

ArchVision AI: An AR and Physics-Integrated Intelligent Platform for Real-Time Interior Design, Structural Stress Simulation, and Budget-Intelligent House Planning

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Abstract - The conventional process of residential interior design and house construction planning is burdened by fragmented toolsets, static 2D blueprints, opaque budgeting, and a complete absence of real-world physical simulation. This paper presents ArchVision AI, a multi-layer intelligent platform that unifies Augmented Reality (AR) visualisation, Unity PhysX-based gravitational and structural collapse simulation, AI-driven layout generation using Google Gemini 2.5 Pro, a Budget Intelligence Engine with contractor-tier cost modelling, Vastu Shastra compliance enforcement through reverse-gravity haptic feedback, a Construction Phase Scheduler with milestone tracking, and a blockchain-anchored smart contract layer for land title verification and contractor payment escrow. Built on a Vite + TypeScript frontend generated via Google Stitch, a PostgREST API atop PostgreSQL managed through InsForge, and Google ARCore (Depth API, Geospatial API, Cloud Anchors), the platform enables users to visualise a complete three-bedroom house anchored to actual GPS coordinates, stress-test structural integrity via Finite Element Method (FEM) analysis, swap materials with real-time compressive-strength and cost recalculation, and digitally sign blockchain contracts -- all within a single web and AR application. Prototype evaluation demonstrated sub-400 ms AR anchor latency, real-time PhysX collapse rendering at 60 fps, a 76% reduction in design iteration time compared to conventional CAD workflows, and a 91% user accuracy rate in Vastu compliance verification, validating ArchVision AI as a viable, next-generation platform for the Indian real-estate and construction sector.

Keywords: Augmented Reality; Google ARCore; Interior Design; Unity PhysX; Structural Simulation; Vastu Compliance; Budget Intelligence Engine; Blockchain Smart Contracts; Gemini 2.5 Pro; InsForge; PostgREST; Geospatial API; Gravity Simulation; Construction Scheduling; FEM Analysis; Smart Cities.

I. INTRODUCTION

The residential construction and interior design sector in India is projected to reach USD 1 trillion by 2030, driven by rapid urbanisation, a growing middle class, and government-backed initiatives such as the Pradhan Mantri Awas Yojana (PMAY) and the Smart Cities Mission [4]. Yet the toolchain available to individual homeowners, civil engineers, and interior designers remains fundamentally unchanged: 2D AutoCAD drawings, physical material samples, verbal contractor estimates, and paper-based agreements. These legacy processes are error-prone, expensive to iterate, inaccessible to non-technical users, and completely detached from the physical reality of the plot being designed.

The proliferation of smartphone-class AR hardware -- specifically devices supporting Google ARCore's Depth API and Geospatial Visual Positioning System (VPS) -- has created an unprecedented opportunity to overlay photorealistic architectural models onto real-world coordinates with sub-metre accuracy [1]. Simultaneously, advances in real-time physics engines (Unity PhysX 5.x), large language model APIs (Google Gemini 2.5 Pro), and decentralised smart contracts (Solana, Polygon) enable an entirely new paradigm of design, simulation, and transaction within a single application.

Existing AR design tools such as IKEA Place [2] and Houzz AR [3] address room-level furniture placement but provide no structural integrity analysis, no geospatially anchored whole-house rendering, no physics simulation of material failure, and no integration with construction budgeting or legal contract workflows. Professional FEM tools (ANSYS, STAAD.Pro) require engineering expertise and expensive licences, placing them beyond the reach of the individual homeowner. ArchVision AI closes this gap by delivering an end-to-end platform across six functional pillars: AR Visualisation, Physics Simulation, AI Layout Generation,

Budget Intelligence, Vastu Compliance, and Blockchain Contracting.

India's National Education Policy 2020 and the Smart Cities Mission both mandate digital-first infrastructure planning [4]. With over 110 smart cities under development and an estimated 25 million housing units required by 2030, the imperative to democratise design and construction tooling has never been greater. ArchVision AI operationalises this mandate at the individual homeowner level, providing tools previously available only to large architectural firms -- at smartphone scale and zero additional licensing cost. The remainder of this paper is organised as follows: Section II surveys related work; Section III describes system architecture; Section IV details each functional module; Section V presents prototype evaluation results; Section VI concludes with future directions.

II. RELATED WORK

A. AR in Architectural Visualisation

Milgram and Kishino's (1994) Reality-Virtuality continuum established the theoretical basis for mixed-reality spatial computing, defining the spectrum from fully real to fully virtual environments and positioning AR as a powerful middle ground [5]. Rokhsaritalemi et al. (2020) reviewed 30 AR applications in urban planning and architecture, concluding that GPS-anchored AR significantly outperforms marker-based AR for plot-scale visualisation [6]. Their findings highlight that anchor stability and sub-metre horizontal accuracy are the primary determinants of user trust in AR-assisted spatial planning.

Commercial tools like IKEA Place rely on ARKit/ARCore plane detection but are restricted to furniture-scale placement; they provide no structural or budgetary context [2]. Snapchat's AR Lenses and Adobe Aero extend AR to creative applications but lack geospatial anchoring for architectural use. ArchVision AI extends ARCore's Geospatial API to whole-plot GPS-anchored house rendering with ± 1 m horizontal accuracy, enabling users to walk through a virtual house on their actual land before breaking ground -- a capability no existing consumer tool provides.

B. Physics-Based Structural Simulation

Traditional Finite Element Method (FEM) structural analysis tools such as ANSYS and STAAD.Pro require engineering expertise, licensed software, and offline computation cycles that may span hours for complex structures. Ding et al. (2022) demonstrated real-time FEM approximation using GPU-accelerated position-based dynamics for interactive deformation, achieving visual fidelity

suitable for design feedback at interactive frame rates [7]. Their work showed that simplified FEM models retain sufficient accuracy for early-stage design decision support when validated against full FEM benchmarks.

Unity PhysX 5.x introduces articulation bodies and continuous dynamic collision detection suitable for architectural collapse simulation at interactive frame rates [8]. Müller et al. (2020) demonstrated position-based dynamics for real-time simulation of heterogeneous materials, providing a theoretical basis for per-material density and restitution coefficients in collapse modelling. ArchVision AI integrates an AI-driven FEM pre-analysis via Gemini 2.5 Pro to identify structurally critical joints, followed by PhysX constraint removal to render realistic gravitational collapse -- a capability absent from any existing consumer design tool.

C. AI-Driven Spatial Layout Generation

Generative AI for floor plan synthesis has advanced rapidly. Nauata et al. (2021) proposed HouseGAN, a graph-constrained GAN for room layout generation that conditions on room adjacency graphs to produce realistic floor plans [9]. Subsequent work by Para et al. (2023) extended this to multi-storey generation using hierarchical graph neural networks. Large multi-modal models such as Gemini 2.5 Pro demonstrate the capacity to generate structured JSON layout specifications from natural language prompts with strong spatial coherence and semantic correctness [10].

ArchVision AI employs Gemini 2.5 Pro as its AI Gateway, translating user intent (e.g., "3BHK under Rs. 40 lakh, Vastu-compliant, east-facing entrance") into room-level layout JSON, material schedules, load-bearing wall annotations, and structural integrity pre-assessments -- then renders these specifications directly in AR. This approach bypasses the need for manually trained domain-specific models, leveraging the broad architectural knowledge embedded in the LLM while maintaining structured output via prompt engineering and schema validation.

D. Vastu Shastra in Digital Design Tools

Vastu Shastra, the ancient Indian science of spatial arrangement, influences over 70% of residential construction decisions in India [13]. Despite its cultural significance, no existing commercial AR or BIM tool incorporates Vastu compliance checking. Bharne and Krusche (2012) documented the geometric and directional principles underlying Vastu, noting their alignment with modern environmental psychology regarding natural light, ventilation, and spatial flow [13]. ArchVision AI's rule-based Vastu engine encodes 48 directives and cross-references them with ARCore's GPS

bearing API, providing real-time compliance feedback that no existing tool offers.

E. Blockchain in Real Estate Contracting

Land title fraud and contractor payment disputes are systemic issues in Indian real estate, with the National Crime Records Bureau estimating over 40,000 property fraud cases annually. Shang and Du (2023) demonstrated Ethereum-based property title registration achieving 98.7% tamper-resistance and 3.2 s average confirmation time [11]. Solana's Proof-of-History consensus achieves 65,000 TPS with sub-400 ms finality, making it viable for real-time contractor milestone-based escrow payments [12]. ArchVision AI integrates Solana and Polygon smart contracts for land title anchoring and construction phase payment release, replacing paper-based agreements with cryptographically verifiable digital contracts and creating an immutable audit trail of construction progress.

III. SYSTEM ARCHITECTURE

ArchVision AI follows a five-tier architecture: a Google Stitch-generated Vite + TypeScript frontend, an InsForge + PostgREST API backend over PostgreSQL, a Google ARCore AR layer, a Unity PhysX physics simulation layer, and a Blockchain smart contract layer on Solana/Polygon. The architecture is designed for horizontal scalability, with each tier independently deployable and communicating via standardised RESTful and WebSocket interfaces.

A. Frontend Layer

The frontend is generated using Google Stitch with Gemini 2.5 Pro, producing a production-ready Vite + TypeScript Single Page Application (SPA) with a premium dark-mode CSS design system. Core UI modules include: the Budget Dashboard with real-time cost recalculation; the Material Swapper with strength-vs-price heat maps; the Gravity Bin Canvas for interactive AR physics; the Construction Scheduler with Gantt-style milestone visualisation; and the X-Ray View for wall penetration analysis. The SPA communicates with the backend via RESTful calls to PostgREST and with the AI Gateway via HTTPS prompts forwarded to Gemini 2.5 Pro. Vite's hot-module replacement and tree-shaking ensure a bundle size under 250 KB gzipped, enabling fast load times even on 4G mobile connections.

B. Backend Layer -- InsForge + PostgREST

InsForge provides a managed PostgreSQL instance with an auto-exposed PostgREST API, built-in row-level security (RLS) for multi-user project isolation, and a proxied AI gateway that forwards prompts to Gemini 2.5 Pro and

OpenRouter model endpoints [15]. The primary database schema comprises five core tables: USERS, PROJECTS, LAYOUTS (JSONB layout specifications), MATERIALS (with compressive strength, thermal conductivity, and current price), and CONSTRUCTION_PHASES with milestone sub-records. All API endpoints are auto-generated from table definitions, eliminating boilerplate controller code and enabling schema-driven API evolution. PostgREST's OpenAPI specification output is consumed directly by the frontend TypeScript client, ensuring type safety across the full stack.

C. AR and Physics Layer

Google ARCore provides three integration points critical to ArchVision AI. The Depth API (ArFrame.acquireDepthImage16Bits()) delivers per-pixel depth maps at 30 fps for accurate floor and wall detection, enabling gravity-respecting component placement with sub-centimetre surface alignment. The Geospatial API (VPS) anchors virtual house models to GPS coordinates with ± 1 m horizontal and ± 1.5 m vertical accuracy, allowing users to superimpose a complete house layout on their actual plot [1]. Cloud Anchors enable collaborative AR sessions wherein an architect and client simultaneously view the same virtual structure from different physical positions, with anchor resolution averaging 1.2 s in outdoor urban environments. Unity PhysX 5.x handles gravitational simulation at 9.81 m/s^2 with per-material density, restitution, and friction coefficients sourced from the MATERIALS database, enabling realistic structural collapse and debris dynamics.

D. Blockchain Layer

The blockchain layer uses Solana for high-throughput operations -- land title NFT minting, contractor payment escrow with milestone triggers -- and Polygon for document-hash anchoring (building permits, inspection certificates). Smart contracts are written in Rust (Solana Anchor framework) and Solidity (Polygon EVM). The Solana Anchor program implements a state machine with five escrow states: FUNDED, MILESTONE_PENDING, MILESTONE_VERIFIED, TRANCHE_RELEASED, and COMPLETED. Contract addresses and transaction hashes are stored in PostgreSQL for frontend retrieval, with real-time Solana WebSocket subscriptions updating the Construction Scheduler upon milestone payment confirmation. Polygon's lower gas fees (avg. \$0.002 per transaction) make it cost-effective for high-frequency document anchoring operations throughout the construction lifecycle.

Table 1: ArchVision AI -- Technology Stack Summary

Layer	Technology	Purpose
UI Generation	Google Stitch (Gemini 2.5)	Text-to-UI screen generation
Frontend	Vite + TypeScript + CSS	SPA with dark-mode design
Backend API	InsForge + PostgREST	Auto-REST API, auth, AI gateway
Database	PostgreSQL	Layouts, materials, schedules
AR Engine	Google ARCore	Depth, Geospatial VPS, Anchors
Physics	Unity PhysX 5.x	Gravity sim, structural collapse
AI Gateway	Gemini 2.5 Pro	Layout gen, FEM pre-analysis
Blockchain	Solana / Polygon	Land titles, contractor escrow

IV. SYSTEM MODULES

A. Budget Intelligence Engine

The Budget Intelligence Engine (BIE) is the financial core of ArchVision AI. Users specify a total construction budget (e.g., Rs. 40 lakh) and select a contractor tier (Economy, Standard, Premium). The BIE queries the MATERIALS table for current market prices of concrete, bricks, steel, tiles, and finishing materials -- updated weekly via a scheduled PostgREST function integrating with Indian commodity price APIs -- and performs room-by-room cost allocation weighted by floor area and material selection. Labour costs are modelled per contractor tier using regional wage indices derived from the Ministry of Labour and Employment's scheduled employment data.

Any material swap in the Material Swapper module triggers an immediate BIE recalculation, displaying updated totals in the Budget Dashboard within 150 ms. Budget overrun alerts are surfaced via red heat-map overlays on the AR house model, spatially highlighting which rooms or structural elements are driving cost exceedance. The BIE also generates a phased cash-flow projection aligned with the Construction Phase Scheduler, enabling users to plan financing draw-downs against actual construction milestones -- a feature particularly valuable for home loan disbursement scheduling under PMAY guidelines.

B. AR Reality Trial -- Six Modes

ArchVision AI provides six AR trial modes, each serving a distinct use case. (1) **Plot Preview Mode** anchors the full house layout to GPS coordinates via the Geospatial API, allowing the user to walk around their plot and view room boundaries in real scale. (2) **Interior Walkthrough Mode** renders room interiors with furniture, lighting, and material textures at 1:1 scale for immersive spatial assessment. (3) **Stress Test Mode** triggers FEM pre-analysis by Gemini 2.5 Pro and then removes PhysX constraint joints to simulate structural failure under overload conditions. (4) **Material Reality Mode** overlays photorealistic material textures (Italian marble, vitrified tiles, wooden flooring) on detected wall and floor surfaces in real time using the Depth API. (5) **Day/Night Lighting Mode** simulates sunlight ingress across the day using the ARCore Geospatial solar angle API, enabling evaluation of natural light in each room at different hours and seasons. (6) **Collaborative Review Mode** uses Cloud Anchors to synchronise the virtual house model across two or more devices, enabling architect-client co-review without physical co-location, with sub-200 ms state synchronisation latency over 4G.

C. Gravity Bin Canvas -- Physics Simulation

The Gravity Bin Canvas is a real-time physics sandbox embedded in the AR session. Architectural components (walls, beams, columns, slabs) are represented as PhysX rigid bodies with material-specific density and compressive strength sourced from the MATERIALS table. The structural integrity score for the current layout is computed by Gemini 2.5 Pro using a simplified FEM model -- a spring-mass approximation of joint stiffness and load distribution -- serialised as a JSON load-distribution map and stored in the PROJECTS table.

If the structural score falls below a defined threshold (default: 60/100), the Gravity Bin Canvas animates the collapse sequence: PhysX removes constraint joints connecting failing members in order of lowest score, components fall under 9.81 m/s² gravity with continuous dynamic collision detection, and debris settles with damped friction coefficients (m = 0.4 for concrete, m = 0.2 for steel). The collapse animation runs at 60 fps on mid-range Android devices (Snapdragon 778G or equivalent), providing an intuitive, non-expert-accessible demonstration of structural risk. Colour-coded stress gradients (green-to-red) are rendered on each component during simulation, matching the visual conventions of professional FEM tools.

D. Material Swapper with AI Recommendations

The Material Swapper allows users to replace any construction material in the layout with an alternative from the

MATERIALS catalogue. Each material record contains compressive strength (MPa), tensile strength (MPa), thermal conductivity (W/mK), thermal mass (kJ/m²K), unit cost (Rs./sq.ft or Rs./kg), fire rating (hours), and availability tier (standard/premium/import). When a material swap is requested, Gemini 2.5 Pro analyses the impact on structural integrity, thermal performance, fire safety, and budget, returning a ranked recommendation list with trade-off explanations in plain language intelligible to non-engineers.

The frontend updates the AR texture overlay, the structural score, and the Budget Dashboard simultaneously within a single API round-trip (avg. 180 ms end-to-end). A strength-vs-price heat map visualises the Pareto frontier of available materials, enabling users to make informed decisions without domain expertise. The Material Swapper also flags materials non-compliant with Bureau of Indian Standards (BIS) specifications, providing a regulatory compliance layer aligned with NBC 2016 construction norms.

E. Construction Phase Scheduler

The Construction Scheduler maps the approved layout to a sequential construction programme divided into nine phases: foundation, superstructure, roofing, masonry, electrical and plumbing rough-in, plastering, flooring, fixtures, and finishing. Each phase is associated with a CONSTRUCTION_PHASES record containing estimated duration (days), labour cost, material cost, quality inspection checklist, and a milestone flag. Phase durations are estimated using a regression model trained on historical construction data from 500+ projects in Maharashtra, calibrated for plot area, contractor tier, and seasonal monsoon delays.

Contractor milestone payments are encoded as Solana smart contract escrow releases: when a site inspector marks a milestone as COMPLETED in the app (verified via a geo-tagged, timestamped photo upload cross-referenced with GPS coordinates within 50 m of the site), the smart contract automatically transfers the corresponding payment tranche to the contractor's wallet within 400 ms. This eliminates payment disputes and creates an immutable audit trail of construction progress accessible to all stakeholders: homeowner, contractor, financial institution, and municipal authority.

F. X-Ray Structural View

The X-Ray View module provides a semi-transparent overlay rendering of internal structural elements -- load-bearing columns, beams, electrical conduits, and plumbing runs -- superimposed on the AR house surface. ARCore's Depth API supplies accurate wall-surface geometry, against which the virtual structural skeleton is aligned and rendered with configurable opacity (10%-80%). Clicking any structural

element queries the backend for its material specification, load rating, connection details, and maintenance history, displayed as a contextual information card anchored to the AR element. During renovation planning, the X-Ray View can import existing building plans from DXF files, aligning the imported structural model with the AR depth scan of the actual building to identify discrepancies between as-built and as-designed conditions.

G. Vastu Compliance Engine

Vastu Shastra, the ancient Indian science of spatial arrangement, influences over 70% of residential construction decisions in India [13]. ArchVision AI encodes a rule base of 48 Vastu directives covering room orientation, door placement, kitchen and bathroom positioning, staircase direction, water body placement, and colour recommendations relative to cardinal compass headings derived from ARCore's Geospatial API GPS bearing. The rule engine evaluates each directive against the current layout in real time, with a total evaluation time under 30 ms for a standard 3BHK layout.

Non-compliant placements trigger a reverse-gravity haptic feedback sequence via the Android Vibration API (three short pulses at 250 ms intervals) and a magnetic repulsion particle effect in the AR view -- providing multi-sensory feedback that prevents inadvertent confirmation of non-compliant placements. Compliant placements emit a green pulse confirmation. A Vastu compliance score (0-100) is persisted in the PROJECTS table and displayed on the Budget Dashboard alongside the structural integrity score. The engine supports three Vastu schools (Classical, Modern, and Simplified Urban), allowing users to select their preferred compliance framework.

H. Blockchain Contract Layer

The Blockchain Contract Layer provides two primary services. (1) **Land Title NFT:** the legal plot registration document is hashed using SHA-256, the hash is minted as a non-fungible token on Solana, and the token address is stored in the PROJECTS table. Any subsequent document modification invalidates the on-chain hash, providing tamper detection with cryptographic certainty. The NFT metadata includes GPS bounding coordinates of the plot, owner wallet address, registration date, and a link to the Polygon-anchored document PDF. (2) **Contractor Payment Escrow:** a Solana Anchor program holds the total contract value in escrow and releases tranches upon milestone completion events emitted by the Construction Scheduler, with each release requiring dual authorisation from both the homeowner's and inspector's wallet signatures, preventing fraudulent milestone claims.

V. RESULTS AND DISCUSSION

A prototype of ArchVision AI was developed and evaluated across two phases: a controlled usability study involving 18 participants (8 homeowners, 5 civil engineers, 3 interior designers, 2 real-estate agents) on a Samsung Galaxy S23 (ARCore-certified, Snapdragon 8 Gen 2) and a performance benchmarking phase targeting latency, frame rate, and accuracy metrics. Participants were recruited via the DBATU University alumni network and local contractor associations in Chandrapur district. Each session lasted approximately 90 minutes, comprising a 15-minute onboarding demonstration followed by structured task completion and a System Usability Scale (SUS) questionnaire. Table 2 summarises the key quantitative outcomes.

Table 2: ArchVision AI -- Prototype Evaluation Metrics

Metric	Result
AR anchor latency (Geospatial VPS)	< 380 ms (± 42 ms)
PhysX collapse render frame rate	60 fps (mid-range Android)
AI layout generation time	2.1 s avg (Gemini 2.5 Pro)
Budget recalculation on swap	< 150 ms end-to-end
Vastu compliance accuracy (vs expert)	91% agreement (n=18)
Structural score vs ANSYS FEM	88.3% correlation
Design iteration time reduction	76% faster vs CAD workflow
Blockchain escrow confirmation	< 400 ms (Solana)
Material Swapper texture update	< 200 ms AR overlay refresh
User Task Completion Rate	94.4% (17/18 participants)
System Usability Scale (SUS)	81.2 / 100 (Grade B+)
Collaborative AR sync latency	< 200 ms (4G network)

The 76% reduction in design iteration time compared to traditional AutoCAD + Excel workflows is the most impactful finding, consistent with Rokhsaritalemi *et al.*'s (2020) observation that AR-based spatial feedback eliminates multiple revision cycles inherent in 2D plan interpretation [6]. Participants reported that the ability to walk through a virtual house on their actual plot -- and immediately see the impact of material or layout changes -- compressed what would typically be a multi-week back-and-forth with architects into a single afternoon session.

The 91% Vastu compliance accuracy validates the rule-based engine against independent expert assessment by a certified Vastu consultant, addressing a critical cultural requirement for Indian residential projects. The 9%

discrepancy was attributable to interpretive differences between Vastu schools -- particularly regarding the placement of the pooja room in flats with non-standard plot orientations -- suggesting that multi-school support (planned for v2.0) will further close this gap.

The 88.3% structural score correlation with ANSYS FEM confirms that Gemini 2.5 Pro's simplified FEM approximation, while not a replacement for licensed engineering analysis, is sufficiently accurate for early-stage design decision support. Discrepancies were largest for non-rectangular column arrangements and cantilever balconies, where the simplified spring-mass model underestimates stress concentration.

These cases trigger a recommendation to consult a licensed structural engineer, maintaining an appropriate safety boundary between AI-assisted design exploration and professional structural certification. The SUS score of 81.2 (Grade B+) indicates strong usability for a prototype. Participants cited AR anchor stability and Budget Dashboard real-time updates as the highest-value features. Lowest-rated aspects included the onboarding flow for the blockchain contract layer (complexity of wallet setup) and occasional AR drift in low-light indoor conditions. Both issues are targeted in the roadmap: wallet abstraction via social login (Google OAuth [®] embedded wallet) and improved low-light Depth API calibration using IR illumination on supported devices.

Table 3: System Modules and Technology Mapping

Module	Key Technology	Output
Budget Intelligence Engine	PostgREST + Gemini 2.5	Cost map, overrun alerts
AR Reality Trial (6 modes)	ARCore Geospatial + Depth	GPS-anchored house AR
Gravity Bin Canvas	Unity PhysX 5.x + FEM	Collapse simulation @ 60 fps
Material Swapper	MATERIALS DB + Gemini 2.5	Texture swap + score update
Construction Scheduler	Solana Anchor + PostgreSQL	Milestone payment escrow
X-Ray Structural View	ARCore Depth + LAYOUTS DB	Internal element overlay
Vastu Compliance Engine	GPS bearing + rule base (48)	Compliance score + haptics
Blockchain Contract Layer	Solana / Polygon	NFT title + escrow contracts

VI. CONCLUSION

This paper presented ArchVision AI, a first-of-its-kind integrated platform that converges Augmented Reality, real-time physics simulation, AI-driven layout generation, budget intelligence, Vastu compliance enforcement, and blockchain smart contracting into a single residential design and construction planning application. By anchoring virtual house models to GPS coordinates via ARCore's Geospatial API, simulating structural collapse through Unity PhysX with AI-guided FEM pre-analysis, and automating contractor payments through Solana escrow smart contracts, ArchVision AI addresses a comprehensive set of pain points that no existing consumer or professional tool resolves end-to-end.

Prototype evaluation confirmed a 76% design iteration time reduction, 91% Vastu compliance accuracy, sub-400 ms AR anchor and blockchain finality latencies, 88.3% structural FEM correlation, and a System Usability Scale score of 81.2 -- establishing the platform's viability for real-world deployment in the Indian construction sector across homeowner, engineer, designer, and contractor user segments.

Future enhancements will investigate: (a) on-device ML models for offline ARCore surface detection in low-connectivity rural areas, critical for India's Tier-3 cities and villages under PMAY; (b) integration of IoT sensor feeds from construction sites into the Scheduler for automated milestone verification; (c) Generative AI-driven 3D model synthesis from 2D plot sketches using Gemini 2.5 Pro's multimodal capabilities; (d) extension of the Vastu engine to support Feng Shui and LEED green-building compliance rule sets for international markets; (e) multi-tenancy support for real-estate developers managing hundreds of simultaneous projects; and (f) integration with municipal building permit portals for automated plan submission and approval tracking aligned with India's Online Building Plan Approval System (OBPAS).

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CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Aachal Arvind Bende: AR module design and implementation, ARCore Geospatial and Depth API integration, Gravity Bin Canvas physics layer, Vastu Compliance Engine, writing -- original draft.

Chetali Sunil Deotale: Frontend SPA development (Vite + TypeScript), Budget Intelligence Engine, Material Swapper, Construction Scheduler UI, X-Ray View module, blockchain smart contract integration, writing -- review and editing.

Asst. Prof. Suraj S. Bankar: Supervision, system architecture review, methodology validation, resources, formal analysis, writing -- review and editing.

DATA AVAILABILITY STATEMENT

Anonymised usability study datasets and prototype evaluation logs are available upon reasonable request to the corresponding author. The ArchVision AI prototype frontend is accessible at the project repository linked in the authors' institutional profile.

DECLARATION OF COMPETING INTEREST

The authors declare no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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