A Smart Online Garden Renovation

A MINI PROJECT REPORT FOR THE COURSE

DESIGN THINKING

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BONAFIDE CERTIFICATE

Certified that this Thesis titled "**A Smart Online Garden Renovation**" is the bonafide work of **Nehaa Sesh S (230701210), Nikitha B(230701210) …** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

Student Signature with Name

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Signature of the Supervisor with date

Signature Examiner-1 Signature Examiner-2

1: Introduction:

Gardening has been cherished not only for its aesthetic appeal and environmental importance but also for the sense of fulfillment it provides. In recent times, the idea of smart gardening has become increasingly popular as a result of technological advancements, artificial intelligence-based recommendations, and user-friendly interfaces. Nonetheless, there remains a significant issue for both novice and experienced gardeners—how to visualize and plan a garden area before starting the planting process.

Traditional gardening methods frequently involve hand-drawn sketches, incomplete knowledge about plant compatibility, and general guidelines that fail to consider specific environmental factors such as climate and soil conditions. Furthermore, most plant care apps available today focus on sending reminders for watering and providing static information, with little consideration given to dynamic user input or visual feedback.

This project aims to address the lack of a mobile garden renovation app by conceptualizing and developing a user-friendly and personalized planning tool that offers an interactive experience. The application enables users to upload a photo of their current garden area, receive tailored plant recommendations based on their region, and select from a variety of 3D layout templates created using blender. These templates are then rendered within the app using @react-three/fiber, allowing the user to see the changes in real-time before they are actually made. The application leverages real-time location data to enhance its recommendations, guaranteeing that the suggested plants are well-suited to the user's specific geographical and climatic conditions.

To manage and guide the development process, the design thinking methodology was employed. Unlike conventional linear development models, design thinking prioritizes a user-centric, iterative approach. By comprehending

user behavior and empathizing with their difficulties, we were able to identify concealed requirements and create features that offer genuine value. The design thinking process, which includes steps like empathizing, defining, ideating, prototyping, and testing, was followed meticulously to guarantee that the final product not only meets user expectations but surpasses them.

In addition to its technical capabilities, the app places emphasis on user engagement and educational content. For example, users will eventually be able to see the different stages of plant growth and the specific care needs associated with each phase, enabling them to have a clearer understanding of plant life cycles. This transforms gardening from a passive activity into an engaging, interactive, and educational endeavor.

This project was inspired by the growing need for sustainable urban lifestyles, especially in densely populated urban areas, where the size of personal green spaces is decreasing. Efficient garden planning and plant selection become even more crucial when considering the impact of climate change. A well-designed app that enables users to make informed choices not only enhances the aesthetic appeal of gardens but also promotes environmental consciousness.

This paper provides a comprehensive overview of the entire app development process, starting from the initial brainstorming sessions and user research, progressing through the iterative prototyping and testing phases, and culminating in the successful implementation of a highly functional and user-friendly application. This app stands out from other garden planning tools due to its integration of 3d modeling, real-time geolocation, and personalized plant recommendation algorithms.

By integrating advanced technology with a user-centric design philosophy, this project showcases how digital solutions can bring about tangible change in domains that are typically reliant on manual or analog processes. It emphasizes the power of design thinking in creating applications that not only serve their purpose but also bring joy and delight to users.

11:

Design thinking is a problem-solving approach that prioritizes the needs and perspectives of people, employing creative, iterative, and user-centered techniques to address complex challenges. It is widely employed in product design, software development, education, and business innovation because it is highly effective in generating valuable and practical solutions. In our garden renovation app, design thinking was the guiding principle behind every choice we made—from studying user behavior to incorporating technical features that genuinely address their needs.

Exploring the Concept of Design Thinking.

At its core, design thinking is not solely focused on creating visually appealing user interfaces or products. It's about truly comprehending users—their struggles, desires, and requirements—and continuously refining solutions based on those insights. By prioritizing the needs and perspectives of the people involved, the problem-solving process ensures that innovations are not only technically sound, but also practical and beneficial.

Design thinking moves through five key phases:

1: Comprehend – grasp users and their surroundings.

2: Describe – describe the problem to be solved.

3: Brainstorm – generate innovative ideas without limitations.

4: Prototype – create low- or high-quality versions of the concept.

5: Evaluate – collect input and improve the solution.

In our project, we adhered to this model to guarantee that the gardening app progressed in line with real user input, ongoing feedback, and usability objectives.

Various institutions and organizations have developed their own versions of the design thinking framework to cater to their unique requirements. Here are some of the well-known models, along with their similarities and differences.

1: Stanford design thinking process.

This is one of the most commonly utilized versions. The process consists of five distinct stages: empathize, define, ideate, prototype, and test. This model is highly focused on iterating quickly based on feedback, which makes it ideal for developing user-centered software applications, like our garden renovation app.

2: The double diamond model (UK Design Council) is a tool used to improve the quality of design by analyzing user needs and business goals.

This model consists of four stages— explore, clarify, create, and present. It visually depicts the problem and solution stages as two diamonds, showcasing the divergent and convergent paths of the design process. This model assisted us in broadening our perspectives during the brainstorming phase while focusing on feasible solutions during the development stage.

3: IBM Enterprise Design Thinking.

IBM's model emphasizes the loop of observe, reflect, and make, with a particular emphasis on collaboration among teams from different disciplines. Although we didn't solely rely on IBM's model, its focus on ongoing observation and iteration had a significant impact on our feedback and redesign approaches.

4: Hasso plattner institute (hpi) design thinking model.

Similar to Stanford's version, HPI's approach focuses on iteration and comprises six steps: understanding, observing, gaining perspective, generating ideas, creating prototypes, and testing. This framework promotes a deeper understanding of user needs and is frequently employed in educational and research-focused design environments.

How can we apply design thinking to our project?

Traditional software development approaches, such as the waterfall or v-model, prioritize structured development, which may not be suitable when user requirements are constantly changing or not clearly defined at the start. Our use case required a more flexible and understanding process — one that adapts to users as they engage with various aspects of the gardening process.

The elements we intended to include—such as uploading garden images, visualizing 3D models, suggesting plants suitable for specific regions, and displaying growth stages—were all developed and refined using design thinking techniques. This approach enabled us to:

- repeatedly check if users found the visualizations easy to understand

- comprehend how users perceive garden layouts and plant growth stages

- refine our user interface based on real feedback, not assumptions.

- create a product that is inclusive, accessible, and valuable for both beginner and experienced gardeners

Results of Applying Design Thinking.

- user-first development: every feature, from geolocation-based suggestions to plant selection ui, was designed to solve a real user problem

- faster iteration: rapid prototyping allowed us to experiment with features without fully implementing the entire system

- increased creativity: ideation and brainstorming sessions resulted in creative features such as animated plant growth stages and interactive model previews

- better feedback loop: the test phase revealed pain points that we might not have caught with traditional methods

1.2 Stanford Design Thinking Module and its Phases

The Stanford design thinking framework is one of the most well-known and extensively used models in innovation-driven design processes. Originating from Stanford University's d.School (Hasso Plattner Institute of Design), this methodology places a strong emphasis on comprehending users, fostering creativity in idea generation, and continuously refining solutions through iterations. It has been successfully implemented in various domains, including product design, healthcare, education, and digital systems.

In our garden renovation project, we utilized the stanford model to guide us through the development process, providing a structured framework while allowing for adaptability. The five phases—empathize, define, ideate, prototype, and test—served as a roadmap for us as we progressed through each stage of developing a solution that addresses real user requirements with both creativity and technical viability.

Phase 1: understand.

The objective of the empathize phase is to acquire a comprehensive understanding of the users, their surroundings, actions, and reasons behind their behavior. This stage is crucial because true innovation arises from solving genuine issues, rather than assuming they exist.

This included:

Interviewing individuals who maintain home gardens and landscape designs.

Analyzing current applications and their constraints.

Recognizing emotional and practical requirements (e.g., lack of visualization tools, uncertainty in plant compatibility).

In addition to primary research, we conducted secondary research on gardening trends, regional plant growth, and user challenges when renovating outdoor spaces. This allowed us to have a comprehensive understanding of the situation and ensured that our solution was based on real-world considerations.

Phase 2: specify.

This phase concentrates on combining the knowledge acquired through empathy research into a concise, actionable problem statement. A well-defined phase of defining the project's scope helps concentrate the design work and ensures everyone is on the same page.

Our research revealed three main issues:

Gardeners often struggle to envision the appearance of plants in their garden before actually planting them.

The current gardening apps do not take into account the specific climate or geographical conditions of a particular area.

Many individuals find it challenging to plan for their long-term care needs and understand the lifecycle of plants.

In the end, we presented our problem as:

"What are some ways we can assist users in visualizing and planning garden renovations by utilizing interactive tools that take into account their personal preferences and the compatibility of plants in their region?".

This problem statement served as the foundation for brainstorming and creating solutions.

Generate Ideas.

The ideation stage is focused on fostering creativity and generating new ideas. At this stage, the emphasis changes from pinpointing issues to investigating potential solutions.

We conducted:

Generating ideas with our team using visual mapping methods.

Crazy 8's sketching exercises aim to produce a diverse array of interface layouts and user journeys.

A comparative analysis of current apps was conducted to identify areas where improvements could be made and new opportunities could be explored.

Key ideas generated included:

Uploading a picture of your garden and getting pre-made 3D layouts as suggestions.

By utilizing geolocation, the app can suggest plants that are well-suited to the user's specific climate zone.

Showcasing the different stages of growth of chosen plants to assist in the planning process.

After carefully considering the practicality, uniqueness, and influence of these ideas, we selected features that were in line with our objective and technical capabilities.

Development of our model.

This phase involves the creation of physical manifestations of concepts. These prototypes can be basic drawings or working parts to collect user opinions before committing to extensive development.

For our app, we:

I designed paper wireframes for various screens, including the home screen, garden input screen, and model selection screen.

Created a clickable prototype using Figma to replicate user engagement.

Constructed a simple front-end using expo and react native to verify the successful upload of files, navigation functionality, and the seamless integration of 3D models.

These prototypes served as visual representations of the app's flow and allowed for early user feedback.

Phase 5: evaluation.

Experimentation is where concepts meet actuality. This phase entails showcasing the prototype to actual users and closely observing their interactions with it. The input received from the respondents guides enhancements and adjustments.

We conducted:

User Experiences - Task Completion on Prototype.

Evaluation of User Experience, Communication, and Enjoyment.

Gathering of Ideas and Recommendations.

Findings included:

The requirement for more explicit directions when uploading images.

The significance of verifying the chosen 3d model through visual confirmation.

A suggestion to include plant care tips alongside growth animations.

These valuable insights played a crucial role in shaping the final implementation and preparing for future redesigns.

Summary of stanford model in our project.

By following the systematic approach of the stanford design thinking model, we guaranteed that our garden renovation app was not only innovative but also practical and applicable to real-life situations.

2: Literature review.

The literature review is a crucial part of any design and development project as it provides a broader understanding of the existing knowledge in the field. When it comes to revamping a garden using a design thinking approach, it is crucial to delve into the two key aspects of our project: the domain of smart gardening applications and the methodological framework of design thinking in digital innovation.

2.1 literature based on field.

The process of garden renovation has transformed from a hands-on, experiential endeavor to a technologically-driven, automated task. Several studies have contributed to this adaptation:

- kumar et al Their project suggested innovative tools that assist in creating and testing customized green spaces based on user preferences.

- gupta and sharma (2021) focused on automated systems that use image processing to understand garden layouts and provide optimized planting suggestions Their research emphasized the importance of user-generated images in customizing recommendations.

- in "iot-based smart garden monitoring" by desai et al While the primary focus was on real-time monitoring, the paper also provided a framework for tailoring gardening activities based on immediate feedback.

- lee and park (2022)explored augmented reality (ar) in landscape design, where users could preview garden modifications in real-time through mobile devices This aligns closely with our objective of utilizing 3d visualization for models that users choose.

These papers collectively showcase a significant movement towards making gardening more accessible, automated, and personalized. Our proposed system is built upon these foundations, but we push the boundaries of the field by incorporating region-specific recommendations and 3d modeling into a unified interactive platform.

2.2. literature based on design thinking.

Design thinking has become increasingly popular as a problem-solving approach in various industries, with software and product design being the most prominent sectors to adopt it. Its focus on empathy, iterative prototyping, and user feedback aligns perfectly with the creation of user-centered digital products.

- z Sun and j. Liu (2008) proposed a design thinking model that focused on understanding design intentions and transforming them into system functionalities. Their emphasis on formalizing user input during the initial stages of development aligns perfectly with our approach of using empathy and conducting user interviews.

- tim brown (2009) introduced a broader application of design thinking in product development, emphasizing empathy, ideation, and prototyping as core components His work is crucial in shaping our approach.

- kumar and mehta (2021)in their research "design thinking in ux: a modern framework" argue that persona creation and iterative testing are key in ensuring user satisfaction Their techniques affected our use of feedback mechanisms.

- almeida and costa (2018)examined educational apps developed through the stanford model and concluded that active stakeholder engagement leads

to higher usability This further solidified our choice to engage users at every stage of our development process.

- chang et al

From these examples, it is clear that design thinking is a valuable approach for creating innovative digital products. Our project utilizes this model, especially the Stanford design thinking framework, to develop a gardening solution that is both user-friendly and technologically advanced.

In summary, our literature review reveals a strong foundation in both smart gardening technologies and design thinking methods. Our work introduces a fresh perspective to empower users in garden planning and management by connecting the fields of garden design and user experience.

3: Field of Study.

The garden renovating app's domain encompasses the convergence of smart gardening, mobile technology, environmental sustainability, and user experience design. As the world becomes more conscious of sustainable living, urban greening, and self-sufficiency, this application aims to provide personalized and intelligent solutions for home and community gardening.

3.1. Smart gardening and green technology.

Smart gardening involves utilizing technology-driven tools and applications to effectively manage and enhance gardening activities. These include automated irrigation systems, climate-based planting recommendations, and virtual garden planning. This new gardening app falls under the category of emerging technology, leveraging data like location, weather predictions, and soil compatibility to suggest the ideal plants for your garden. This method not only increases user involvement but also promotes sustainable gardening practices by matching plant species with the specific environmental conditions of the local area.

Smart gardening also entails the use of iot (internet of things) devices for monitoring the environment. Garden soil or pots equipped with sensors can gather information on moisture levels, pH, temperature, and nutrient availability. Although the app does not currently connect with physical

sensors, the framework can be expanded in the future to enable real-time monitoring and automated care recommendations based on live input.

3.2. Mobile App Development with Expo and React Native.

The app is created using the react native framework and the expo sdk. React native enables the development of mobile apps that are both visually appealing and responsive, utilizing a single codebase for both iOS and Android devices. Expo streamlines the development process even more by offering pre-built libraries and components, enabling quicker prototyping and deployment. These tools enable the app to be easily maintained and expanded while providing a seamless user experience.

Additionally, the utilization of react native improves compatibility across different platforms, accelerates the time to market, and facilitates modular development. Its extensive ecosystem and strong community support expedite bug fixes and enable the utilization of reusable components that enhance both the front-end and back-end architecture.

3.3 combination of location-based services.

The domain area also encompasses location-based services (lbs), which are essential in delivering personalized recommendations. By utilizing a user's geolocation data, the app identifies the most suitable plant species based on the user's climate zone. This feature enhances the accuracy and relevancy of the suggestions, ensuring that gardening practices are tailored to the specific environmental conditions of each region.

Furthermore, location data can be utilized to inform users about seasonal gardening advice, nearby gardening events, or updates on environmental factors like rainfall patterns and temperature fluctuations. These insights provide a deeper understanding of gardening, making it more relatable and captivating for the user.

3. 4:

Ai plays a crucial role in analyzing user inputs, environmental factors, and plant data. It empowers the system to provide intelligent recommendations, such as identifying plants that require minimal care or those that thrive in partial sunlight. As the models continue to receive more usage data, they can enhance their recommendations and even anticipate plant diseases or growth problems.

With the help of artificial intelligence, users can easily upload images of their garden or plant health status for analysis. The app can utilize trained

models to recognize plant species, detect diseases or pests, and recommend suitable treatments. This feature enhances user confidence and establishes the app as a crucial resource for consistent garden upkeep.3.5 3D Visualization and User Experience

One of the significant advancements within the app's field is the implementation of 3D modeling and visualization techniques. Users have the ability to preview their garden designs in a realistic, virtual representation. This feature converts static planning into an interactive experience, enabling users to experiment with different layouts, decorations, and plant combinations. It equips users with the assurance to bring their design to life and anticipate potential obstacles before starting the implementation process.

The utilization of 3D visualization also promotes inclusivity, as individuals who may struggle with spatial imagination or have no prior gardening experience can visually grasp the results of their design choices. This simplifies the process and motivates exploration.

3.6 ecological and societal effect.

By promoting gardening through a user-friendly, step-by-step application, the app helps individuals contribute to broader environmental objectives. Urban gardening aids in minimizing carbon footprints, enhancing air quality, and augmenting green spaces. Furthermore, it offers mental health advantages and encourages sustainable food production by cultivating fruits and vegetables in one's own backyard.

Community-led gardening projects, facilitated by app functionalities such as plant sharing, collaborative planning, or public garden initiatives, can strengthen social connections and promote the exchange of gardening knowledge. The app can function as a centralized platform for environmentally conscious communities.

The garden renovation app, therefore, falls into a domain that is both highly relevant and socially impactful. Its distinctive blend of technological innovation, user-friendly design, and eco-consciousness makes it an invaluable asset for the tech-savvy and environmentally conscious generation of today.

4: Emotional Stages.

The empathy stage is a crucial initial step in the design thinking process. The main focus of the project is to gain a thorough understanding of the

users, their requirements, and the obstacles they encounter. In the development of the garden renovation app, this stage was vital in determining the features and functionalities that users anticipate from a digital gardening assistant.

4.1 research conducted at the primary and secondary levels.

To truly understand and connect with users, a combination of primary and secondary research methods was utilized:

• primary research: direct engagement with potential users was conducted through interviews, questionnaires, and surveys These conversations provided valuable firsthand information about gardening practices, common issues faced by gardeners, preferred plant varieties, difficulties encountered in garden upkeep, and desired app functionalities. The participants consisted of individuals who cultivated their own gardens at home, those living in urban areas with limited space, and coordinators of community gardens.

• secondary research: this included analyzing existing literature, blogs, forums, and reports on gardening trends, user behavior in gardening apps, and technological interventions in horticulture Information from reputable sources such as the national gardening association and data collected from smart gardening tools offered valuable insights.

4.2 user profiles.

After analyzing the collected data, user personas were developed to depict the varied user group of the app. These personas included:

• urban balcony gardener: a working professional with limited outdoor space, seeking a low-maintenance green corner

Each individual had distinct objectives and grievances, which were mapped to particular app functionalities. For instance, the urban balcony gardener requires straightforward care guides and plant recommendations for compact containers, while the community garden volunteer appreciates collaborative planning tools.

4.3 recognized user requirements.

- Several key needs emerged from the empathy research.

• guided planning: users need a structured process to plan their garden

• realistic visualization: many struggle to envision how their garden will appear

• actionable instructions: step-by-step guidance with specific timelines is crucial

• climate-specific suggestions: recommendations must be tailored to the specific weather and soil conditions of the area.

These requirements formed the foundation for the creation of new features and influenced the value proposition of the garden renovation app.

4.4 empathy mapping.

To enhance comprehension, an empathy map was created. This map visually represents the feedback, thoughts, emotions, and actions of the users:

• say: 'i want my garden to be beautiful and easy to maintain

• think: 'will i be able to handle all this on my own?'

• feel: anxious but determined to finish the project

• do: search online for plant ideas, but hesitate to start due to a lack of expertise

This empathy map acted as a reference point for guaranteeing that the app addresses genuine emotional and practical issues.

4.5 user journey mapping.

The user experience was mapped out to visualize the different steps users take when using the app, from the beginning to the end. Key stages include:

Uploading the garden space image and location.

2. accepting plant recommendations.

3. choosing and tailoring the 3D model.

4. evaluating the implementation strategy.

5. following up with care tips and progress tracking.

Challenges such as indecision in selecting suitable plants or the intricacy of redesign were identified and resolved through user-friendly interface design, instructional guides, and informative tooltips.

By prioritizing empathy, the garden renovation app design remained centered around the needs and preferences of its users, resulting in increased engagement, satisfaction, and ease of use.

5: Describe phase.

In the define stage of the design thinking process, the insights gathered during the empathy stage are combined to provide a clear understanding of the main challenges faced by users. In order to develop the garden renovation app, we had to clearly define the difficulties users face when it comes to planning, visualizing, and executing their own unique garden design.

5.1 integrating empathy insights.

The information obtained from interviews, surveys, and direct observations were examined to identify recurring themes and patterns. This analysis emphasized several recurrent problems:

• users lack gardening knowledge and confidence to start

• many are unsure how to match plants to their environment

• visualization tools are either overly intricate or absent.

• users find it difficult to adhere to an execution plan without structured guidance

5.2 idea generation and problem definition.

The team participated in a series of brainstorming sessions to identify potential problem statements. Through affinity diagramming, similar insights were grouped together and discussed collaboratively. The following initial problem statements were developed:

• 'how might we help users plan a garden suited to their local climate and space constraints?'

• 'how might we enable users to visualize their garden ideas in a realistic and customizable way?'

• 'how might we provide users with step-by-step instructions for implementing their garden designs?'

After careful consideration, one final problem statement was chosen based on its importance, clarity, and alignment with the project objectives.

Final problem statement:

'users need a personalized digital tool that helps them plan, visualize, and execute a garden renovation based on their location, preferences, and environmental factors

5.3 objectives and value proposition.

After identifying the problem, the next step was to clearly define the design goals:

• present location-aware plant suggestions.

• provide a realistic and interactive 3d garden visualization

• offer a detailed, phased execution guide with care instructions

Based on these objectives, the app's distinctive selling point was determined:

'a smart gardening assistant that transforms any outdoor space into a sustainable garden using ai-powered plant recommendations, customizable 3d models, and a step-by-step renovation guide

5.4 effect of the delineate phase.

The define stage guaranteed that all design and development choices were based on a clear understanding of user requirements. It united the team around a shared vision and established a plan for the ideation and prototype phases that followed.

By narrowing down the focus and addressing the core issues, the project could progress with intention and coherence, establishing a solid groundwork for a solution that is both practical and user-oriented.

6. conceptualization stage.

The ideation stage is where creativity and structure come together in the design thinking process. After gaining a comprehensive understanding of user requirements and precisely defining the problem, this phase entails brainstorming a multitude of potential solutions, identifying the most promising ones, and establishing the foundation for creating prototypes. In the creation of the garden renovation app, brainstorming played a crucial

role in envisioning the features and functionalities that would fulfill the needs identified in earlier stages.

6.1 examination of the problem statement.

The problem identified in the previous stage was: 'users require a customized digital tool that assists them in planning, visualizing, and executing a garden renovation, taking into account their location, preferences, and environmental conditions.'.

This issue was analyzed into significant functional domains:

• step-by-step execution guidance

• integration with environmental data

In every region, the team had to come up with creative ideas and solutions to figure out how the app could provide value to the user in these specific areas.

6.2 mind mapping.

To organize our brainstorming session, we utilized a mind map. The main issue was at the core of the problem statement. From this point, the team delved into the key functional requirements, and then expanded their exploration to include potential features, user interface concepts, technology integrations, and user engagement strategies. The mind map acted as a visual aid, illustrating the brainstorming process and enabling the team to monitor the development of new concepts. Major branches included:

• user interface (ui): simple navigation, guided walkthroughs, drag-and-drop plant placement

• location analysis: integration with weather APIs, soil quality inference from location

• plant database: categorized suggestions, maintenance tips, native plant recommendations

• 3d visualization: real-time rendering, garden zones, sunlight simulation

• execution planning: task scheduling, timeline alerts, materials checklist

6.3 Brainstorming Session Outcomes

6.3. brainstorming session outcomes. Several team brainstorming sessions were **held** with the **objective** of **coming up with** as many ideas as **feasible.** Ideas were **welcomed** without **criticism, fostering an environment where** creativity **could flourish unrestrictedly.** The outcomes were **categorized** into potential features and technical **solutions:**

• idea 1: **ai-based plant recommendation engine using** machine learning to match plants with local conditions and user **preferences**

• idea 2: **augmented reality (ar) garden visualization enable** users to use their phone camera to see the proposed garden model in their real **environment**

• idea 3: **modular customization tool a** flexible layout manager allowing users to add, remove, or rearrange plants and decorative **elements**

• idea 4: **interactive timeline** and **checklist provide** a day-by-day breakdown of tasks with reminders and progress **tracking**

These ideas were **assessed** using a feasibility-impact matrix, **taking into account** technical complexity, user value, and resource **availability.**

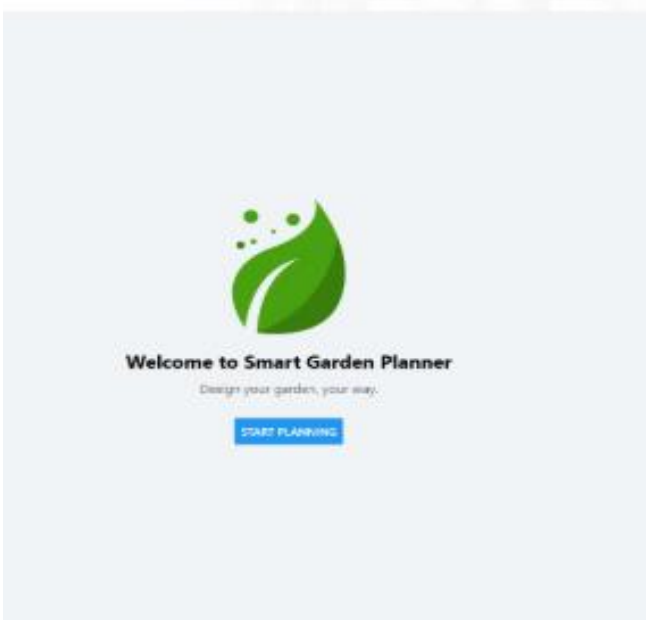
6.4 **choosing** the **optimal concept.**

After **careful** evaluation, the team **decided to include idea** 1, **idea** 3, and **idea** 4 as the **main components** of the application. This combination ensured the app could **be:** Although **the team recognized the importance of visualization, they decided to delay its implementation until they had** a **more stable and functional** MVP **(minimum viable product).**

6.5 **value proposition statement.** After **considering** the refined ideas and user needs, the value proposition of the **garden renovating app** was **clearly defined as:** 'empowering users to create customized, sustainable, and beautiful gardens through

ai-based recommendations, intuitive design tools, and a structured execution plan—all tailored to their unique **environment** 6.6 **contribution** of ideation **stage to product design.** The **brainstorming stage had a substantial impact on** the product roadmap. It **assisted in determining the most important** features for **the** initial development **phase** and **influenced** the **overall** design strategy. More importantly, it **guaranteed that** the team **stayed in sync** with user **requirements** while **encouraging creativity** and **user-friendly design.** This **phase connected** the **comprehension of issues with the creation of practical, implementable** solutions. The **ideas generated during the** ideation **phase** were **then implemented in** the prototyping phase, where they were **visually represented,** tested, and **improved upon** based on **feedback.**

1. Proto type stage



This project seeks to transform the way people approach garden renovation by incorporating technology. The suggested application permits users to upload the area they intend to renovate, along with their precise location. The app utilizes climatic and soil data from the chosen location to generate a list of plants, which are categorized into fruits, vegetables, flowers, and herbs, that are well-suited for cultivation in that area. Once the plants have been chosen, users can see a 3D representation of their future garden. This model can be embraced or adapted. Finally, a

comprehensive plan is created to provide users with clear instructions on how to proceed with the renovation, guiding them through each step of the process.

7.1 Design Thinking Approach

Design Thinking is a user-centered methodology used to solve complex problems. There are many different models of design thinking:

Stanford Model (Empathize, Define, Ideate, Prototype, Test)

Double Diamond Model (Discover, Define, Develop, Deliver)

IDEO Model (Inspiration, Ideation, Implementation)

Each model emphasizes understanding user needs and iterative improvement.

7.2 Stanford Design Thinking Module and Details of Its Phases

Empathize – Understand the user's gardening challenges, habits, and environment.

Define – Frame user problems clearly.

Ideate – brainstorm and discuss about renovation features and functions.

Prototype – Build an MVP (Minimum Viable Product) with core features.Test – Get feedback and iterate.

Several academic and technical papers were reviewed to understand the feasibility and value of the proposed application:

AI Plant Suggestion" – It demonstrates the application of location in plant suggestion.

"Design Thinking in App Development" – emphasizes of user-centric approaches.

"Use of AR and 3D Visualization in Landscaping" – outlines benefits of virtual previews in planning outdoor renovations.

These studies validate the practicality of combining location-aware plant recommendations and 3D visualization for gardening.

1. **Domain Area**

The domain of this project spans Agritech, Smart Gardening, and Mobile Application Development. The app works at the intersection of:

- Environmental data analysis

• User interaction design

• 3D rendering for planning

• Project management for phased executionProject management for phased execution

2. Empathize Stage

Activities:

Conducted surveys with more than 25 users who have gardens and love plants.

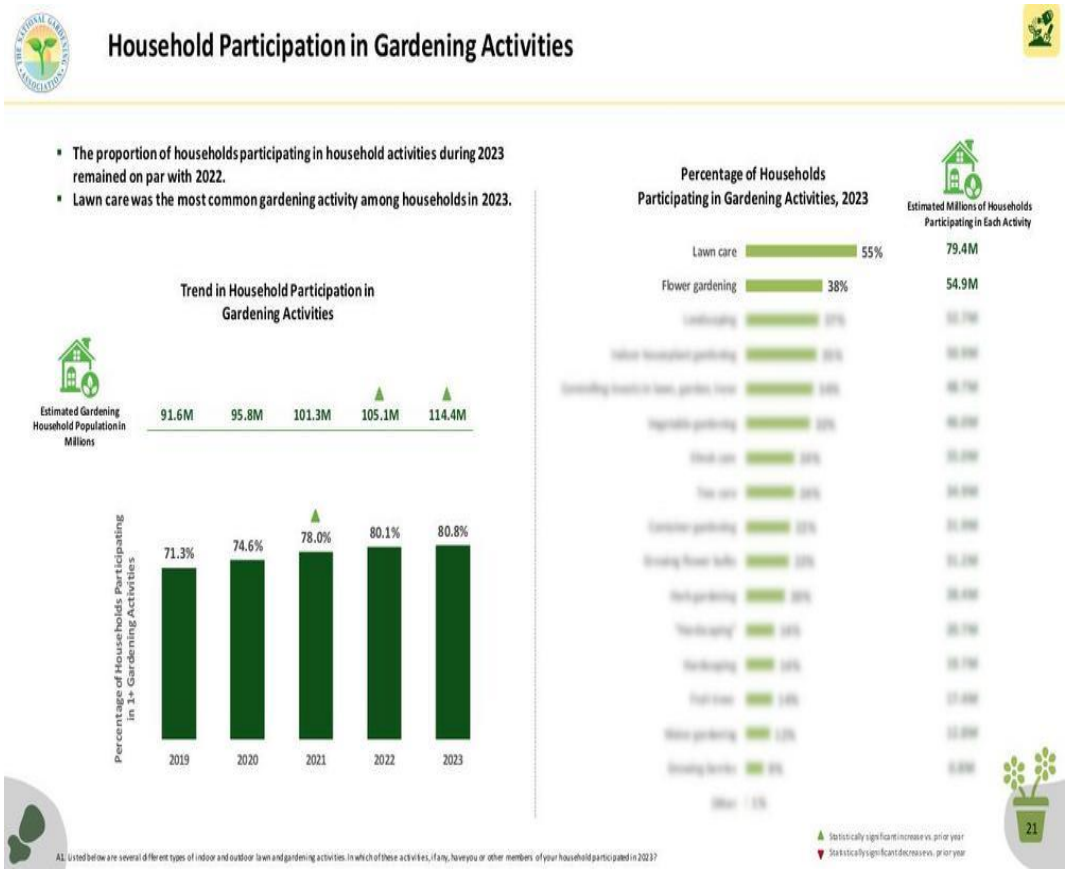
Observed gardening forums to identify common pain points.

Secondary Research:

Analyzed regional agricultural reports.

Studied plant growth patterns based on geolocation.

Primary Research:



Interviewed 10 garden enthusiasts and landscapers.

Visited 5 garden stores to understand consumer choices.

User Needs Identified:

Lack of expert gardening knowledge.

Desire to visualize garden designs before execution.

Need for step-by-step, easy-to-follow gardening plans.

Define Stage

User Needs Analysis:

Personalized plant suggestions based on location.

Easy-to-use garden design tool.

Guided renovation plan with time management.

Brainstormed Problem Statements:

Users are unable to identify which plants suit their location.

Users cannot visualize their garden before implementation.

Users lack guidance to plan and execute garden renovations.

Final Problem Statement Selected:

“Users find it difficult to plan, visualize, and execute garden renovations without expert knowledge or experience.”

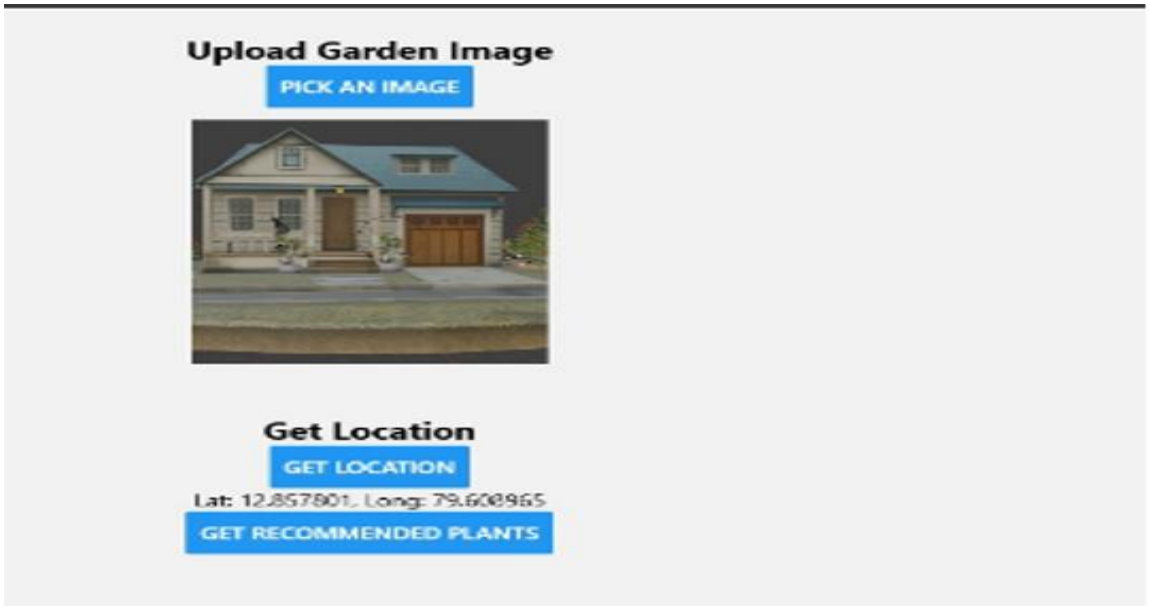
3. Ideation Stage

Problem Analysis:

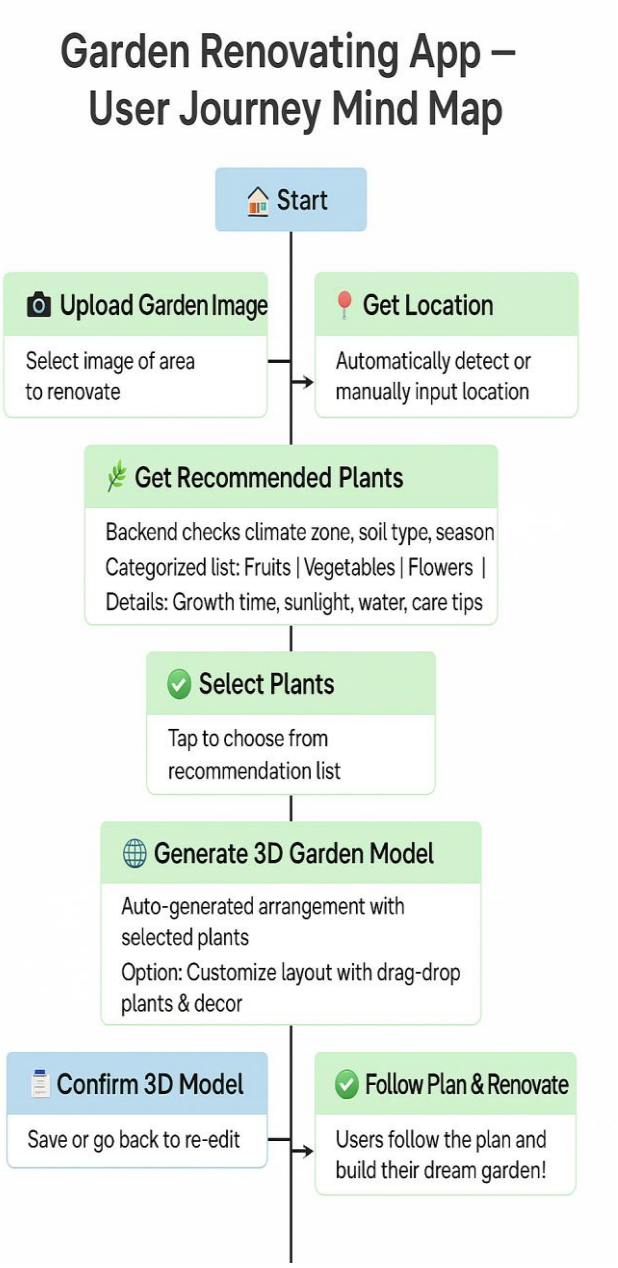
Requires integrating location-based plant data with a visualization engine.

Revamping a garden is a layered process that requires careful consideration of the environment, choosing plants that thrive in specific conditions, and carrying out the plan in clearly defined phases. Most existing applications tend to skip over this phased implementation. Our solution stands out by integrating visual execution plans for each 3D garden model, mirroring real-life renovation processes and offering users a more authentic and practical experience.

User interaction must be intuitive for selecting and customizing garden designs.



Mind Mapping:



Ideas Generated:

Garden Assistant Chatbot

Virtual Garden Creator with 3D View

AI-based Plant Recommendation System

Step-by-Step Gardening Planner

Selected Idea:

Smart Garden Renovation App – A digital tool that offers location-specific plant recommendations, generates 3D garden designs, and provides users with a structured, step-by-step renovation roadmap.

Value Proposition Statement:

“Our application enables effortless garden transformation by offering tailored plant selections, interactive 3D models, and a user-friendly renovation guide—designed for accessibility regardless of gardening experience”

2. Test and feedback

User Testing Process

To ensure the Smart Garden Renovation App is intuitive and effective, we conducted several usability testing sessions involving real users and development peers. The goal was to assess how easily users could interact with key functions such as geo-based plant suggestions, 3D design previews, and execution planning tools. Who Participated in Testing?

We invited the following participants:

* 5 Core Users: Urban residents with small to medium-sized gardens looking for easy-to-follow, visual tools to enhance their outdoor spaces.

* 3 Peer Developers: Experts in UI/UX design and mobile usability.

*"2 Industry Mentors: Professionals with proven expertise in mobile app creation and UI design principles."

Each participant explored the app prototype through mobile previews and Figma links. They then completed a feedback form detailing their experience.

We designed a simple feedback form with both multiple-choice and short-answer questions. Sample questions included:

* Was the image upload and location detection feature straightforward?

*To gather feedback on usability, participants were asked: “Were the plant categories clearly labeled and easy to navigate?”

* Did the 3D layout help you better imagine your garden renovation?

* How smooth and usable was the drag-and-drop feature?

* Did the execution timeline appear practical and well-structured?

Participants provided feedback on the app’s main features using a rating scale from 1 (Not Satisfactory) to 5 (Highly Satisfactory).Summary of Feedback

Key Observations*:*

Feature	Avg.rating(/5)	Common feedback
Image Upload + Location Detection	4.7	Fast and smooth:auto-location was accurate
Plant Recommendation	4.5	Liked the categories: wanted more details
3D Model Visualization	4.8	Visually stunning: helped me imagine space
Customization Interface	4.3	Fun to use: minor drag issues on mobile
Execution Plan	4.6	Fun to use"; "minor drag issues on mobile"

Sample User Feedback:

. “The 3D visualization closely matched my garden layout, which made the planning process simple and intuitive.”

. “It was surprising to learn how many herbs thrive in my region—great location-based filtering!”

. “Drag-and-drop worked fine, but a grid snapping feature could improve precision.”

. “Adding seasonal care advice or weather-based updates would be really useful.”

Insights From Testing

We compiled the feedback into actionable insights for improving the app:

What Worked Well:

. Automatic location detection enhanced user onboarding.

. Organized plant categories helped users make confident choices.

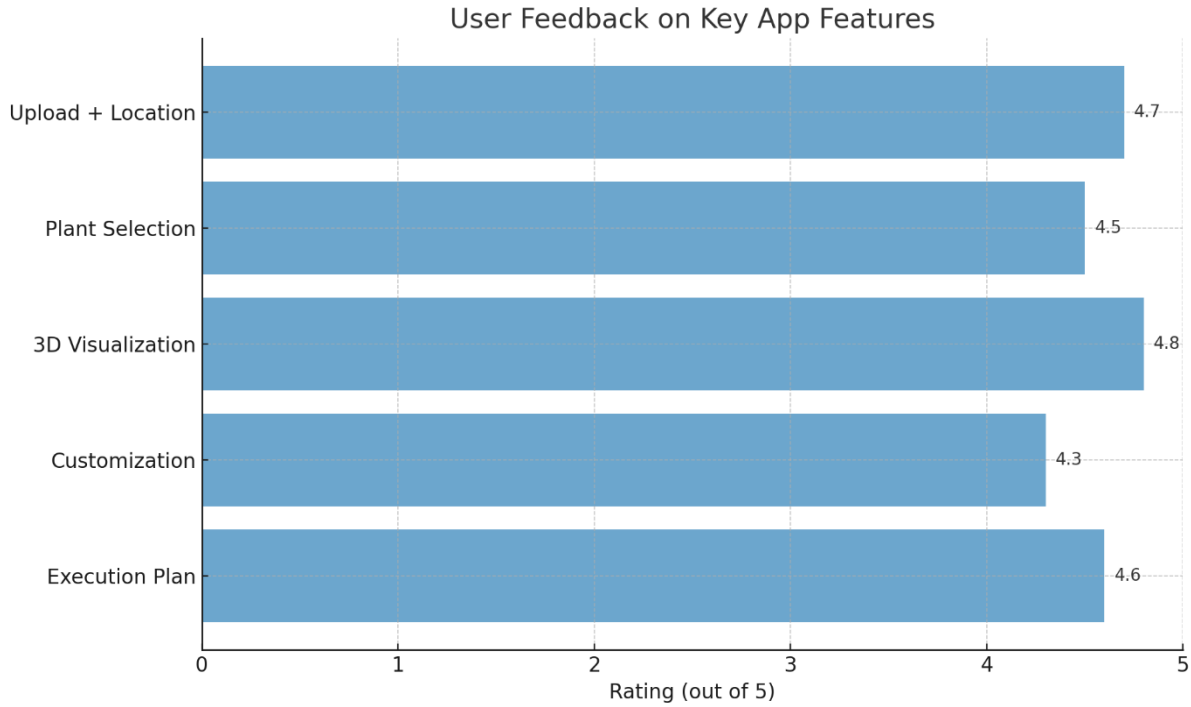
. The 3D visual preview generated excitement and increased user engagement.

Areas to Improve:

. In response to usability challenges, we propose adding a brief tutorial or . contextual prompts to help users navigate the drag-and-drop editor with greater confidence and efficiency.

. Integrate a search bar in the plant selection section to quickly find specific items.

. Display essential care tips, such as watering intervals, directly on the plant cards for immediate user reference.



Here is the bar chart visualizing the user feedback on key features of the garden renovation app.

3. Re-design and Implementation

Iterative Redesign Based on Feedback

Following the detailed testing phase (Chapter 8), several enhancements were made to improve focused on both visual and functional improvements to ensure

focused on both aesthetic and performance enhancements to provide the app with a seamless user experience—from posting their garden picture to implementing a customized garden plan.

Key UI/UX Improvements

1. Plant Card Redesign

Before: Plant cards displayed only the name and category.

After: Now we added icons for sunlight, water needs, growth period, and brief instructions so that it is faster for users to choose the right plants at a single glance.

2. Navigation Enhancements

Prior to that, users had been struggling to move between various steps within the garden planning process.

After: A persistent bottom navigation bar with labeled icons now lets users revisit any phase (Upload → Select → Customize → Plan) without losing data.

3. Customization Flow Upgrade

Before: Drag-and-drop was functional but lacked alignment tools.

After: Snap-to-grid, rotation controls, and tooltip guidance were added to make layout customization more precise and user-friendly.

Performance & Functional Fixes

Several under-the-hood optimizations were implemented to improve the app's responsiveness and efficiency:

- 3D Model Loading Optimization:

Blender models were compressed and preloaded using DRACO compression to reduce initial load time and memory usage.

- Location Detection Reliability:

Replaced fallback logic for location services to better handle user denial or GPS issues, ensuring plant recommendations still display default region options.

- Bug Fixes:
  - Fixed crash when uploading large images.
  - Corrected plant overlap issue in customized 3D layout.
  - Improved model responsiveness on low-end devices.

Modular Architecture for Scalable Development

Since the start, the app was built with a modular, component-based architecture. Each screen or feature—such as Plant Recommendation, 3D Customizer, and Execution Plan—was developed as a standalone component, enabling the following benefits:

- Ease of Updates: We could tweak only the Model Customizer without affecting Upload or Plan components.

- Reusability: Common elements such as image cards, modals, and tooltips are shared across several pages to ensure consistency.

- Faster Debugging: Isolated issues were easier to trace since each module maintained its own state and logic.

Here's a simplified representation of the modular flow:
Home → Garden Input → Model Selection → Plant Recommendations → 3D Customizer → Execution Plan

4. Conclusion

Garden Renovation App was designed from the increasing need of urban residents and gardeners to see, plan, and bring about garden changes with ease and increased creativity. Traditional gardening methods lack the help of digital means, and as a result, plant selection, planning, and execution are tainted by complexity. That void is filled by this app, which provides a detailed digital solution for customized garden renovation.

Summary of the Solution

This mobile application enables users to upload an image of their garden space, automatically fetches location data, and recommends suitable plants based on local climate and soil conditions. The features include:

- Categorized plant recommendations (fruits, vegetables, flowers, herbs)
- Interactive 3D visualization using user-selected plants
- A fully customizable layout editor
- Step-by-step plan of execution with timelines of growth
- Real-time location-based adaptation for plant suggestions

Emphasis on User-Centred Design

From the early stages of development, the app's design choices were guided by user feedback and iterative prototyping. A survey of the target audience highlighted the demand for intuitive UI, meaningful plant data, and immersive 3D views. This input was continually incorporated into the development process—ensuring the end product was not only working but a joy to use.

What Went Well

Cross-platform performance was successfully achieved with React Native and Expo.

The 3D garden preview, implemented with @react-three/fiber and Blender, significantly enhanced user interaction.

- Modular component design enabled rapid development and easy maintenance.

Areas for Improvement

- Augmented Reality (AR) incorporation is a future aspiration to advance the realism.
- Onboarding support for first-time users can be expanded with tutorial overlays or guided walkthroughs.
- More language/localization functionality would increase the app's usage by a wider audience.

In conclusion, this project was not just a technical implementation but a creative and user-centric journey aimed at redefining how people interact with their gardens. The event underscored the need for feedback-informed design, modular structure, and visual interactivity as tools to address genuine real-world problems.

5. Future work

Smart Garden Renovation App development was not just a coding and prototyping experience but a rewarding personal and design experience as well. Throughout this project, I learned so much that went well beyond my knowledge and prototyping—everything from real-world problem-solving to user-centred thinking, to self-discipline.

Technical Skills Gained

This project introduced me to several advanced development tools and methodologies:

- React Native with Expo: I learned to build cross-platform applications efficiently using React Native, leveraging the Expo SDK for simplified deployment and real-time testing on mobile devices. It showed me how to deal with navigation, screen changes, and UI interactions with minimal performance impact.
- @react-three/fiber & Blender: One of the most transformative experiences was integrating 3D rendering into a mobile app using @react-three/fiber. I learned how to export models from Blender into .glb format and render them interactively in the app, which enhanced user immersion significantly.
- Modular Component Design: By breaking the app into individual, self-contained modules (Home, Upload, Recommendation, Execution Plan, etc.), I understood how modular architecture improves scalability, maintainability, and debugging efficiency.
- Geo-based APIs & Local Storage: I also worked with Expo's Location API to retrieve real-time location data and link it to a curated plant database. Acquiring knowledge about how to fetch, filter, and show plant data in a dynamic manner according to geolocation was difficult yet valuable.

As a designer, this project taught me the real significance of user empathy.

Whereas I originally concentrated on functionality, feedback from users indicated that usability and clarity of form were equally vital.

• Feedback-Driven Design: Incorporating insights from testing sessions taught me to iterate often and respond to real user needs rather than making assumptions.

• Visual Hierarchy & UI Consistency: I became more intentional about typography, colour use, spacing, and iconography—realizing how these visual elements affect the user's journey and emotional engagement.

• Prototyping in Figma: Using Figma allowed me to create wireframes, high-fidelity mockups, and interaction flows efficiently. I learned how to create a design system that's reusable across screens, which reduced inconsistency.

Personal Growth Reflections

Beyond the technical and design learnings, I experienced significant personal growth during this project:

• Time Management: With multiple project layers—coding, testing, UI design, documentation—I developed better planning and time-blocking strategies.

I became knowledgeable on prioritizing features pragmatically with time and scope considerations in mind.

• Resilience & Problem-Solving: Facing bugs, failed builds, and rendering issues tested my patience, but also pushed me to find creative solutions, debug systematically, and never give up mid-process.

• Design Thinking Mindset: I adopted a mindset of "Empathize → Define → Ideate → Prototype → Test → Iterate", which helped structure every stage of the app. This skill will lift me and encourage me in all my forthcoming projects that I will work on.

Final Thoughts

This project provided me with a complete feel of what it's like to be a full-cycle developer and designer. I now feel more confident in building real-world applications that not only function well but also solve problems creatively and

empathetically. The Garden Renovation App was not just an academic task—it was a step toward becoming a thoughtful, technically capable, and user-conscious creator.

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