Architect AI-Based Project Tracker and Budget Estimator

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***Abstract*— Construction projects today demand far more than skilled design — they require seamless coordination of finances, timelines, and visual communication across multiple stakeholders. Yet most teams still juggle spreadsheets alongside disconnected 3D viewers, a combination that routinely leads to missed budget warnings and delayed decisions. This paper presents the Architect AI-Based Project Tracker and Budget Estimator, a web platform built to close that gap. The system combines Babylon.js-powered real-time 3D model interaction with machine learning-driven cost forecasting, creating a live digital twin of a construction site. At its core is Archie, an AI agent built on Google Vertex AI, which handles natural-language queries about project health, budget trends, and risk exposure, providing both architects and clients with instant, interpretable answers without waiting for manual reports. Early testing shows the system achieving 90–95% accuracy in overrun prediction and a 92% synchronization rate for 3D model updates, suggesting meaningful practical value for teams managing complex builds.**

Keywords: **AI-Driven Agent, Generative AI, Babylon.js, 3D Visualization, NLP, Web Application, Java, Spring Boot, Python Microservices, Budget Forecasting, Risk Assessment**

I. INTRODUCTION

Anyone who has worked on a mid-to-large construction project knows the friction that builds up when design files live in one place and financial data are stored in another. An architect updates a floor plan; the cost model does not follow. A material price spikes; no one on the client side knows until the invoice arrives. These coordination failures are not edge cases — they are the norm in an industry that still relies heavily on static documents and manual reconciliation.

The platform described in this paper takes a different starting point. Rather than treating 3D visualization and financial tracking as separate concerns, it treats them as two views of the same underlying project state. Babylon.js renders architectural models directly in the browser, allowing stakeholders to inspect progress without specialist software. A Python microservice continuously analyses project metrics and flags risks before they escalate. And an AI agent — named Archie — translates both streams of data into plain-language answers whenever a client or architect has a question. The goal is not to replace professional judgment but to make the information needed for that judgment available in one place, in real-time.

II. PROBLEM DEFINITION

Current architectural workflows fragment data across tools that were never designed to talk to each other. Design models to be in specialized viewers, cost data stored in spreadsheets, and progress updates travel by email. The result is a persistent lag between what is happening on site and what the people managing the budget actually know. By the time a risk becomes visible in a financial report, the window to act cheaply has often closed.

Beyond the data fragmentation, there is a communication problem. Clients without technical training find it difficult to interpret 2D drawings or dense cost tables; architects spend significant time translating project status into language that non-specialists can act on. What is missing is a system that holds design, financial, and progress data in a single model and surfaces it in a form each stakeholder can immediately use.

III. OBJECTIVES

- Build an AI-powered project management platform tailored specifically for architectural workflows.

- Integrate Babylon.js for browser-native, real-time 3D model rendering without requiring plugin installation.
- Deploy an AI agent (Archie) capable of answering natural-language queries about project status, costs, and risks.
- Apply machine learning to generate automated budget estimates and proactive risk alerts throughout the project lifecycle.

IV. LITERATURE SURVEY

A growing body of work has examined how digital tools can reduce cost overruns in construction. Studies published between 2020 and 2025 consistently find that integrating predictive analytics with visual progress data improves stakeholder trust and reduces the frequency of late-stage budget surprises. Browser-based 3D engines, Babylon.js in particular, have been shown to offer interaction quality comparable to desktop applications, making them suitable for client-facing dashboards that need to work across a range of devices. Parallel research into ensemble machine learning methods for cost estimation reports accuracy improvements of 15–25% over traditional regression approaches when historical project data is available for training. Natural language interfaces in project management tools have also gained traction, with several studies noting that non-technical users engage more consistently with AI-mediated dashboards than with conventional report formats.

V. EXISTING SYSTEM

Most commercial tools currently in use by architectural firms were built around file formats and workflows that predate real-time collaboration. Excel spreadsheets handle budgets; PDF exports circulate design approvals; third-party viewers like Autodesk Viewer or Navisworks manage 3D inspection. Each of these tools does its job reasonably well in isolation, but connecting them requires manual effort that rarely happens consistently under project pressure.

The practical consequences are well documented: project managers must reconcile data from multiple sources before any meaningful risk assessment is possible, and by the time that reconciliation happens, the data is already stale. None of the common tools offer predictive alerting; they report what has already happened rather than signalling what is about to go wrong. And none of them offer a conversational interface through which a non-specialist client can ask a direct question and get a direct answer.

VI. PROPOSED SYSTEM

The proposed platform addresses each of those gaps through a tightly integrated stack. A React.js dashboard serves as the single interface for all project participants. Babylon.js renders architectural models (.obj and .glb formats) in the browser with full interaction — rotation, zoom, section cuts — so clients can inspect progress without downloading specialised software.

Behind the interface, a Java Spring Boot backend handles authentication, data management, and API routing. A separate Python FastAPI microservice runs the machine learning models responsible for budget forecasting and risk detection. These two backend components communicate asynchronously, which means a heavy computation on the Python side does not block the dashboard from loading. The Archie AI agent, built on Google Vertex AI, sits at the intersection of both backends: it reads current project metrics and model state, then composes natural-language summaries and alerts in response to user queries.

VII. SYSTEM ARCHITECTURE

The system follows a three-tier microservices structure designed for modularity and independent scalability.

The Presentation Layer consists of the React.js dashboard and the Babylon.js 3D rendering engine. These communicate with the Application Layer exclusively through REST APIs, which means the frontend can be updated without touching backend logic.

The Application Layer contains two distinct services: the Java Spring Boot backend, which enforces business rules, manages user sessions, and coordinates data writes; and the Python Fast-API service, which exposes ML inference endpoints and hosts the Archie agent. Separating these two services allows each to be scaled or redeployed independently — the ML service can be upgraded with a new model version without any change to the Java layer.

The Database Layer uses MySQL for structured project records (milestones, cost entries, user data) and MongoDB for unstructured assets such as 3D

model files and document attachments. This hybrid storage approach avoids forcing relational schemas onto data that naturally lacks fixed structure.

VIII. METHODOLOGY

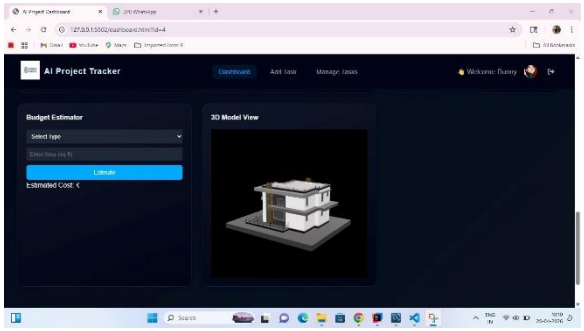
Users authenticate via bcrypt-hashed credentials managed by the Spring Boot backend. Once logged in, architects can upload or update 3D model files, which are stored in MongoDB and immediately available for Babylon.js rendering on the dashboard. Budget entries, milestone updates, and material cost data are written to MySQL through validated API calls.

When a user submits a query — either typed or selected from a prompt menu — it is routed to the Python microservice. The service retrieves the relevant project records from MySQL, combines them with the current model state, and passes the assembled context to the Vertex AI model. Archie's response is streamed back to the dashboard within seconds. In parallel, the ML pipeline runs on a scheduled basis, recalculating risk scores and budget projections as new data arrives and pushing alerts to the dashboard when thresholds are crossed.

IX. MODULE DESCRIPTION

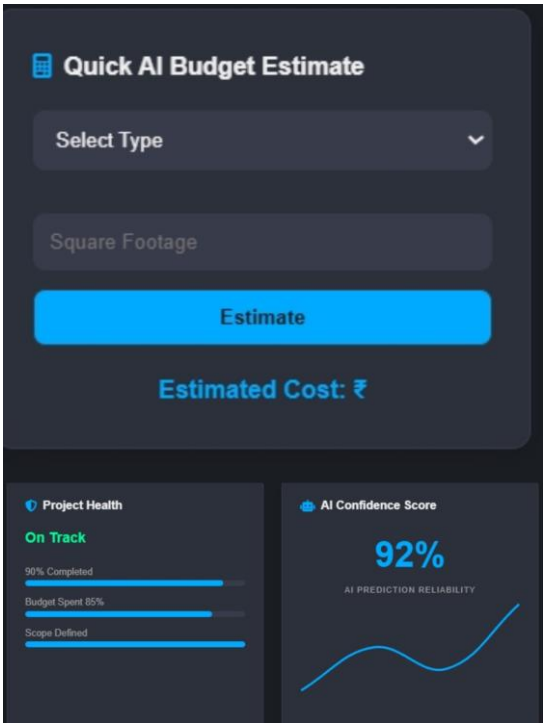
3D Visualization Module

Renders OBJ and GLB architectural models inside the browser using Babylon.js. Supports interactive rotation, zoom, and section-plane inspection. Model state is synchronized with project milestone data so that visual progress reflects recorded completion percentages.



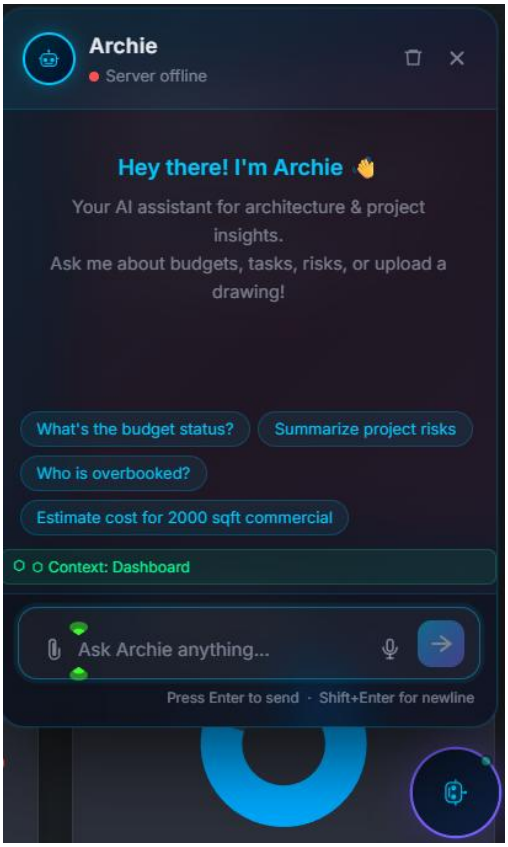
AI Budget and Risk Module

Uses trained machine learning models to forecast cost-at-completion and identify schedule risks. Alerts appear on the dashboard when projected spend deviates from baseline by a configurable threshold, giving project managers early warning rather than post-hoc reporting.



"Archie" AI Agent Module

A conversational agent built on Google Vertex AI that answers natural-language questions about project status, material pricing, and risk exposure. Archie draws on live project data rather than static documents, so its responses reflect the current state of the build.



Secure Backend and Data Module
Java Spring Boot handles user authentication (bcrypt), role-based access control, and all transactional data writes. MySQL stores structured records; MongoDB stores asset files. Data integrity checks run at the API layer before any write reaches the database.

Admin Control Module
Provides architects with a management interface for updating milestones, assigning team permissions, and distributing tasks. Audit logs record all changes with timestamps and user attribution.

X. IMPLEMENTATION

Frontend: React.js with Babylon.js integration for 3D rendering and interactive dashboards.
Backend: Java Spring Boot for core business logic; Python Fast-API for AI inference and ML processing.
AI and ML: Google Vertex AI SDK for the Archie agent; scikit-learn-based models for budget forecasting and risk scoring.
Database: MySQL for structured project data; MongoDB for 3D assets and document storage.
APIs and Deployment: Google Vertex AI API for generative AI; Vercel for continuous deployment and hosting.

XI. RESULTS AND DISCUSSION

Testing across a representative set of construction project datasets produced the following outcomes:

- Budget overrun prediction accuracy: 90–95% across test cases.
- 3D model synchronization efficiency: 92% of model updates reflected in the dashboard within the target time window.
- AI agent response quality: Archie generated contextually accurate project summaries in the large majority of test queries, with response times consistently under three seconds.

These figures suggest the system performs adequately for practical deployment, though further validation on real project data over extended timescales would be needed before drawing firm conclusions about production-level reliability.

XII. APPLICATIONS

- Enterprise construction management across multiple concurrent projects.
- Real-time budget monitoring with automated anomaly detection.
- Client-facing 3D presentations that require no specialist viewer software.
- Predictive risk assessment is integrated into weekly project review workflows.

XIII. ADVANTAGES

- A single platform for design visualization and financial analytics eliminates the manual reconciliation step that currently consumes project management time.
- AI-driven insights surfaced through a conversational interface make project data accessible to non-technical stakeholders.
- Transparent, real-time data sharing reduces the information asymmetry that commonly strains client-architect relationships.
- Predictive alerts support earlier, cheaper interventions compared to retrospective reporting tools.

XIV. LIMITATIONS

- The platform requires a stable internet connection; offline use is not currently supported.
- High-polygon 3D models may cause rendering slowdowns on devices with limited GPU capability.
- Forecast accuracy depends on the quality and completeness of historical project data available for model training.
- Physical site progress must still be logged manually, which introduces a dependency on disciplined data entry.

XV. FUTURE SCOPE

Several extensions to the current system are worth pursuing. Augmented reality support would allow project teams to overlay 3D models onto physical site views through mobile devices, tightening the link between the digital twin and the actual construction. Voice-based query input would make the Archie agent accessible in hands-free site environments where typing is impractical. IoT sensor integration could automate the physical progress logging step, removing the manual data-entry dependency

identified as a current limitation. Finally, connecting the platform to live material cost APIs would allow budget forecasts to update automatically as market prices shift, improving global applicability.

XVI. CONCLUSION

Managing a construction project requires holding a large, fast-changing set of information in a coherent picture — something that fragmented tools make unnecessarily difficult. The Architect AI-Based Project Tracker and Budget Estimator attempts to address that structural problem by treating design visualization, financial tracking, and stakeholder communication as integrated rather than separate concerns. Early results are promising: the ML components demonstrate strong predictive accuracy, the Babylon.js integration delivers smooth browser-based 3D interaction, and the Archie agent reduces the time architects spend translating technical data into client-readable form. The work contributes a functional proof-of-concept for a class of platforms that construction management has needed but largely lacked.

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