records	Outdated or inaccurate inspection data	Moderate	Periodic data review and updates are scheduled.

3.3. Data Preprocessing

Date	09 February 2026

Team ID	LTVIP2026TMIDS66183
Project Title	Civil Engineering Insight Studio
Maximum Marks	6 Marks

Preprocessing

Data preprocessing is performed to ensure that the collected raw data is accurate, consistent, and suitable for analysis. Initially, the raw data from various sources is cleaned by removing duplicate records, correcting errors, and handling missing values. Data formats, units, and naming conventions are standardized to maintain consistency across datasets. Outliers and invalid entries are identified and treated appropriately to improve data reliability

Section	**Description**
Data Overview	The data used in this project consists of civil engineering project inputs such as project details, construction progress, cost, schedule, resource usage, and inspection records. The data is collected through user inputs and simulated project datasets.
Data Cleaning	Raw project data is cleaned by removing duplicate records, correcting inconsistencies, and handling missing or invalid values.
Input Validation	Ensures that mandatory project fields are completed, progress values are within valid ranges, cost data is realistic, and resource usage entries are non-negative.
Data Standardization	Standard units, formats, and naming conventions are applied across all datasets to maintain consistency.
Analytical Processing	Validated and standardized data is processed using analytical techniques to derive project performance metrics and trends.
Error Handling	The system handles invalid inputs and processing errors gracefully by displaying appropriate messages and preventing system failure.
Data Preprocessing Templates	
Loading Data	Project-related inputs such as project details, construction progress, cost, schedule, and resource usage are collected through the application interface using text and numeric input fields.

Input Validation	Validation logic ensures that all mandatory fields are filled and that numeric values (cost, progress percentage, resource quantities) fall within acceptable ranges before further processing.
Data Structuring	The validated inputs are organized into a structured data format suitable for analysis and storage.
Analytic Handling	The structured data is processed using analytical methods to compute project performance metrics, trends, and indicators
Output Handling	The generated insights, reports, and visual dashboards are displayed through the application interface for user review and decision-making.

4. MODEL DEVELOPMENT PHASE

4.1. Model Selection Report

Date	12 February 2026
Team ID	LTVIP2026TMIDS66183
Project Title	Civil Engineering Insight Studio
Maximum Marks	5 Marks

Model Selection Report

In this project, the focus is simple analytical models are chosen due to their transparency, ease of interpretation, and suitability for structured civil engineering project data. These models ensure reliable insights and efficient system performance. The modular design of the platform also allows future integration of advanced machine learning models, such as predictive models for delay and cost estimation.

Model Selection Report:

Model	Description
Analytical Processing Model (Rule-Based & Statistical Models)	A lightweight and efficient analytical approach used to compute civil engineering project metrics such as construction progress, cost variance, schedule variance, and resource utilization. This model is well-suited for real-time project monitoring and provides transparent, easy-to-interpret insights.
Other Models (Considered)	Advanced machine learning and predictive models were conceptually reviewed, but rule-based and statistical models were selected due to their simplicity, reliability, faster processing time, and suitability for structured civil engineering project data. These models also allow easy future integration of AI-based prediction techniques if required.

Justification for Model Selection

The analytical processing model based on rule-based and statistical techniques is selected for the **Civil Engineering Insight Studio** project due to its suitability for structured civil engineering project data. These models provide clear, transparent, and easily interpretable results, which are essential for engineers and project managers to understand project performance metrics such as progress, cost variance, and resource utilization. They require minimal computational resources, ensure fast response times, and reduce system complexity. Additionally, this model supports reliable real-time monitoring and allows seamless future integration of advanced machine learning or predictive models if needed.

4.2. Initial Model Training Code, Model Validation and Evaluation Report

Date	15 February 2026
Team ID	LTVIP2026TMIDS66183
Project Title	Civil Engineering Insight Studio
Maximum Marks	10 Marks

Initial Model Training Code, Model Validation and Evaluation Report

This project does not involve custom machine learning model training. Instead, it utilizes **analytical processing models** to analyze structured civil engineering project data. Therefore, this phase focuses on model initialization, rule-based computation, analytical processing, and output evaluation rather than traditional model training and validation.

Model Initialization and Integration (5 marks):

The analytical processing model used in the **Civil Engineering Insight Studio** project is based on predefined rules and statistical calculations implemented within the application backend. The model is initialized by configuring project-specific parameters such as progress thresholds, cost variance limits, and scheduling constraints.

The system receives structured inputs including project details, construction progress updates, cost data, resource utilization, and schedule information. Based on these inputs, the analytical

model computes key performance indicators such as project completion percentage, cost variance, schedule variance, and resource efficiency metrics.

Model Validation and Evaluation Report (5 marks):

Model validation in the **Civil Engineering Insight Studio** project ensures that the analytical processing model produces accurate, consistent, and reliable project insights. Since the project uses rule-based and statistical analytical models rather than trained machine learning models, validation focuses on correctness of computations and reliability of outputs.

Validation is performed by comparing the model-generated metrics, such as project progress percentage, cost variance, and schedule variance, with manually calculated results using sample project data. Input boundary testing is conducted to verify that the model handles minimum, maximum, and invalid values correctly. Consistency checks ensure that repeated inputs produce identical results, confirming model stability.

5. MODEL OPTIMIZATION AND TUNING PHASE

5.1. Tuning Documentation

Date	18 February 2026
Team ID	LTVIP2026TMIDS66183
Project Title	Civil Engineering Insight Studio
Maximum Marks	10 Marks

Model Optimization and Tuning Phase

The **Model Optimization and Tuning Phase** in the **Civil Engineering Insight Studio** project focuses on improving the efficiency, accuracy, and reliability of the analytical processing model rather than adjusting machine learning parameters. Since the project uses rule-based and statistical models, optimization is achieved by refining calculation logic, improving data handling, and enhancing system performance.

Threshold values for project metrics such as progress completion, cost variance, and schedule deviation are adjusted to better reflect real-world civil engineering scenarios. Data preprocessing rules are optimized to reduce noise, handle missing values effectively, and ensure consistent inputs. Computational workflows are streamlined to minimize processing time and improve responsiveness of dashboards and reports.

Performance testing is conducted to ensure the system handles multiple project records efficiently without degradation. These optimization and tuning activities enhance the overall accuracy and usability of the Civil Engineering Insight Studio, ensuring reliable insights for effective project management.

Model	Tuned Parameters	Description

Analytical Processing Model (Rule-Based & Statistical)	Threshold Values	Defines acceptable limits for project progress, cost variance, and schedule deviation to identify risks accurately.
	Data Validation Rules	Ensures input values are within realistic and acceptable ranges for civil engineering projects.
	Aggregation Logic	Controls how data is summarized across tasks, phases, and projects to provide meaningful insights.
	Update Frequency	Determines how often analytics and dashboards are refreshed to reflect the latest project data.

Hyperparameter Tuning Documentation (8 Marks):

The Civil Engineering Insight Studio project does not employ machine learning models that require traditional hyperparameter tuning. Instead, the system uses rule-based and statistical analytical models, where tuning focuses on adjusting operational parameters to improve accuracy, reliability, and performance of project insights.

Multiple test scenarios, including normal progress, delayed execution, and budget overrun cases, are used to evaluate and fine-tune these parameters. Through iterative testing and adjustment, the system achieves consistent and reliable analytical outputs, ensuring effective decision support for civil engineering stakeholders.

Optimization Approach

- Optimize data preprocessing to remove noise, duplicates, and inconsistencies
- Refine rule-based and statistical calculations for accurate project metrics
- Tune threshold values for progress, cost variance, and schedule deviation
- Improve data aggregation logic for meaningful project-level insights

5.2 Final Model Selection Justification (2 Marks):

Final Model	Reasoning
Analytical Processing Model (Rule-Based & Statistical Models)	The final model configuration provides an optimal balance between accuracy, interpretability, and execution speed for civil engineering project analysis. The tuned thresholds, validation rules, and aggregation logic improve the reliability of project insights without increasing system complexity, making the model well-suited for real-time monitoring and decision support in civil engineering projects.

6. RESULTS

6.1. Output Screenshots

The complete execution of Civil Engineering Insight Studio application is represented step by step in the following screenshots.

Step 1: To run the Streamlit Application we have to use the command streamlit run app.py in the terminal

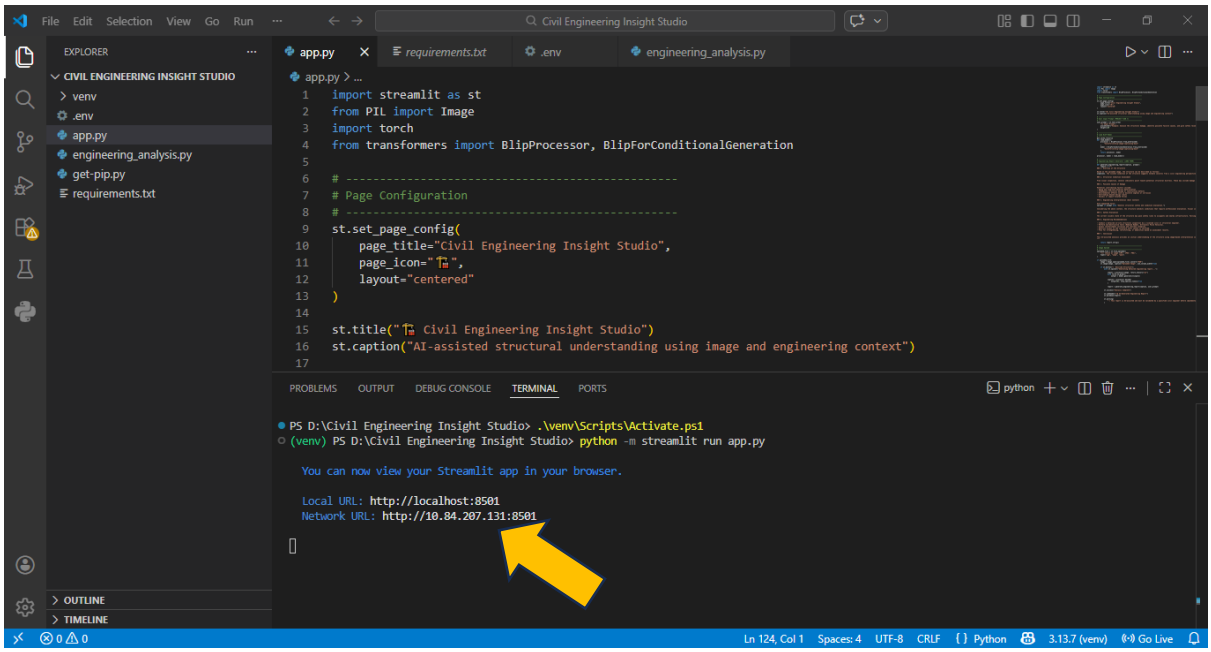


Fig 6.1.1:code running in terminal

Step 2: Opening the Application in Browser

Open your browser and navigate to:

- http://localhost:8501

Fig 6.1.2:Home page Interface

Step 3: The user has to upload the images of building to predict the reports

- Drag the image click enter**.**
- The backend processes the request using the trained model and encoder.

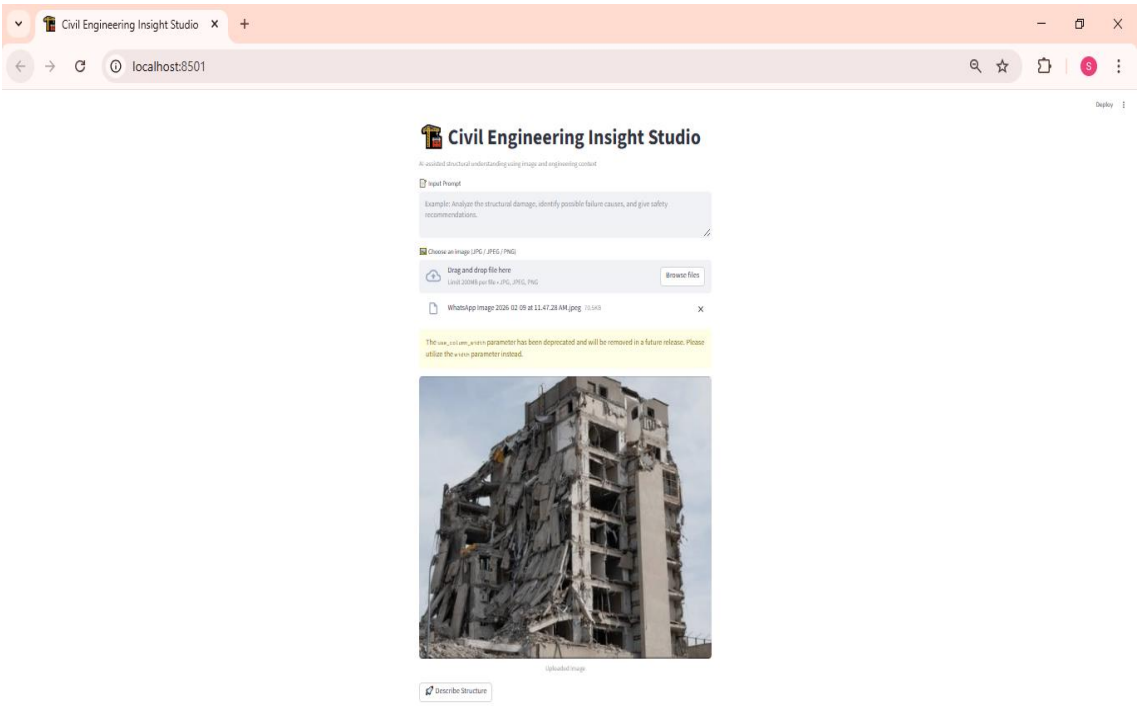


Fig 7.13: Input the image

Step-4: Viewing the Prediction Output

- The predicted insights /reports shown below:
- **Screenshot Example:**
- *Prediction result shown below the form: "* **Civil Engineering Insight Studio***: Reports "*

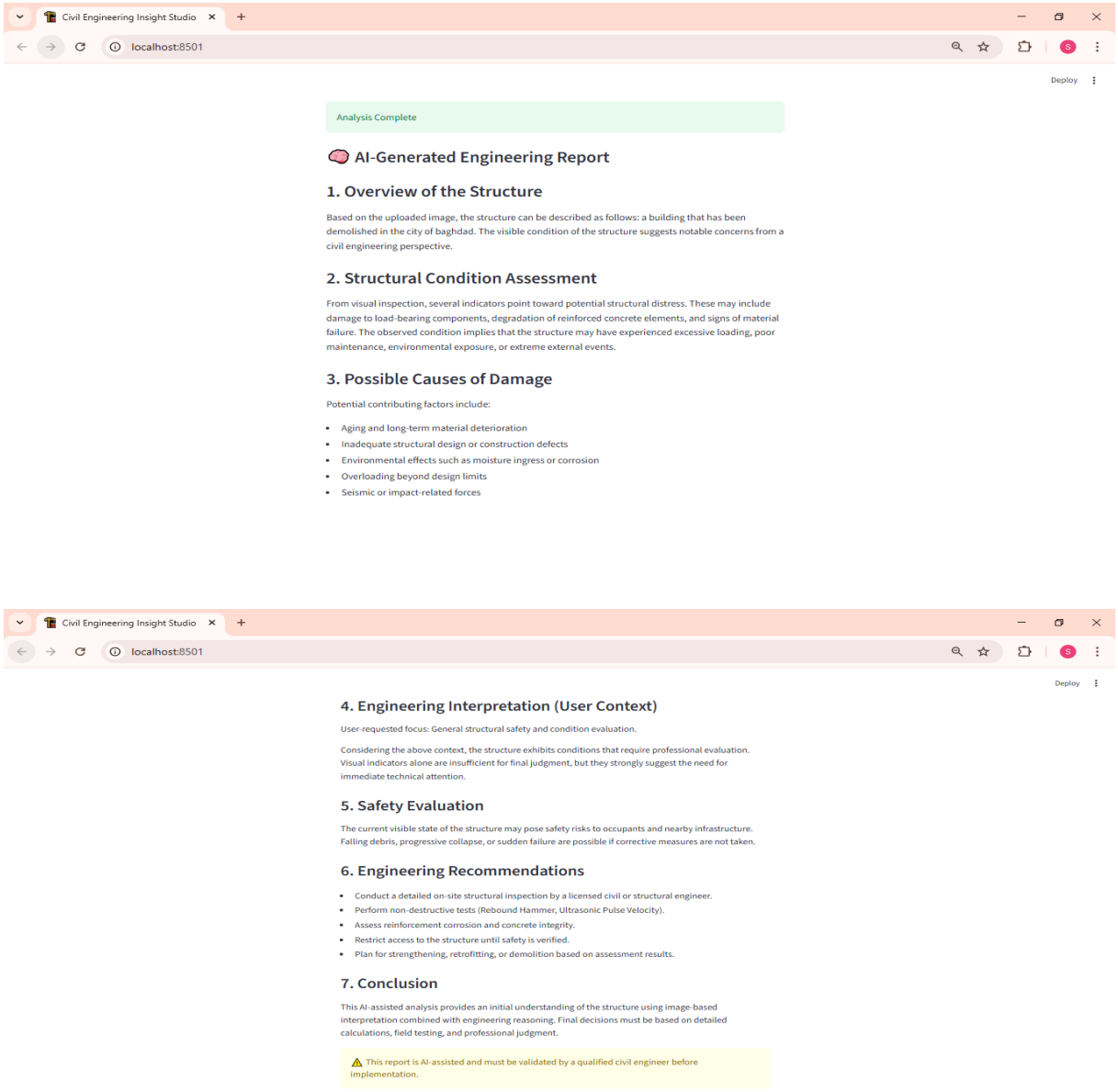


Fig 6.1.4: Predicted Outputs

7. ADVANTAGES AND DISADVANTAGES

7.1 Advantages:

1. Improved Decision-Making

Provides data-driven insights that help civil engineers and planners make informed decisions during design and construction phases.

2. Enhanced Structural Safety

Analyzes loads, stress, and safety factors, reducing the risk of structural failures and improving reliability.

3. Cost Optimization

Supports material comparison and cost analysis, helping minimize construction expenses and material wastage.

4. Time Efficiency

Reduces manual calculations and report preparation by automating analysis and insight generation.

5. Sustainability Support

Evaluates environmental impact and promotes eco-friendly construction practices.

6. Better Project Monitoring

Helps track project performance, progress, and key metrics throughout the project lifecycle.

7. Scalability

Can be extended to different civil engineering domains such as buildings, roads, bridges, and urban infrastructure.

8. Academic & Industry Use

Useful for students, researchers, and professionals for learning, analysis, and planning purposes.

7.2 Disadvantages

1. Dependency on Input Data Quality

Incorrect or incomplete project data can lead to inaccurate analysis and insights.

2. Initial Setup Effort

Requires time and effort to configure analytical models and project parameters.

3. Limited Real-Time Integration

Early versions may not support live site data or sensor integration.

4. Learning Curve

Users may need basic training to effectively use analytical features and dashboards.

5. Computational Requirements

Complex analysis may require higher computational resources for large projects.

6. Limited Automation in Early Stages

Some engineering decisions may still require manual validation and expert judgment

8. CONCLUSION

The **Civil Engineering Insight Studio** project can be enhanced by integrating advanced AI and machine learning models for predictive analysis and failure detection. Real-time data from construction sites and sensors can be incorporated for live monitoring. Integration with BIM and CAD tools will improve design accuracy and collaboration. Cloud-based deployment can enable multi-user access and large-scale project handling. The platform can also be expanded to support smart city and infrastructure planning applications.

9. FUTURE SCOPE

1. Integration of **AI and machine learning models** for predictive analysis of project delays, cost overruns, and risk assessment.
2. Real-time data collection using **IoT sensors** for infrastructure health and site monitoring.
3. Integration with **Building Information Modeling (BIM)** systems for advanced visualization and planning
4. Cloud-based deployment for **scalability and remote access**
5. Development of a **mobile application** for on-site data entry and monitoring
6. Advanced reporting with **automated alerts and recommendations**
7. Support for **smart city and large-scale infrastructure projects**

10. APPENDIX

Source Code:

All codes are submitted in Git-Hub Repository.

Git-Hub Repository Link:

Civil-Engineering-Insight-Studio-project

Project Demo Link:

https://drive.google.com/file/d/1qpsdvMhTD0QAe--R4HJQe3mXXMu_zJVL/view?usp=drivesdk