1. Definition of the Problem

Problem Description

The engagement ring purchasing experience presents significant challenges for consumers navigating the complex landscape of the 4Cs (cut, carat, colour, clarity), metal types, and setting styles. Traditional jewelry retail suffers from opaque pricing structures, overwhelming product selections, and limited transparency regarding ethical sourcing practices. Research indicates that consumers experience decision fatigue when confronted with numerous configuration options without clear guidance on quality-price trade-offs or budget optimization strategies.

Furthermore, the rising consumer demand for ethically sourced diamonds, particularly lab-grown alternatives, lacks dedicated platforms that combine transparent pricing, educational content, and intelligent recommendation systems. Current e-commerce solutions often replicate physical retail experiences without leveraging digital capabilities to reduce cognitive load and enhance decision-making confidence.

The COVID-19 pandemic accelerated e-commerce adoption in luxury goods, yet many jewelry platforms maintain complex navigation structures, hidden pricing until final configuration, and limited personalization features. This creates barriers for first-time buyers who lack domain expertise and seek guidance without high-pressure sales tactics.

Significance

Solving this problem addresses multiple stakeholder needs within the jewelry industry and consumer behavior research. For consumers, a streamlined, transparent platform reduces purchase anxiety, ensures ethical sourcing confidence, and optimizes budget allocation across ring components. The lab-grown diamond market is projected to grow significantly (estimated 15-20% CAGR through 2030), indicating substantial commercial relevance.

From a technical perspective, this project demonstrates the integration of real-time pricing algorithms, recommendation engines, and conversational AI within an e-commerce context. The solution contributes to human-computer interaction research by implementing design patterns that mitigate decision fatigue through progressive disclosure, comparison tools, and budget-aware filtering.

Ethically, prioritizing lab-grown diamonds addresses environmental and social concerns associated with traditional diamond mining, aligning with growing consumer preferences for sustainable luxury goods. The project also explores transparent cost breakdowns, educating consumers about markup structures typically obscured in traditional retail.

2. Aims, Objectives, and Scope

Aim

The primary goal of this project is to develop a modern, user-centric e-commerce web application for engagement rings featuring exclusively lab-grown diamonds. The project aims to address decision fatigue through transparent live pricing, intelligent budget-aware recommendations, and an AI-powered shopping assistant that guides users through the configuration process while maintaining ethical sourcing principles and mobile-responsive design.

Objectives

1. **Develop a guided ring configurator** that enables users to select and customize engagement rings across multiple dimensions (cut, carat, colour, clarity, metal type, setting style) with real-time price updates and visual feedback.

2. **Implement a budget-aware recommendation engine** using content-based filtering algorithms that suggests optimal component combinations based on user budget constraints, prioritized preferences (e.g., prioritizing carat over clarity), quality-price trade-offs, and diamond attribute similarity scoring.

3. **Integrate an AI-powered chatbot assistant** using the API to provide:

   – Guided shopping assistance with contextual questions
   – Educational content explaining the 4Cs and ring components
   – Personalized recommendations based on conversation history
   – Transparent information about ethical sourcing and company policies

4. **Create comparison and exploration features** including side-by-side ring comparison, "customers also viewed" suggestions, customer reviews, and persistent favorites/wishlist functionality.

5. **Design a responsive, accessible user interface** following modern UX principles with fully responsive web design, intuitive navigation, progressive disclosure to reduce cognitive load, and innovative hand model visualization for ring preview.

6. **Develop a transparent pricing model** that displays component-level cost breakdowns, budget impact indicators, and clear value propositions for different quality tiers.

7. **Implement data storage and management** using appropriate techniques (in-memory storage for prototype, JSON-based persistence) with seeded product catalogs, customer reviews, and user interaction logs.

8. **Conduct usability and performance testing** with documented test cases, user feedback sessions, and performance metrics to validate design decisions and identify improvement areas.

Scope

Inclusions

- **User Authentication & Accounts:** Login system, user profiles, or order history
- **Ring Configurator Module:** Interactive step-by-step configurator for diamond (4Cs), metal type (platinum, gold variants, rose gold), and setting style selection
- **Live Pricing Engine:** Real-time price calculation with component-level breakdown and budget threshold alerts
- **Recommendation System:** Content-based filtering algorithm considering user budget, preferences, and quality trade-offs with ranked suggestions based on diamond attribute similarity (4Cs), setting compatibility, and budget constraints
- **AI Chatbot Integration:** Conversational assistant using Anthropic Claude API for guidance, education, and recommendations
- **Product Catalog:** Seeded database of lab-grown diamonds with varied specifications, metals, and pre-designed settings
- **Hand Model Visualization:** Interactive hand model view showing ring on finger with skin tone slider (lighter to darker) and size reference, similar to virtual try-on experience
- **Comparison Tools:** Side-by-side comparison feature (up to 3 configurations) with highlighted differences
- **Social Proof Features:** Customer reviews (seeded data), ratings, "customers also viewed" recommendations
- **Favorites/Wishlist:** Persistent user favorites with session-based storage
- **Responsive UI:** Responsive web design optimized for desktop, tablet, and mobile browsers
- **Educational Content:** Tooltips, modal dialogs, and chatbot explanations for technical terms
- **Basic Analytics:** User interaction logging for configurator steps, popular combinations, and drop-off points
- **Email Notifications:** Order confirmation or follow-up email automation

Exclusions

- **Payment Processing:** No actual payment gateway integration; checkout process will be simulated
- **Inventory Management:** No real-time stock tracking or supplier integration
- **3D Interactive Models:** No WebGL/Three.js 3D rotation; will use high-quality 2D images with hand model visualization
- **Admin Dashboard:** No backend content management system for product updates
- **Multi-language Support:** English only for prototype phase
- **Legal/Compliance Features:** No GDPR consent management or accessibility audit tools (basic accessibility will be implemented)

3. Background Review

Key Findings (Literature / Systems)

The lab-grown diamond market continues rapid expansion due to increased consumer preference for ethical, sustainable, and affordable alternatives to natural diamonds. The global lab-grown diamond industry is valued at approximately USD 29.7 billion in 2025 and projected to nearly triple to USD 97.8 billion by 2034 with a CAGR of about 14% [precedenceresearch.com, 2025][fortunebusinessinsights.com, 2024]. Millennials and Gen Z consumers prominently drive this growth, valuing environmental impact and affordability.

Despite strong growth, significant consumer knowledge gaps exist. Many shoppers lack expertise in the 4Cs diamond grading system (cut, carat, color, clarity) critical for informed decision-making [GIA, 2024]. Cognitive science research highlights decision fatigue caused by excessive choice overload, which reduces purchase satisfaction and increases abandonment rates [Schwartz, 2004; Vohs et al., 2008]. Additionally, e-commerce platforms often lack transparent recommendation logic and fail to integrate budget constraints effectively, impairing user trust and conversion.

Recommendation systems have evolved from basic rule-based filters to sophisticated content-based and hybrid models. Content-based filtering, especially suitable for structured product attributes like diamonds, utilizes mathematical similarity indices and user preferences to present tailored options. However, major platforms do not incorporate dynamic budget-aware recommendation adjustments nor transparent explanations, leaving a critical gap [Pazzani & Billsus, 2007; BigCommerce, 2025].

Conversational AI advancements with large language models enable personalized, context-aware shopping assistants that provide education and recommendation synergy. Yet, jewelry e-commerce lags in deploying AI chatbots capable of meaningful domain-specific guidance combined with real-time configurator integration [Thunai AI, 2025].

Gaps in Research and Technology
- Lack of guided, progressive configuration to mitigate decision fatigue
- Non-transparent, budget-agnostic recommendation systems that reduce trust and relevance
- Absence of contextual, AI-driven educational tools integrated within the shopping flow
- Mixed product inventories complicate ethical messaging for lab-grown diamonds
- Limited interactive physical visualization tools reduce user confidence in selection

How This Project Addresses Gaps

This project proposes a user-centric engagement ring configurator focused exclusively on lab-grown diamonds featuring:

- A stepwise, guided configuration interface reducing cognitive load
- A content-based filtering recommendation engine incorporating explicit budget constraints and dynamic customization of attribute priorities
- An AI-powered chatbot assistant integrated for just-in-time education and personalized guidance
- Exclusive lab-grown diamond inventory ensuring clear ethical positioning
- An interactive hand model visualization with skin tone adjustment providing realistic physical context

4. Comparison with Similar Software Applications/Products

Blue Nile

Strengths: - Largest independent online vendor with over 600,000 certified diamonds - Advanced filtering by all 4Cs criteria and 360° diamond photography - Transparent pricing on loose diamonds and educational content

Weaknesses: - Overwhelming product options causing decision fatigue - No guided configurator or conversational AI assistant - Limited mobile-friendly design and unclear pricing breakdown for settings - No budget-aware recommendations leading to lower conversion support

James Allen

Strengths: - Industry-leading 360° HD diamond videos with exceptional magnification - Real-time human gemologist chat support - Virtual try-on via customer photo uploads and extensive educational resources

Weaknesses: - Heavy reliance on human support rather than AI automation - No budget optimization tools or dynamic priority weighting - Photo upload requirement for try-on raises privacy and friction concerns - Complex navigation with unpersonalized recommendations

Brilliant Earth

Strengths: - Strong ethical brand with Beyond Conflict Free™ standard - Significant focus on lab-grown diamonds and sustainability reporting - Real-time ring customisation preview - Omnichannel retail presence

Weaknesses: - Lack of AI chatbot and transparent recommendation algorithms - Style quiz lacks budget integration - Pricing higher than competitors - Limited comparison capacity and no session-based favorites without accounts

Differentiation and Gap Analysis Table

Feature	Blue Nile	James Allen	Brilliant Earth	Proposed Project
Guided Step-by-Step Configurator	No	Partial	Partial	Yes
AI Chatbot Assistant	No	Human Chat	No	Yes (LLM-powered)
Budget-Aware Recommendations	No	No	No	Yes (Content-based)
Real-Time Pricing Breakdown	Partial	Partial	Partial	Component-level full
Quality Trade-Off Visualization	No	No	No	Yes
Lab-Grown Diamond Focus	Mixed	Mixed	Yes	Exclusive
Multi-Item Comparison (3+)	Limited	Limited	2 Items	Up to 3
Mobile-First Responsive Design	No	No	Partial	Fully Responsive

Feature	Blue Nile	James Allen	Brilliant Earth	Proposed Project
Hand Model Visualization	No	Photo Upload	No	Built-In Interactive
Contextual Education Integration	Separate	Separate	Separate	Fully Integrated
Transparent Ethics Information	No	No	Yes	Yes
Session-Based Favorites	No	No	No	Yes

5. Tools (Hardware / Software)

Hardware

- **Development Computer:** Laptop or PC with at least 8GB RAM and a multi-core processor for smooth development and testing
- **Testing Devices:**
  - Multiple browsers (Chrome, Firefox, Safari, Edge) for checking compatibility
  - Different screen sizes using browser tools — mobile (375–428px), tablet (768–1024px), and desktop (1280px and above)
  - A real Android or iPhone device to test responsive design
- **Network Testing:** Test performance on Wi-Fi and 4G connections to ensure smooth user experience

Software

Frontend Development

- **React 18.x:** Main JavaScript library for building the user interface using reusable components
- **Vite 5.x:** Fast build tool and dev server for React. Provides instant updates while coding and optimized production builds

- **Tailwind CSS 3.x:** Utility-based CSS framework that helps build modern, responsive UIs quickly
- **React Router 6.x:** Handles navigation within the app (e.g., moving between configurator steps)
- **Zustand / React Context:** Used for managing shared data like user preferences, cart items, and favourites

Data Management (Backend)
- **PostgreSQL 16.x:** Relational database to store diamonds, settings, and reviews securely and efficiently
- **Django 5.x:** Python framework for building backend APIs quickly with built-in security and admin panel
- **Django REST Framework (DRF):** Helps create RESTful APIs for communication between the frontend and backend
- **psycopg2 / psycopg3:** Database adapter connecting Django with PostgreSQL
- **LocalStorage API:** Browser storage for temporarily saving favourites or cart data without a database connection
- **Custom Content-Based Filtering Algorithm:** Your own recommendation system built in Python/Django using:
    - NumPy for similarity calculations (e.g., cosine similarity)
    - Weighted scoring for user preferences
    - Budget filtering to show options within price limits
    - Django ORM for efficient database queries

Development & Testing Tools
- **Visual Studio Code (VS Code):** Main IDE for React and Python development with built-in terminal and extensions
- **PyCharm (Optional):** IDE for advanced Django features and database tools
- **Git & GitHub:**
    - Git: Version control system to track code changes
    - GitHub: Online platform to store, share, and collaborate on code

---

6. Use Cases and Diagrams

UC1: Browse Diamonds

Actor: User
Goal: View available diamonds and apply filters by 4Cs and price
Precondition: Diamonds are listed in the database
Postcondition: Filtered list of diamonds displayed

UC2: Customize Ring

Actor: User
Goal: Customize diamond cut, metal, and setting
Precondition: User has selected a base diamond
Postcondition: Personalized design preview generated

UC3: Get Price Estimate

Actor: User
Goal: View real-time pricing for selected design and attributes
Precondition: Design configuration completed
Postcondition: Updated price shown within budget

UC4: Compare Options

Actor: User
Goal: Compare multiple diamonds or designs side by side
Precondition: User has selected multiple items
Postcondition: Comparison chart displayed

UC5: View Recommendations

Actor: User
Goal: Get similar or suggested diamonds/designs
Precondition: User has viewed or selected an item
Postcondition: Personalized recommendations displayed

UC6: Save Favourite Design

Actor: User
Goal: Save preferred diamond or design for later
Precondition: User is browsing designs
Postcondition: Design saved to favourites

UC7: Chat with Assistant

Actor: User
Goal: Ask questions and receive guided help during customization
Precondition: Chatbot interface active
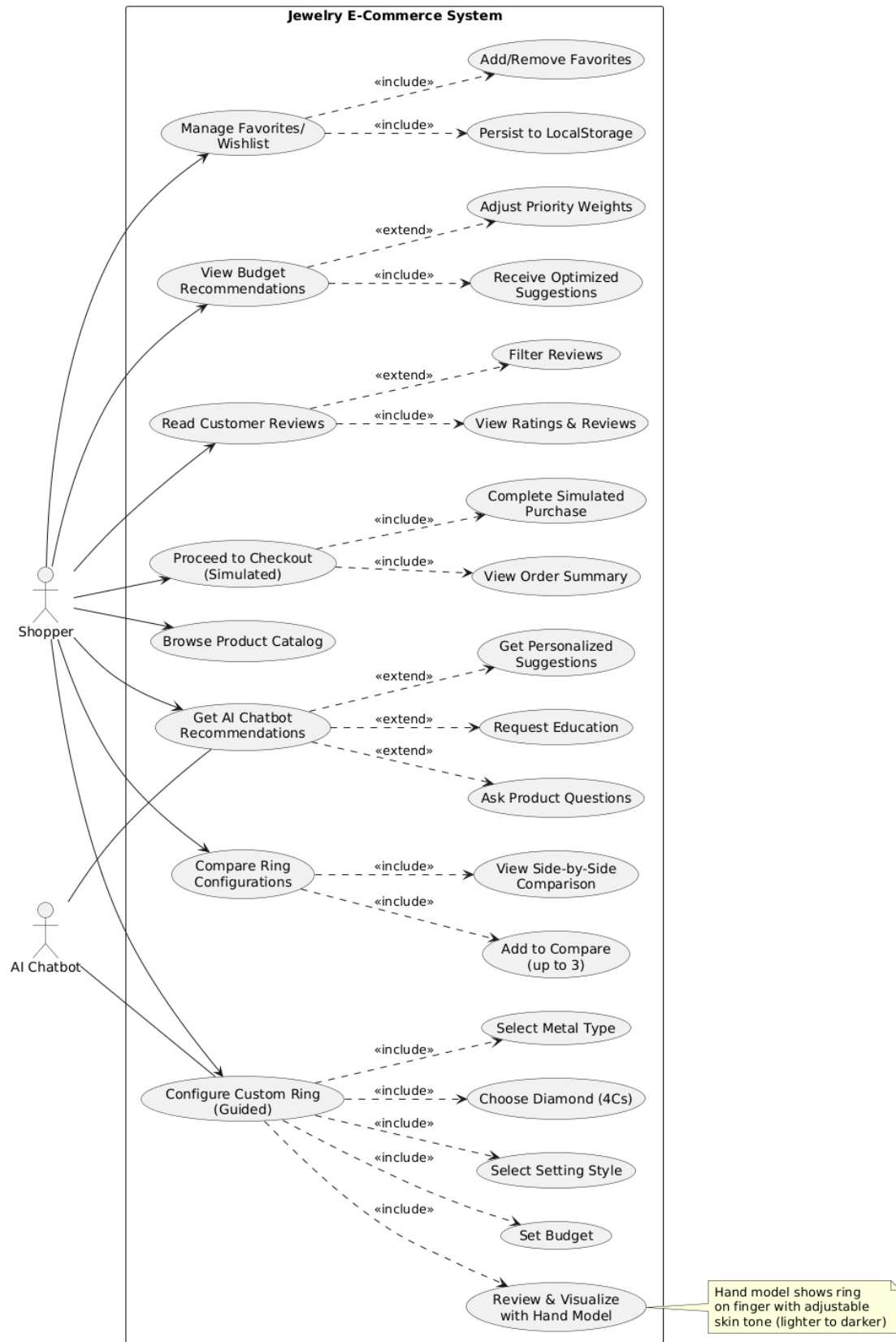**Postcondition:** Query answered or action guided

UC8: Checkout

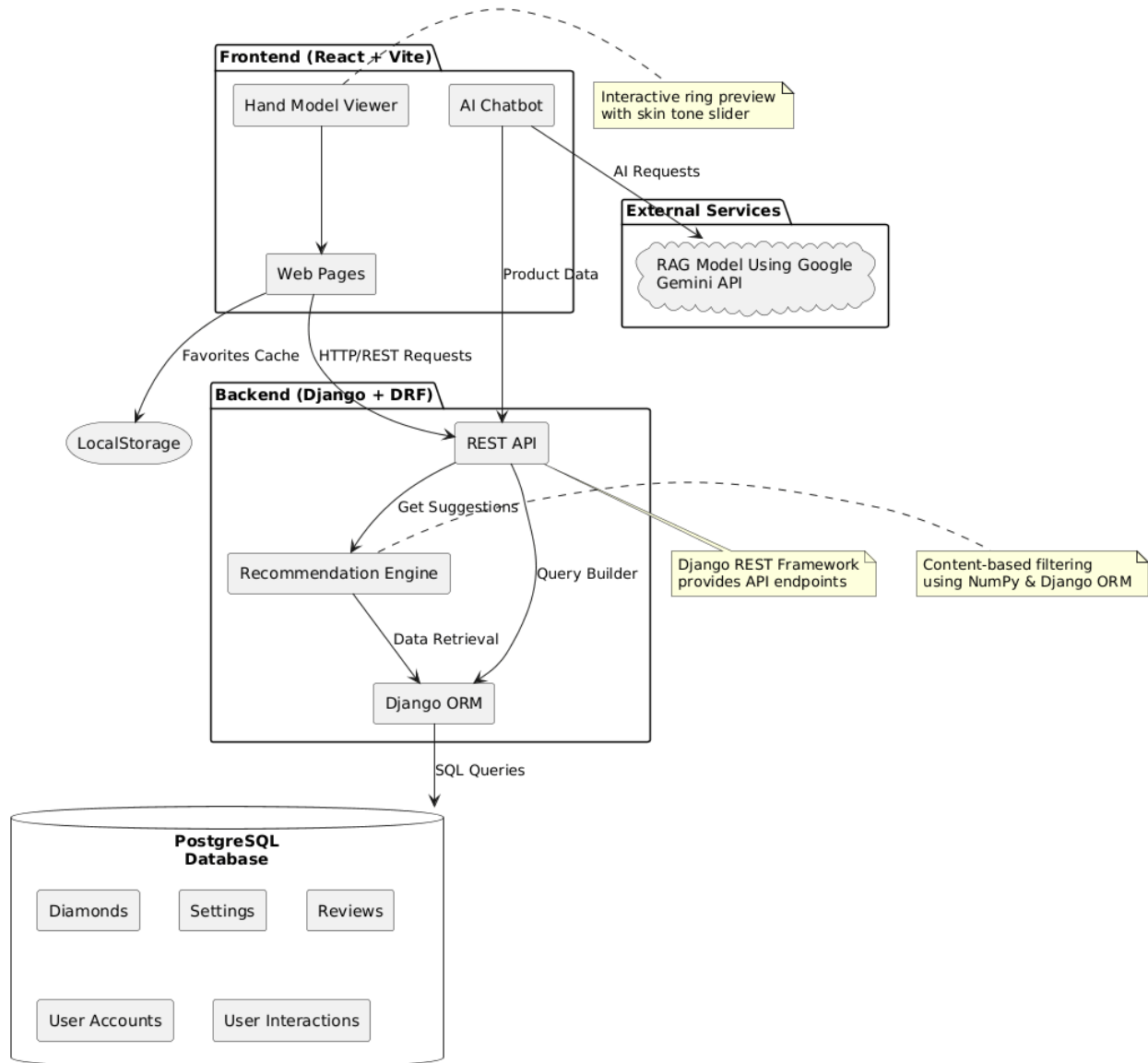**Actor:** User
Goal: Proceed to purchase selected design
Precondition: Design finalized and within budget
Postcondition: Order confirmation displayed

Use Case Diagram

Jewelry E-Commerce System

Shopper

- Manage Favorites/Wishlist
  - «include» → Add/Remove Favorites
  - «include» → Persist to LocalStorage
- View Budget Recommendations
  - «extend» → Adjust Priority Weights
  - «include» → Receive Optimized Suggestions
- Read Customer Reviews
  - «extend» → Filter Reviews
  - «include» → View Ratings & Reviews
- Proceed to Checkout (Simulated)
  - «include» → Complete Simulated Purchase
  - «include» → View Order Summary
- Browse Product Catalog
- Get AI Chatbot Recommendations
  - «extend» → Get Personalized Suggestions
  - «extend» → Request Education
  - «extend» → Ask Product Questions
- Compare Ring Configurations
  - «include» → View Side-by-Side Comparison
  - «include» → Add to Compare (up to 3)
- Configure Custom Ring (Guided)
  - «include» → Select Metal Type
  - «include» → Choose Diamond (4Cs)
  - «include» → Select Setting Style
  - «include» → Set Budget
  - «include» → Review & Visualize with Hand Model

AI Chatbot

Hand model shows ring on finger with adjustable skin tone (lighter to darker)

System Architecture Diagram

Component Descriptions:

- **Frontend:** React application with configurator, browse, comparison, and chatbot features
- **Backend API:** Django REST Framework providing RESTful endpoints for all operations
- **Django ORM:** Object-Relational Mapping layer for database interactions
- **PostgreSQL Database:** Stores diamonds, settings, reviews, and user interaction logs
- **Recommendation Engine:** Content-based filtering using NumPy for similarity calculations
- **LocalStorage:** Browser storage for temporary favorites and session data

- **SessionStorage:** Temporary data like comparison lists and configurator state

External Services:

- **Gemini API:** Powers conversational AI chatbot with product knowledge and recommendations

Deployment Infrastructure:

- **Vercel/Netlify CDN:** Hosting and content delivery with automatic deployments from Git

---

7. Requirements Elicitation

Approach (4 Methods):

1. **Literature Review & Competitive Analysis** - Studying existing platforms and academic research
2. **User Persona Development** - Creating 3 detailed personas (first-time buyer, knowledgeable shopper, gift buyer)
3. **Scenario-Based Requirements Analysis** - Walk-through scenarios for key user journeys
4. **Supervisor Consultation** - Regular validation and feedback

Techniques:

- MOSCOW Prioritization
- Use Case Modeling
- Data Modeling (ER diagrams)
- Wireframing
- Functional Decomposition

Requirements Specification:

- **11 Functional Requirements Categories (FR1-FR11)** covering:
    - Product catalog, configurator, hand model, recommendations, chatbot, comparison, favorites, reviews, browsing, checkout, logging
    - 50+ specific functional requirements with clear numbering
- **10 Non-Functional Requirements Categories (NFR1-NFR10)** covering:
    - Performance, usability, accessibility, responsiveness, security, maintainability, scalability, reliability, ethics, browser compatibility
   - 40+ specific non-functional requirements

---

8. Time Schedule

Gantt Chart Overview

Week	Date/Deadline	Phase	Tasks & Deliverables
S1-W1	26 Sep 2025	Project Initiation	Attend Lecture 1; Review Blackboard materials and handbook; Begin brainstorming project ideas
S1-W2	03 Oct 2025	Supervisor Request	Attend Lecture 2; **Submit Request for Project Supervision Form**; Begin literature search
S1-W3	10 Oct 2025	Supervisor Allocation	Attend Lecture 3; Receive supervisor assignment; Prepare for first meeting
S1-W4	17 Oct 2025	Requirements Gathering	Attend Lecture 4; **First Supervision Meeting**; Conduct competitive analysis; Develop user personas
S1-W5	24 Oct 2025	Ethics & Research	Attend Lecture 5; Complete literature review; Draft requirements; Begin Ethics Application
S1-W6	31 Oct 2025	PPRS Development	Self-study week; Create use case diagrams; Write PPRS
S1-W7	07 Nov 2025	PPRS Finalization	Attend Lecture 6; Finalize PPRS slides and handout; Complete Ethics form; Obtain supervisor signature
S1-W8	**13 Nov 2025**	**PPRS Submission**	**Attend Lecture 7; SUBMIT PPRS (15%)** - Presentation slides, Handout, Signed Ethics Form
S1-W9/10	21-28 Nov 2025	PPRS Presentations	Present PPRS to supervisor; Receive feedback and marks
S1-W11	05 Dec 2025	Development Setup	Attend Lecture 8; Set up development environment; Install React, Django, PostgreSQL,Design database schema; Develop wireframes
S1-W12	12 Dec 2025	**Milestone 1**	**Supervision Meeting**; Present refined requirements list; Begin database implementation
Winter Break	17 Dec - 06 Jan	Independent Development	Create Django models; Run migrations; Seed database; Build basic API endpoints
S2-W1	23 Jan 2026	**Milestone 2**	**Supervision Meeting**; Demonstrate initial code; Show API endpoints and frontend
S2-W2	30 Jan 2026	Core Development 1	Build React components; Implement filtering; Connect frontend to API
S2-W3	**05 Feb 2026**	**IPD Submission**	**SUBMIT IPD (15%)** - Video presentation, Prototype code, Video demo

S2-W4	12 Feb 2026	IPD Presentations 1	Present IPD to supervisor; Demonstrate prototype
S2-W5/6	13-20 Feb 2026	IPD Feedback	Receive marks and feedback; Address suggestions
S2-W7	27 Feb 2026	Core Development 2	Implement configurator; Build pricing engine; Create hand model component
S2-W8	06 Mar 2026	Recommendation Engine	Attend Lecture 9; Implement content-based filtering; Build recommendation API
S2-W9	13 Mar 2026	Comparison & Favorites	Progress Review; Implement comparison feature; Build favorites with LocalStorage
S2-W10	20 Mar 2026	AI Integration	Attend Lecture 10; Integrate Google Gemini API; Build chatbot UI
S2-W11	27 Mar 2026	Testing	Self-study Lecture 11; Unit testing; Usability testing; Cross-browser testing
S2-W12	03 Apr 2026	Final Development	**Final Supervision Meeting**; Polish UI/UX; Implement accessibility; Fix bugs
Easter Break	04-21 Apr 2026	Report Writing 1	Begin FYP Report; Write Introduction, Background, Methodology sections
Week 24	22 Apr 2026	Report Writing 2	Complete Implementation, Testing, Evaluation sections; Create video demo
Week 25	**23 Apr 2026**	**FYP Submission**	**SUBMIT Final Year Project (70%)** - Report, Code, Video Demo
Week 26-28	30 Apr - 19 May	Viva Preparation	Review report and code; Practice demo presentation
Week 28-29	**30 Apr - 19 May**	**Viva**	**Attend 1-hour Viva Voce**; Demonstrate system; Defend design decisions

Key Milestones

#	Milestone	Date	Weighting
1	PPRS Submission	13 November 2025	15%
2	IPD Submission	05 February 2026	15%
3	FYP Report & Code	23 April 2026	70%
4	Viva Voce	30 Apr - 19 May 2026	Part of 70%

Lab-Grown Diamond E-Commerce Platform - Project Timeline
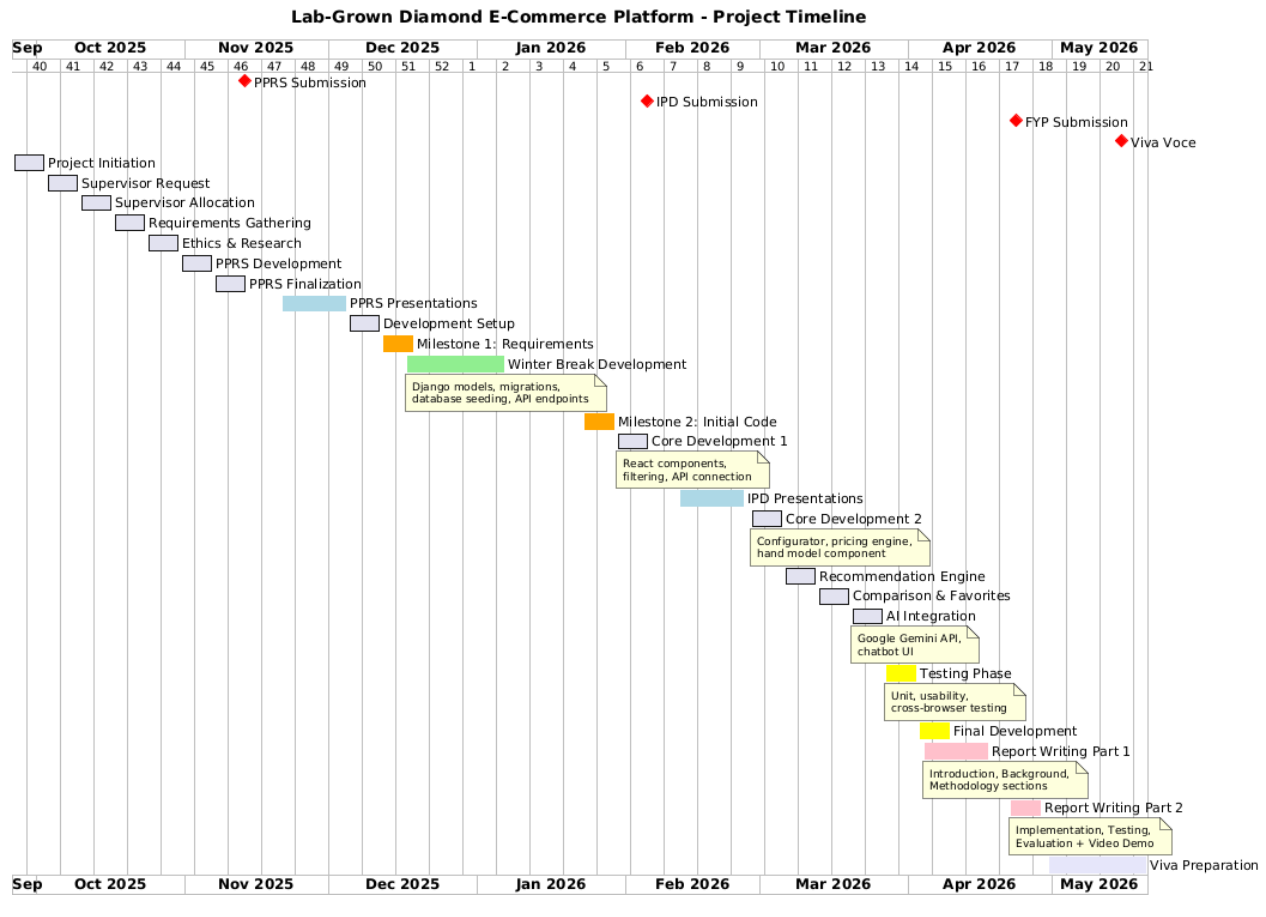
References / Bibliography

Bain & Company. (2023). *Global Lab-Grown Diamond Market Report*. Retrieved from industry databases.

BigCommerce. (2025). *Ecommerce Recommendation Engine: Best Options and Implementation Guide*. Retrieved from https://www.bigcommerce.com/

Cognitive Clicks. (2025). *What Is Decision Fatigue? How It Impacts Consumer Behavior*. Retrieved from https://cognitive-clicks.com/

Fortune Business Insights. (2024). *Lab Grown Diamond Market Size, Share, Trends*. Retrieved from https://fortunebusinessinsights.com/

GIA. (2024). *Understanding the 4Cs of Diamond Quality*. Retrieved from https://www.4cs.gia.edu/

Pazzani, M.J., & Billsus, D. (2007). Content-Based Recommendation Systems. In *The Adaptive Web: Methods and Strategies of Web Personalization* (pp. 325-341). Springer-Verlag.

Schwartz, B. (2004). *The Paradox of Choice: Why More Is Less*. New York: Ecco.

Thunai AI. (2025). *Guide to Using AI Chatbots For E-Commerce*. Retrieved from https://www.thunai.ai/

Trustpilot. (2025). *Blue Nile Reviews | Read Customer Service Reviews.* Retrieved from https://www.trustpilot.com/

Vohs, K.D., Baumeister, R.F., Schmeichel, B.J., Twenge, J.M., Nelson, N.M., & Tice, D.M. (2008). Making choices impairs subsequent self-control: A limited-resource account of decision making, self-control, and active initiative. *Journal of Personality and Social Psychology, 94*(5), 883-898.

Additional References

- https://www.precedenceresearch.com/lab-grown-diamonds-market
- https://www.researchandmarkets.com/reports/5948682/lab-grown-diamonds-market-report
- https://www.fortunebusinessinsights.com/lab-grown-diamond-market-110569
- https://www.tribuneindia.com/partner-exclusives/outlook-for-the-lab-grown-diamond-industry-in-2025-and-beyond/
- https://www.growndiamondcorp.com/blog/lab-grown-diamond-jewelry-market-forecast-size-to-double-by-2025/
- https://www.marketresearchfuture.com/reports/lab-grown-diamond-jewelry-market-24833
- https://www.gia.edu/gia-news-research/gems-gemology-summary-latest-research-lab-grown-diamonds
- https://www.futuremarketinsights.com/reports/synthetic-diamond-market
- https://uk.finance.yahoo.com/news/cvd-lab-grown-diamonds-global-143100761.html
- https://www.paulzimnisky.com/What-a-Mature-Lab-Grown-Diamond-Jewelry-Market-Could-Look-Like