PROJECT REPORT

Advancing Nutrition Science Through Gemini AI

Internship Program : APSCHE Google Cloud Generative AI

Organization : Smartbridge

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Abstract

The construction industry significantly relies on manual site audits, which are inherently labor-intensive, time-consuming, and prone to human error, particularly in material counting and structural verification. Discrepancies in these manual logs often lead to project delays and financial losses. This project introduces the **Civil Engineering Insight Studio**, an AI-powered web platform designed to automate and enhance the structural auditing process.

The methodology involves a cloud-based application that leverages the multimodal capabilities of the **Google Gemini 2.5 Flash API** to perform visual reasoning on high-resolution construction site imagery. By integrating a **Streamlit** frontend with a **Python** logic layer and **PostgreSQL** database, the system allows field engineers to upload site photos and receive real-time material identification, automated counts for structural members like rebar and beams, and comprehensive technical audit reports.

The results demonstrate that the application can successfully process complex structural data in under 30 seconds, significantly reducing the manual workload from hours to minutes while providing a centralized digital history for project tracking. This solution bridges the gap between traditional civil engineering inspections and modern artificial intelligence, offering a scalable and secure framework for improving construction quality and operational efficiency.

Keywords: *AI-powered Audit, Google Gemini 2.5 Flash, Structural Engineering, Visual Reasoning, Construction Automation, Streamlit, Site Inspection.*

1. INTRODUCTION

1.1 Project Overview

The **Civil Engineering Insight Studio** is an AI-driven web application designed to modernize construction site inspections. By leveraging multimodal Large Language Models (LLMs), specifically **Google Gemini 2.5 Flash**, the system automates the tedious task of manual material counting and structural auditing. Field engineers can upload high-resolution images of site skeletons (like rebar cages and beams) and receive immediate technical insights, material counts, and standardized audit reports.

1.2 Purpose

The primary purpose of this project is to eliminate human error in construction inventory management and provide a scalable, fast, and secure platform for structural progress tracking. It aims to reduce the hours spent by engineers on manual logging, allowing them to focus on high-level quality assurance and safety.

2. IDEATION PHASE

2.1 Problem Statement

Manual construction site auditing and material counting (e.g., rebar, bricks, or cement bags) are slow, labor-intensive, and highly prone to human error. These inaccuracies often lead to significant project delays, budget overruns, and unreliable inventory logs.

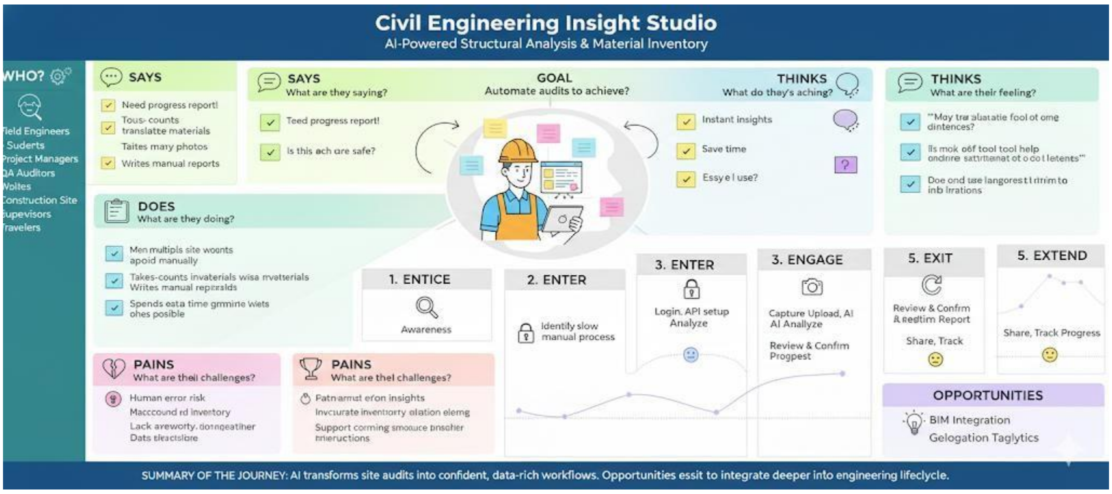
2.2 Empathy Map Canvas

Say: "I spend too many hours counting steel rods manually."

Think: "There must be a more accurate way to track site progress."

Feel: Frustrated by repetitive tasks and anxious about potential inventory discrepancies.

Do: Takes site photos and manually enters data into spreadsheets or logbooks.



2.3 Brainstorming

The ideation involved exploring ways to use mobile technology for site audits. The team brainstormed using computer vision and settled on **Visual Reasoning** via the **Gemini 2.5 Flash API** because it can interpret complex, unorganized structural environments better than traditional object-detection models.

3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

Preparation: Engineer identifies a site area for audit.

Interaction: Engineer captures a photo and uploads it to the **Streamlit** dashboard.

Processing: The system validates the image and the AI analyzes the structural members.

Result: The engineer reviews the material count and structural integrity report.

Completion: The report is saved to the audit history and downloaded for stakeholders.

3.2 Solution Requirement

Functional Requirements (FR):

FR-1: User Registration via Form, Gmail, or LinkedIn.

FR-2: User Confirmation via Email or OTP.

FR-3: AI-based structural member identification and counting.

FR-4: Automated PDF/Markdown report generation.

Non-functional Requirements (NFR):

NFR-1 (Usability): Intuitive UI for field use.

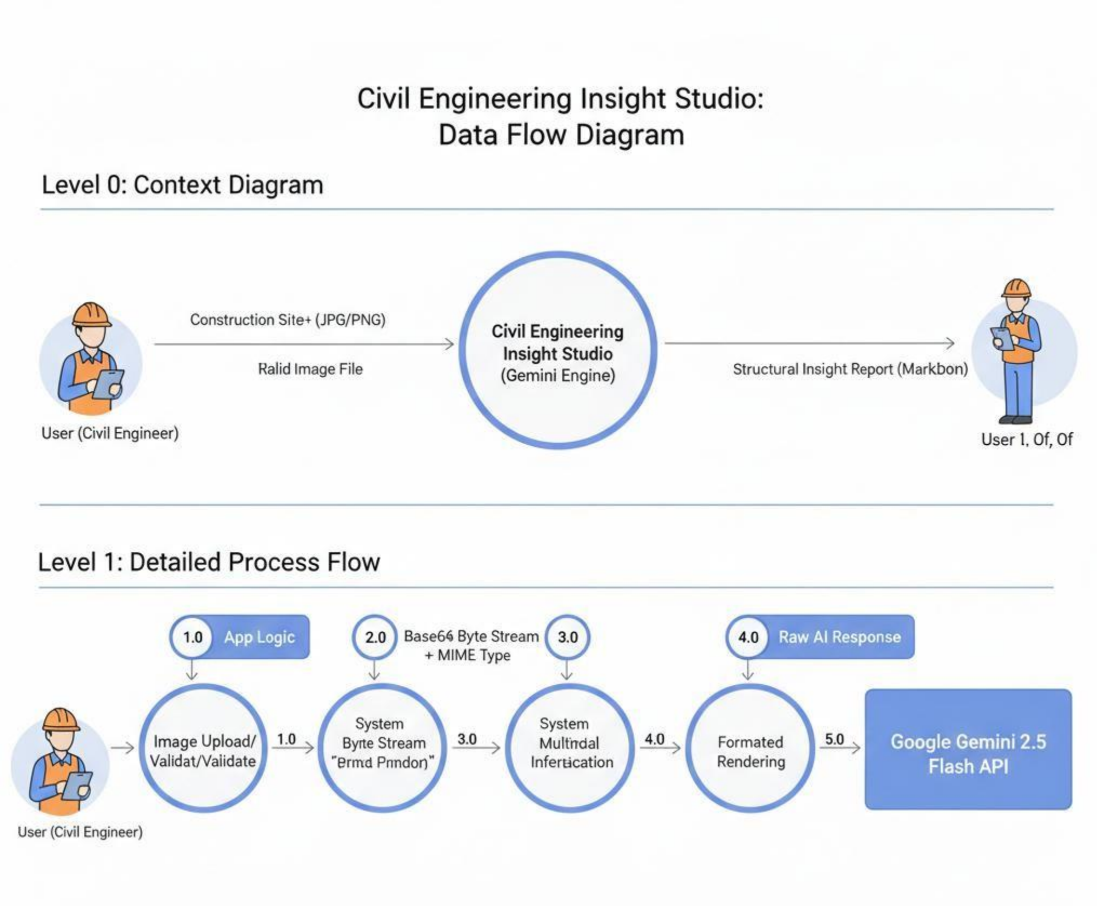
NFR-2 (Security): Data encryption for site imagery.

NFR-4 (Performance): AI inference completed within 15–30 seconds.

NFR-6 (Scalability): Cloud-based architecture to handle multiple sites.

3.3 Data Flow Diagram

Level 0: Engineer uploads image $\rightarrow$ System $\rightarrow$ Engineer



receives Report.

Level 1:

Image Validation: Validates file format.

AI Orchestration: Sends image and prompt to Gemini API.

Data Storage: Saves audit results to **PostgreSQL**.

Report Generation: Formats technical insights into a final document.

3.4 Technology Stack

User Interface: Streamlit (Python-based Web Framework).

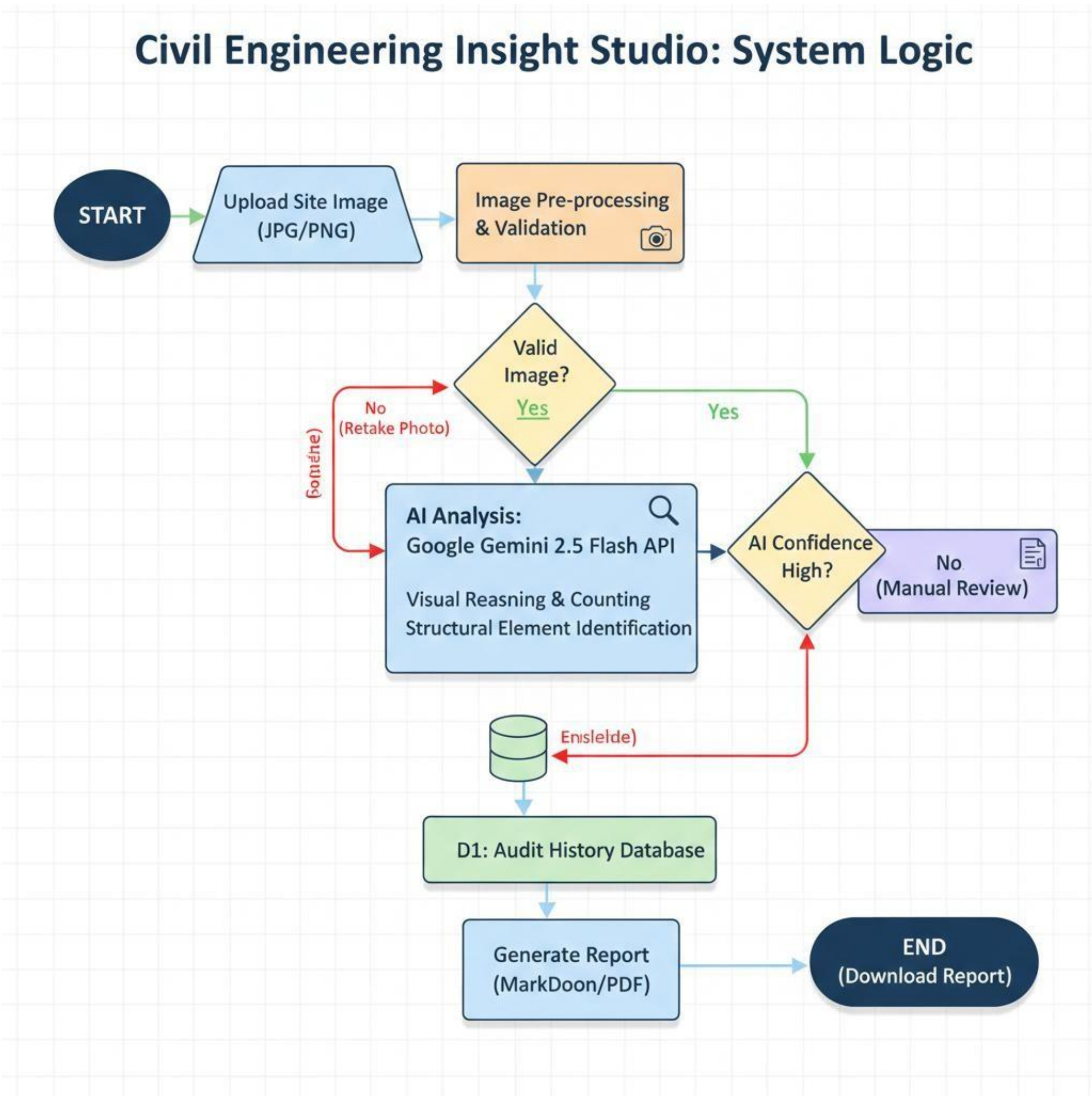
Logic Layer: Python 3.10 and Google Generative AI SDK.

ML Model: Google Gemini 2.5 Flash API.

Database: PostgreSQL (Cloud SQL).

Infrastructure: Google Cloud Platform (GCP).

Libraries: Pandas and NumPy for data structuring and calculations.



4. PROJECT DESIGN

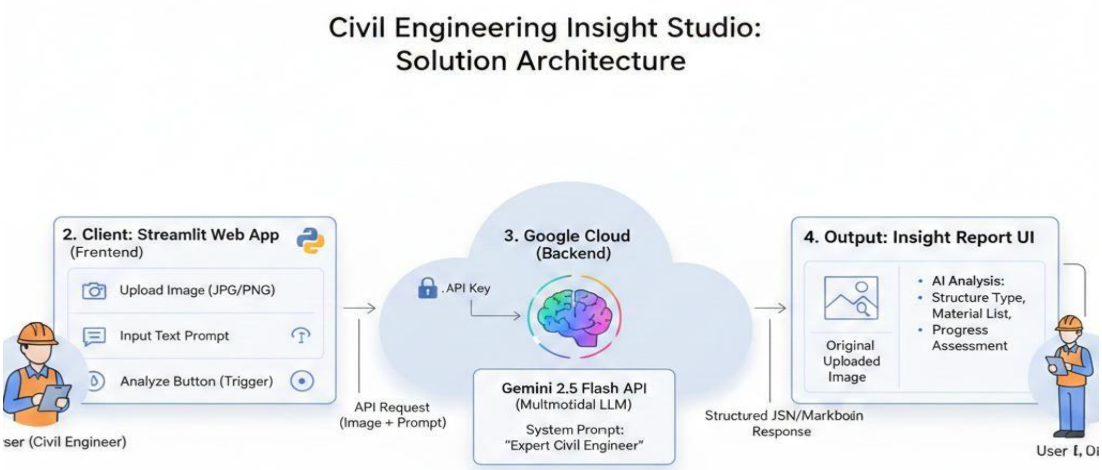
4.1 Problem Solution Fit

The project addresses the "manual audit" problem by fitting a digital AI-layer over existing engineer behaviors. Instead of changing *how* they inspect, it changes *how* the data is processed, moving from manual entry to automated visual reasoning.

4.2 Proposed Solution

A cloud-hosted platform where engineers upload photos of construction structural members. The **Gemini 2.5 Flash API** acts as a "second pair of eyes," identifying rebar, beams, and columns while generating a material inventory automatically.**4.3**

4.3 Solution Architecture



5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Internship Duration: December 2025 – February 15, 2026.

Sprint Schedule:

Sprint 1 (Dec): User registration, login, and UI foundation.

Sprint 2 (Jan 1-15): Integration of Gemini 2.5 Flash API for site analysis.

Sprint 3 (Jan 16-31): Report generation and history dashboard.

Sprint 4 (Feb 1-15): Security implementations and final testing.

6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

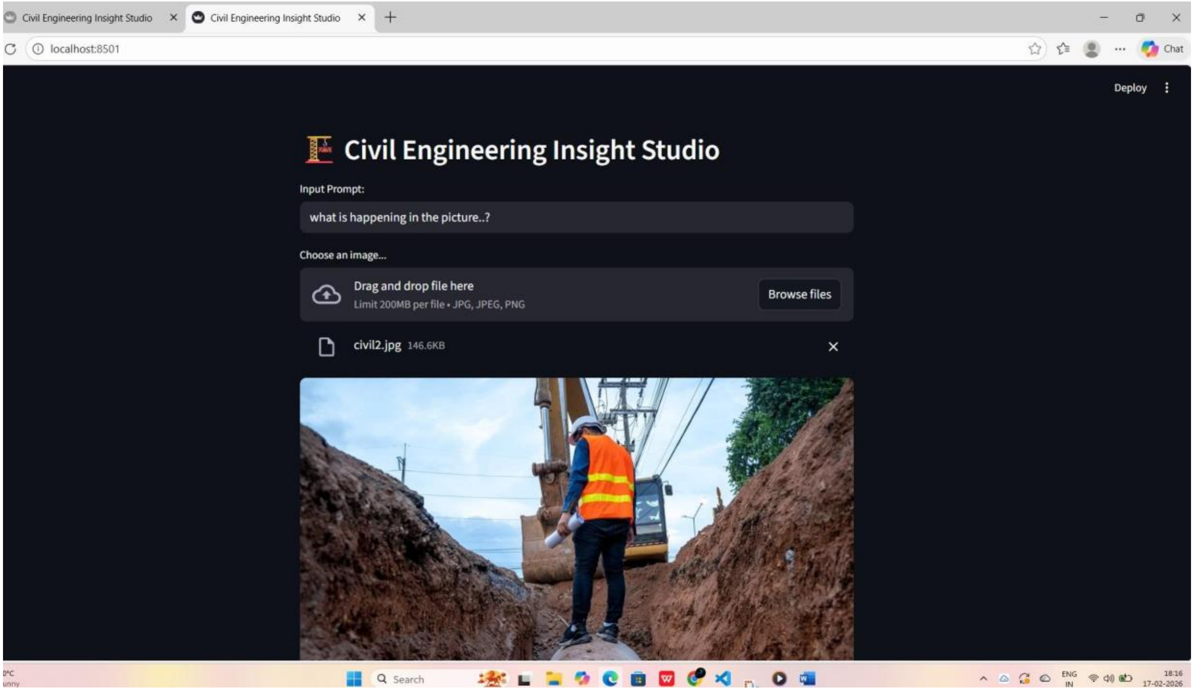
Inference Time: AI analysis must conclude in <30 seconds for a 10MB image.

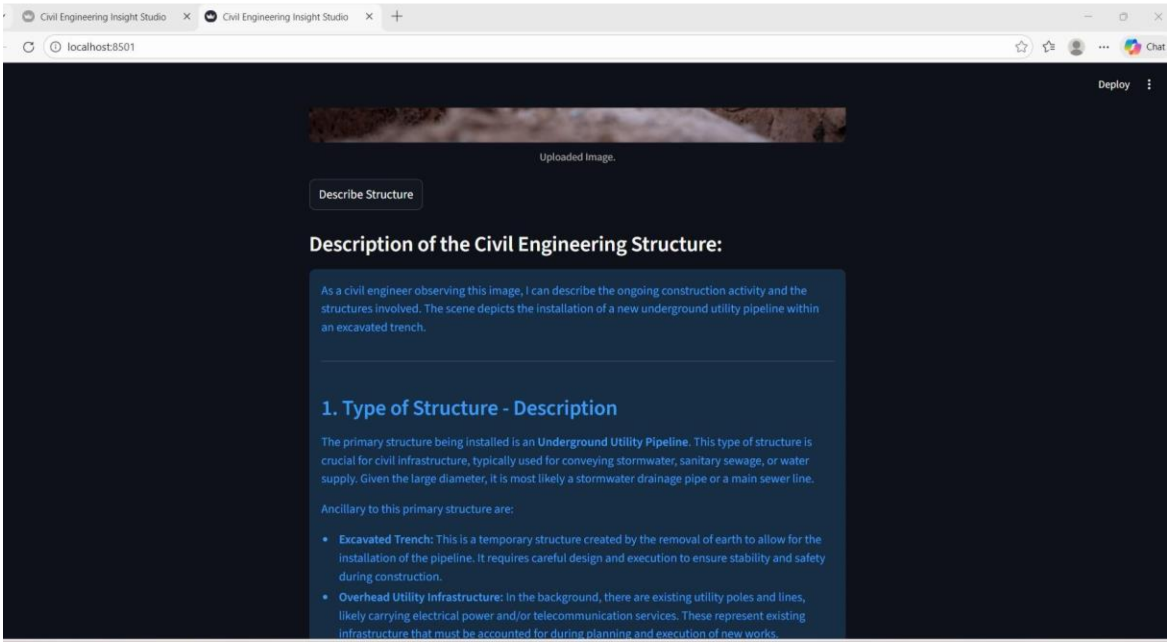
Concurrency: System must support 50+ concurrent uploads using GCP load balancers.

Reliability: 99% accuracy in material identification under standard daylight conditions.

7. RESULTS

7.1 Output Screenshots





8. ADVANTAGES & DISADVANTAGES

Advantages: Significant time savings, reduced human error, historical tracking, and accessibility on standard smartphones.

Disadvantages: Requires internet connectivity for API calls and accuracy may decrease in extremely low-light/night conditions.

9. CONCLUSION

The **Civil Engineering Insight Studio** successfully demonstrates that multimodal AI can effectively automate labor-intensive construction audits. By integrating Google Gemini with a Streamlit frontend, the project provides a professional, scalable tool that improves both accuracy and engineer efficiency.

10. FUTURE SCOPE

3D Reconstruction: Integration of photogrammetry to create 3D models from uploaded images.

AR Integration: Live augmented reality overlays for engineers during site walkthroughs.

Offline Mode: Edge-AI capabilities to process simple counts without active internet.

11. APPENDIX

SourceCode:

https://drive.google.com/file/d/1Dhbnzr7HAhkkox5D1PsHnQ7foydH08L1/view?usp=drive_link

Project Demo:

https://github.com/hyndavid15/Civil-Engineering-Insight-Studio/tree/main/video

GitHub Link : (Project link) :

https://github.com/hyndavid15/Civil-Engineering-Insight-Studio/tree/main