

Prototype Design Report

F20AD | Advanced Human Computer Interaction

Heriot Watt University Dubai | Coursework 1

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1 Introduction

Human Computer Interaction is a subject that involves the study of how humans interact with computer systems and designing computer interfaces that optimize the use of people and their computers. The main object of studying human computer interaction is to create engaging experiences with users based on information gathered regarding human psychology and computer sciences, allowing for the creation of functional and easy to use technology [1].

This report details the steps taken to develop an application prototype based on different concepts provided, considering the essentials to create good human computer interaction experiences, accounting for the different users, creating tasks with fixed goals, developing an easy-to-use interface, and considering the use case in an environmental and user-based context.

1.a. Overview of the Project Concept

The chosen concept for this project aimed at creating an app focused on providing a family with information regarding their energy consumption, by creating an engaging and educational app interface that can be applied to different age groups and disability criteria which may be faced by users of the app. This includes creating a gaming interaction which would be suitable for one of the children, aged 13 and 5, while providing both parents with information regarding energy usage, providing personal and family-based overviews.

1.b. Purpose and Scope of the Prototype

The main purpose the prototype serves is to provide families with the ability to conserve energy within their households, by being able to see energy usage based on devices and transport used and allowing remote control of the electronics, which was achieved by utilizing smart devices all connected through Internet of Things (IoT).

The specific application, known as ‘Zivon,’ tracks energy usage of the different personae created for this project based on the different use cases each of the family members are assigned to help all of them achieve the common goal of conserving energy.



Figure 1 - Logo for Zivon

The IoT connections allow for smart control and full tracking of energy consumption of lighting, air conditioning, and other appliances such as fridges and ovens, with additional features allowing users to track their energy usage and carbon emissions outside the household based on travel distance and mode of transport utilized on a journey, with the use of gamified features to encourage energy saving habits.

1.b.i. Project Aim and Objectives

The main aim of the project is to create an app prototype, using Figma, to encourage the reduction of energy usage by a family, using design elements and gaming interactions in order to educate users and promote energy efficiency.

To do this, the following objectives must be met.

- Utilize Figma to create a user-friendly app prototype.
- Provide goal-based tasks that vary based on persona characteristics.
- Implement multimodal gaming interactions that employ suitable modalities.
- Ensure the application is accessible to all people, considering age groups and disabilities and how they would affect user experience.

1.b.ii. Project Timeline

In order to visualize the breakdown of tasks that needed to be completed within the period of time assigned for the project, a Gantt chart was drawn. The chart, as seen below in Figure 2, shows the splitting of tasks between different stages of the project and the different deliverables expected during the duration of the project, with initials at the side showing the people assigned to each task.

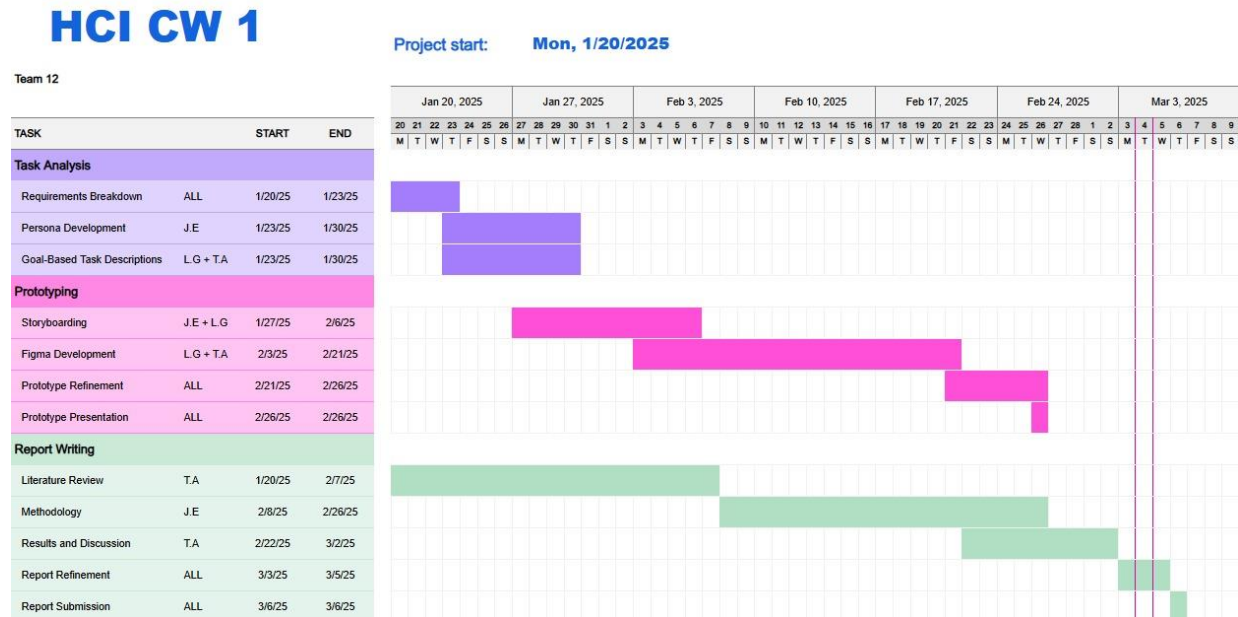


Figure 2 - Gantt Chart of Project Development

2. Background Research and Literature Review

To understand the basic requirements in order to create an engaging product, one can look at reports which underline the aspects of effective human computer interaction, with previous literature providing insight into the concepts and psychology behind certain design choices.

2.a. Ethics, Privacy, and Human Computer Interaction

Given the rate at which the dependance of technology in everyday life and interactions has become, ensuring developers understand the ethical responsibilities required when undertaking activities relating to human computer interaction is imperative. Human Computer Interaction functions by developing solutions based off of users and user needs, and ensuring that the developed technology respects user rights, privacy, and well-being means understanding the different factors and impact the technology will have on individuals and societies [2].

Given the use case of the app, ensuring privacy and security is important since the data involved is extremely sensitive. Several issues can occur in the recording, processing, and reporting of data, with high chance of unethical behaviors including privacy breaches, misuse of information, wrong interpretation of data and the exploitation of the tools and techniques within the app development and final release process. Data should be secured, with partnerships with government entities encouraged to ensure that data security is ensured [3].

2.b. IoT impacts on User Behavior

IoT, or the Internet of Things, is a term used to describe a connected system over the internet with the ability to exchange information over devices and systems. This can be done using user-provided prompts, sensors, and other inputs that can adjust and synchronize device responses to achieve a set goal for the developed system. As such, it is becoming an exponentially integrated technology in industries, including in home systems. Since systems can be developed in order to meet goals such as increasing energy efficiency, users could experience better results if consumers are willing to adopt and pay for these services, which means they have to weigh the positives and negatives of the technology in a financial, environmental, and social way to see how it would affect their application [4].

2.c. Accessibility in App Development

Given the context of people with disabilities, existing universal guidelines act as a powerful tool to help ensure content is accessible. One such guideline is the WCAG, or the Web Content Accessibility Guidelines, which set the main international standards for internet activity for not just people with disabilities but all different user specifications [5]. When looking specifically at people with visual impairments, a characteristic assigned to one of the personae in this project, ensuring that the content on screens is highly compatible with screen readers or using the integration of voice prompts to accommodate for low visibility and blind users. Further, utilizing sufficient contrasts, style, and sizing between different elements on a screen allows for further accessibility [6].

2.d. Motivation Techniques

Applications can utilize both intrinsic and extrinsic motivation in order to allow users to achieve certain goals. Intrinsic motivation involves users being pushed by their own personal desires in order to achieve a certain task, such as personal goals which can influence user decisions, while extrinsic motivation is the motivation through rewards or to avoid consequences [7]. While intrinsic motivations allow users to feel more accomplished, certain personal issues or hesitancy could prevent learning, and as such, the integration of extrinsic motivations into applications can allow for better learnings. These simulate the brain into releasing dopamine, and can provide further positive experiences by associating the actions done in the app with further external rewards that can be personal to the users [8].

2.e. Child-Friendly Gamification and Visual Storytelling

Since technology has been integrated, especially after recent global events, into the lives and daily use-cases of children, ensuring that the gamification techniques used in developed applications is child-friendly is important to prevent declines in children's health, which requires developers to understand the environment in which the child operates the gamified software in. Gamification allows for the creation of a better educational environment, with points, levels, progress, and leaderboards providing more motivation for continuation within a game, whether educational or not. When these factors are directly linked with education and specific positive actions that are to be rewarded, it allows children to become more motivated in completing their tasks, with research showing that game mechanisms can be used to change behaviors in children [9].

The impact of gamification is strong, and can also be used in all age groups, but ensuring that the welfare of children is a priority is important in making an effective and trust-worthy application. Further cues, storytelling, and engaging visuals can help ensure content is more memorable and easier to come back to. The interface the user interacts with must be easy to navigate and understand, and strong visual storytelling helps greatly improve usability and user experience [10].

2.f. Smart Devices and IoT in Practice

The utilization of smart devices is one which has exponentially increased over recent years, with it being estimated that almost 25% of households internationally would utilize would integrate at least one smart system, with the aim to increase support and be more efficient with resources [11]. In theory, the integration of smart appliances would allow for greater energy efficiency, with the advance in technology allowing for smooth integration of smart devices into the user's households. However, this is not always the case, with smart devices causing conflict while not always providing the expected energy efficiency [12], which can be primarily caused by a lack of proper integration of advanced human computer interaction.

While the world is moving towards more technologically advanced interactions, the utilization of IoT is contested when it comes to places defined as safe and personal areas for users, with a large pushback against the integration of technology capable of controlling the living environment due to their ability to cause damage to a living space and to persons [13]. This requires developers of

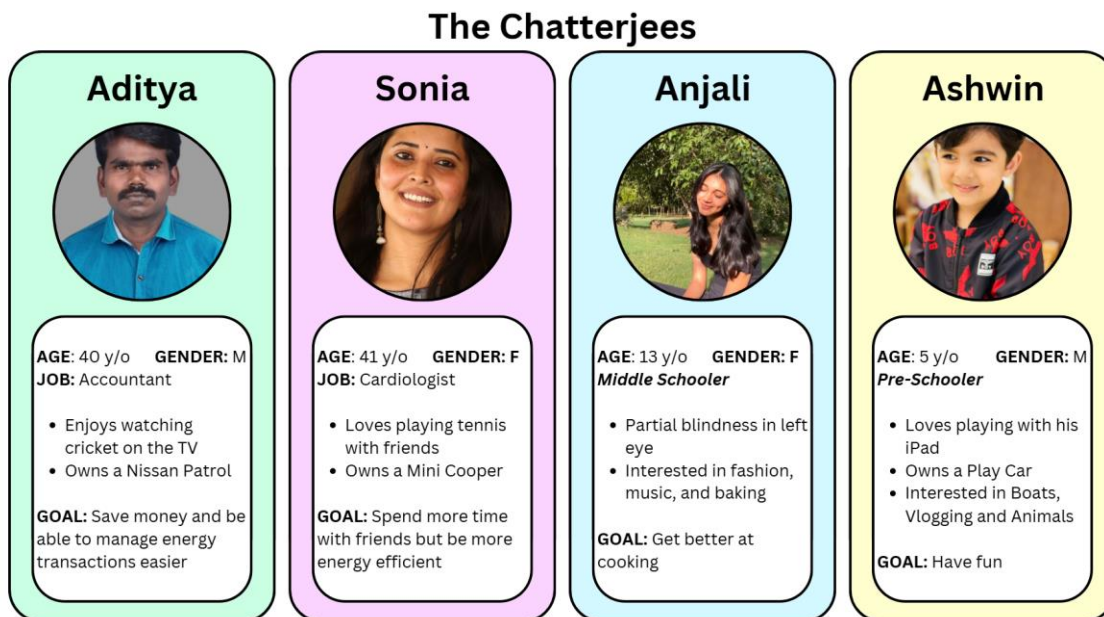
applications relating to energy, home-life, and automation to focus on providing a safe environment with other forms of control available to them to encourage the usage of the product. Control, along with security and transparency, would allow for the development of trust which is necessary in a human computer interaction context to help reduce the uncertainty and risk which users may face when using products and services [14].

3. Creation of Personae, Storyboards & Use Cases

To fully flesh out the prototype, certain factors need to be considered. These factors directly affect the design, structure, available features, and use cases which are implemented into the final product. These can be defined using personas, which are fictional characters that represent potential final users of the product. Each of these personae are given key characteristics, including age, gender, any potential disability, interests, and goals, which the product acts as a solution for [15].

3.a. User Personas

In order to display the different people and their reasons for using the app, personas were created based around the structure of a family of four people – two parents and two children, a boy and a girl, aged 5 and 13 respectively. The key characteristics and goals for each of the personae are listed below.



A happy family living together in a Bungalow in Dubai

Figure 3 - Persona Characteristics and Goals

3.b. Storyboards

Storyboards are tools used to describe how interactions would occur between users and the product. It involves graphical representations of tasks and interactions the user can experience when using the application, allowing developers to identify the specifications required for the software and how to ensure good user experience. Due to its simplicity and low cost, it proves a useful tool for developing applications in the earlier stages of prototyping, allowing easier communication and providing a framework to develop an app around [16].

The storyboards for the energy-saving app prototype, designed for a family of four, were created with careful consideration of each family member's individual needs, preferences and goals. It focused on educating each member, with further additions allowing them to manage and reduce their energy consumption. While drawing the initial draft, the following unique features for each family member were considered:

- **Aditya** (the dad) required an easy way to track family activity and manage secure bill payments, supporting his goal of saving money and energy.
- **Sonia** (the mom) needed to have a calendar to keep track of her busy schedule and daily tasks. Along with that, a journey tracker would be extremely helpful in monitoring her journeys carbon footprint as her goal is to spend more time hanging out with friends while still being energy efficient.
- **Anjali** (the 13-year-old daughter) has customizable widgets that allow her to enjoy her music in the app. Moreover, she loves cooking and wants to learn how to bake. With smart kitchen controls, she can manage appliances and listen to music hands-free. Careful consideration also needed as she suffers from poor eyesight, so the app needed to be user friendly with speech command options, along with bigger, simple, and pleasant aesthetics.
- **Ashwin** (the 5-year-old son) needed a gamified version of the app suitable for young kids, to learn about energy conservation in a fun and easy way to ensure retention of energy efficiency concepts.

A common feature for all family members is the smart home control system, which allows them to manage lights, air conditioning, and other appliances through the app. This was done for ease of control and access by all users. Another common feature was the ability to earn points in the app, which can be exchanged for rewards to provide extrinsic motivation for family members, with offers provided by the app for food, activities, and entertainment. The detailed tasks and interaction options that can be achieved in the app by each family member are illustrated in Figures 4 to 7.

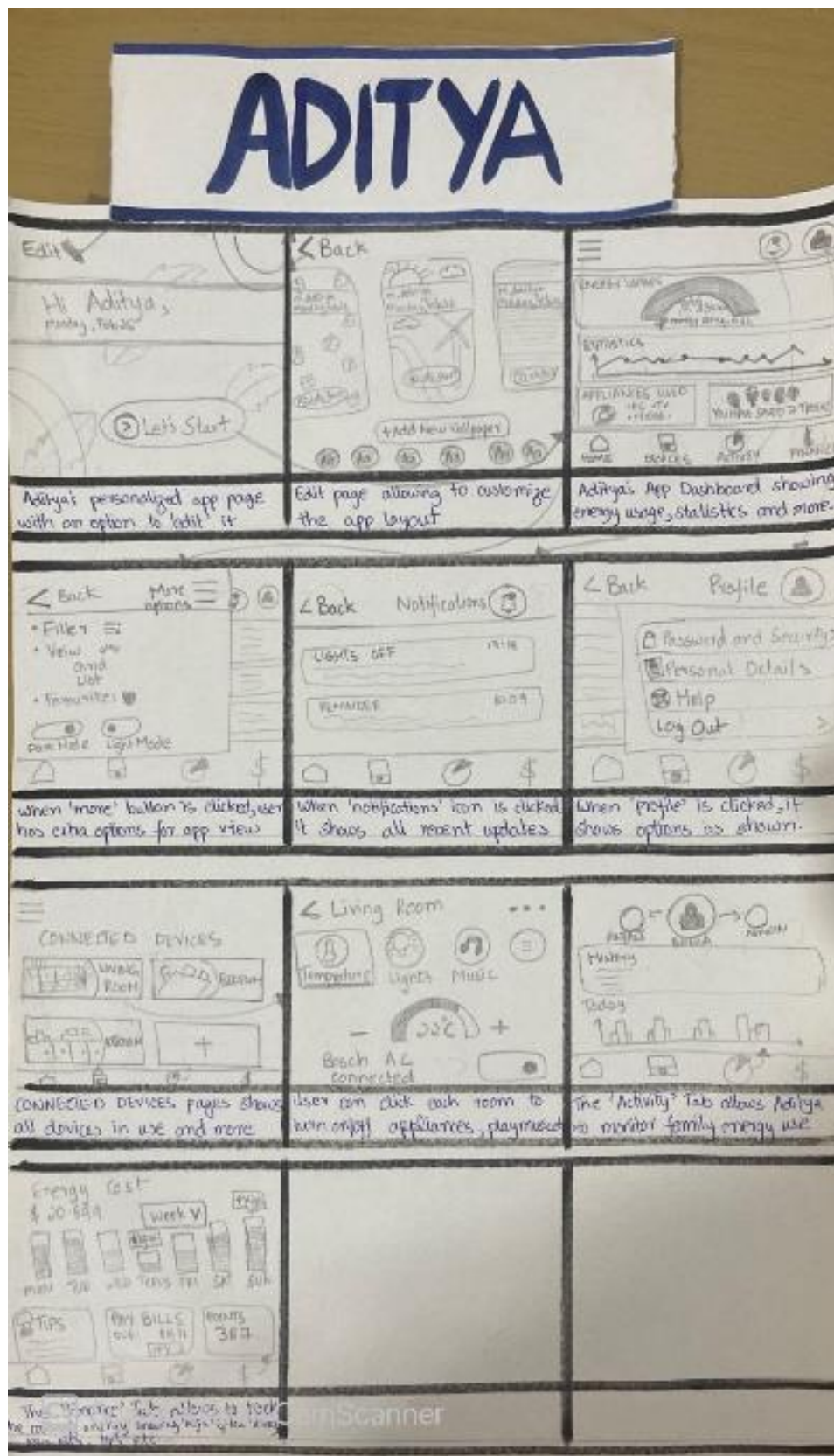


Figure 4 4 - Storyboard for Aditya

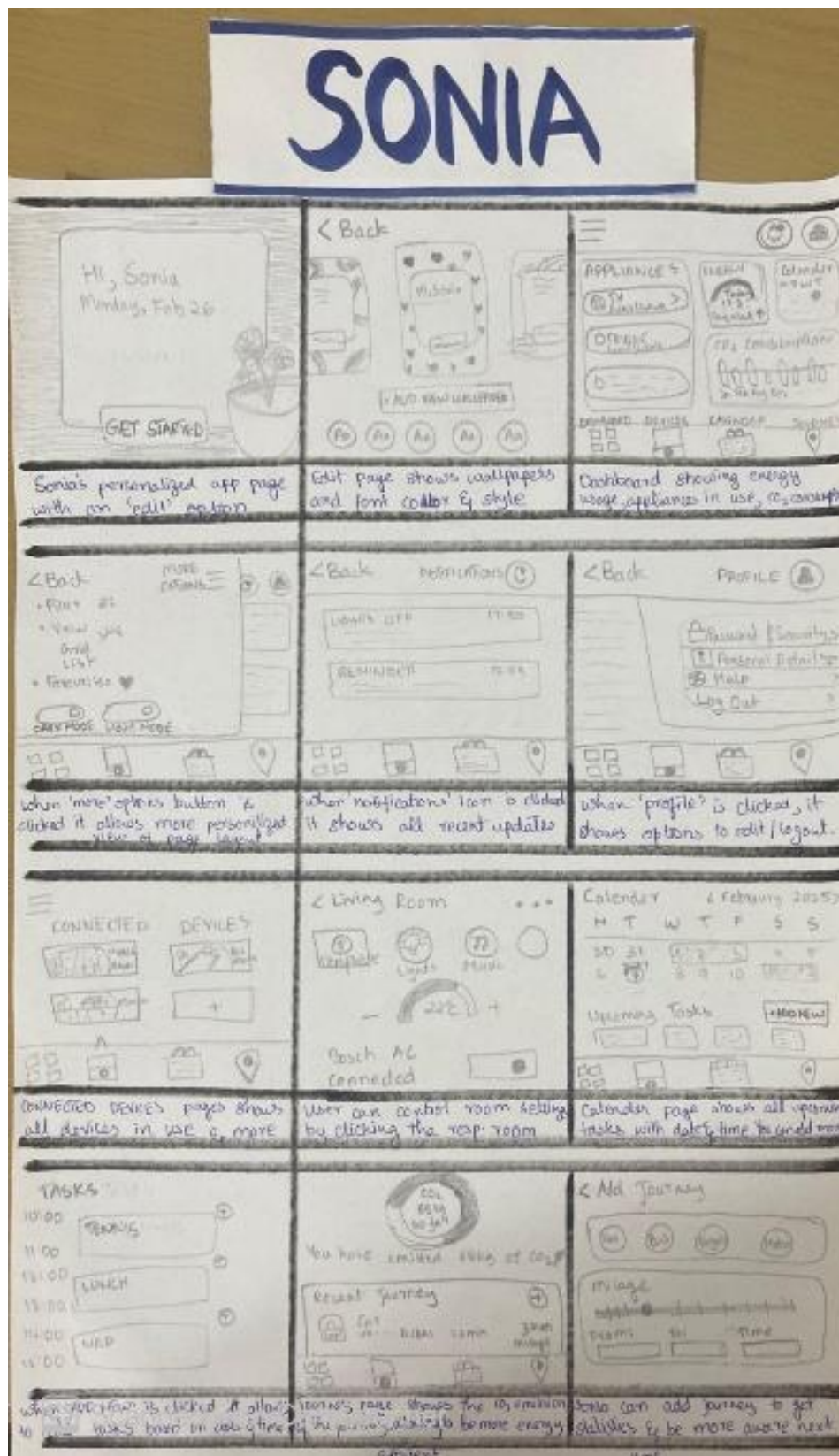


Figure 55 - Storyboard for Sonia

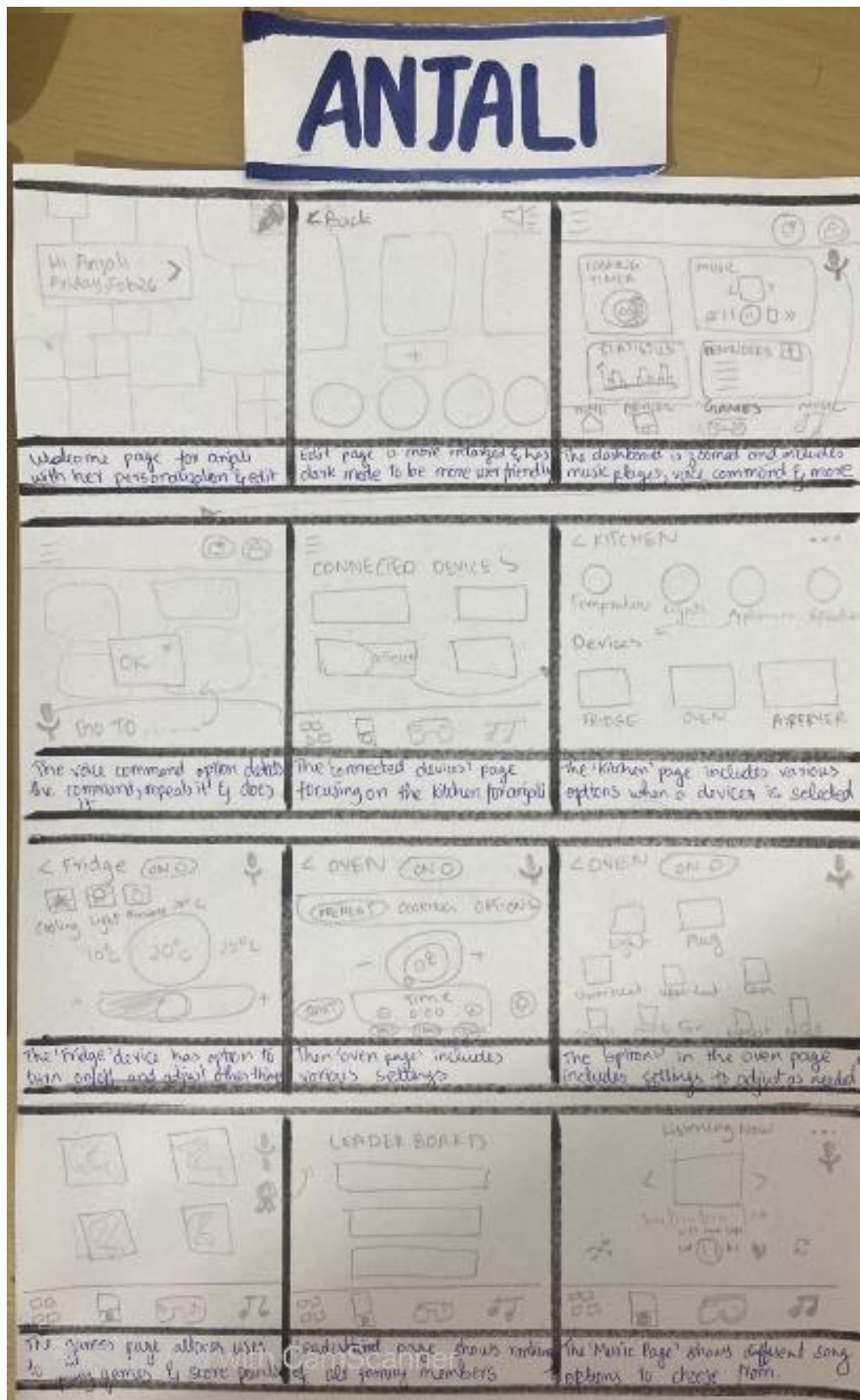


Figure 6 6 - Storyboard for Anjali



Figure 77 - Storyboard for Ashwin

3.c. Use Cases

In this section of the report, the individual unique use cases which are experienced by the different personae are looked into, detailing the main goal, which is in relation to previously defined goals and characteristics, and the steps taken within the app to achieve these goals.

3.c.i. Aditya

Use Case 1: Paying Bills

Actor: Aditya

Goal: Pay electricity bills conveniently through the app.

Steps:

1. Aditya logs into the app.
2. Navigates to the “Finance” page.
3. Views the current energy bill due.
4. Clicks PAY option.
5. Select the payment method and complete the transaction securely.
6. Receives a confirmation notification and reward points for timely payment.

Use Case 2: Tracking Family Energy Activity

Actor: Aditya

Goal: Monitor the energy usage of family members.

Steps:

1. Aditya logs into the app.
2. Navigates to the “Activity” page.
3. Views energy usage reports for each family member.
4. Tracks monthly progress and savings in energy costs.

3.c.ii. Sonia

Use Case 1: Managing Calendar for Energy Efficient Planning

Actor: Sonia

Goal: Plan daily tasks while being mindful of energy use.

Steps:

1. Sonia logs into the app.
2. Open the “Calendar” page.
3. Adds or edits tasks (e.g., go to the GYM).
4. Keeps track of the task , gets reminders and successfully completes tasks on time

Use Case 2: Tracking CO₂ Emissions from Journeys

Actor: Sonia**Goal:** Monitor and reduce carbon footprint from travel.**Steps:**

1. Sonia logs into the app.
2. Navigates to the “Journey” page.
3. Inputs travel data (car trips, public transport use, to & from etc.).
4. Journey gets added on the page.
5. Receive insights into CO2 emissions and energy-efficient alternatives.
6. Sets goals for reducing emissions and earns rewards for eco-friendly travel choices

3.c.iii. Anjali

Use Case 1: Playing Music Hands-Free**Actor:** Anjali**Goal:** Listen to music while cooking or studying.**Steps:**

1. Anjali logs into the app.
2. Opens the “Music” page.
3. Uses voice commands or large, high-contrast buttons to play songs.
4. Chooses songs from different playlists and vibe.

Use Case 2: Controlling Smart Appliances in the Kitchen**Actor:** Anjali**Goal:** Store baked items in the fridge in a specific required setting.**Steps:**

1. Anjali logs into the app.
2. Opens the "Connected Devices" page.
3. Navigates to KITCHEN
4. Goes to the connected device shown as FRIDGE.
5. Turns appliances on/off via large buttons or voice commands.
6. Can set the cooling temperature as required.
7. The app gives alerts if an appliance is left on for too long.
8. Anjali earns reward points for turning off unnecessary appliances.

3.c.iv. Ashwin

Use Case: Playing an Energy-Saving Game

Actor: Ashwin

Goal: Learn about energy conservation through a fun game.

Steps:

1. Ashwin logs into the app.
2. The page loads and enters the daily game's part.
3. Plays each game (e.g., "How many lights are on?").
4. Completes daily levels.
5. Mystery Box earned for completing all the tasks.
6. Earning rewards and learning about energy efficiency in an engaging way.

3.c.v. Common Features: Smart Home Controls & Rewards

Use Case: Turning Off Appliances to Save Energy

Actor: Any family member

Goal: Reduce energy consumption and earn rewards

Steps:

1. The user logs into the app.
2. Opens the "Connected Devices" page.
3. Choose the room (e.g.: Living Room, Bedroom etc.)
4. View the appliances (e.g.: Lights, AC etc..) that are on/off.
5. Turns off unnecessary lights, AC, or appliances.
6. Earns reward points that can be redeemed for vouchers.

4. Prototype Development in Figma

4.a. Key Changes from Storyboard to Final Prototype in Figma

Several key improvements were made when transitioning from the lo-fi storyboard model to the high-fi Figma prototype to enhance user experience, accessibility, and functionality. Across all pages, an additional “default” setting for the app view was introduced, along with day and night modes, allowing users to easily switch back to the default interface for added convenience.

For Aditya’s page, a secure payment pathway that automatically redirects users to a trusted payment gateway was added, allowing for more reliable and secure transaction activity, helping reduce the security concerns that come with financial and home-based decisions. A variety of payment options, such as Apple Pay, Visa, and Mastercard were introduced, with users being able to utilize their preferred banking partner.

On Sonia’s page, the “Add Tasks” option in Calendar was simplified by introducing a drop-down menu for selecting the date and time details for events, with more straightforward fields for naming tasks. Additionally, her “Add Journey” task feature in the Journey page, which allows her to track daily CO₂ emissions made by her travel, was made more convenient by allowing her to directly pin the start and end location of her trip, reducing manual inputs.

Given Anjali’s disability, the accessibility was improved by incorporating larger icons and fonts, while providing higher contrast options when compared to the other personas. The homepage was decluttered, with the layout being a much simpler, four-widget homepage when compared to other homepages. Another app feature was also adjusted to be more accessible, being the music playing option to allow her to directly play background music from the app.

And finally, with Ashwin’s experience of the app, a gamified app interface with brighter, kid-friendly colors, playful icons, fun buttons, and music tunes was utilized, hoping to make the experience more engaging and enjoyable for a young child. Further work was done for all user experiences, introducing changes to fonts, text styles, layout, and colors, experimenting and adjusting to create an accessible, aesthetically pleasing, and visually cohesive final product.

4.b. Overview of App Structure

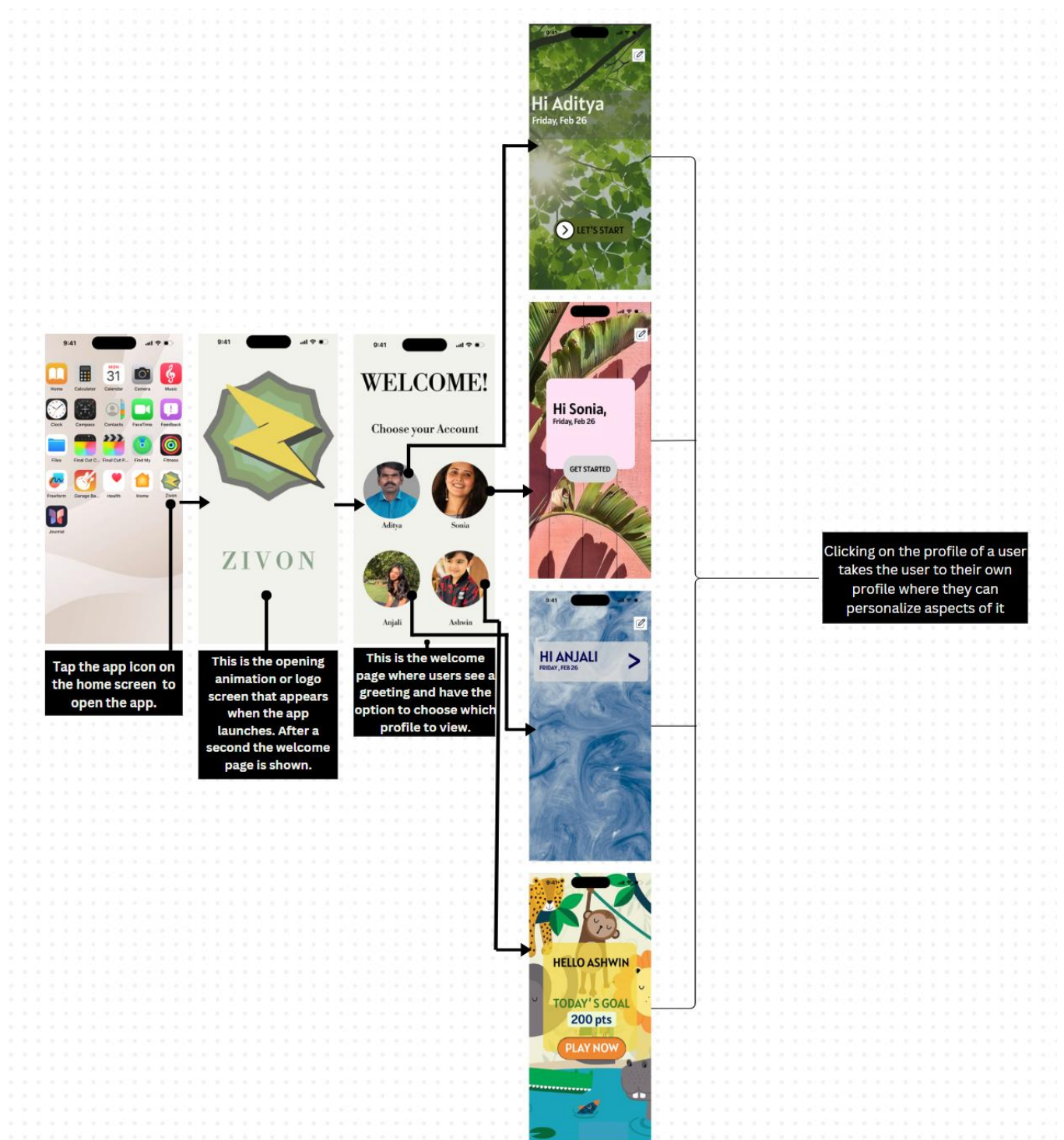
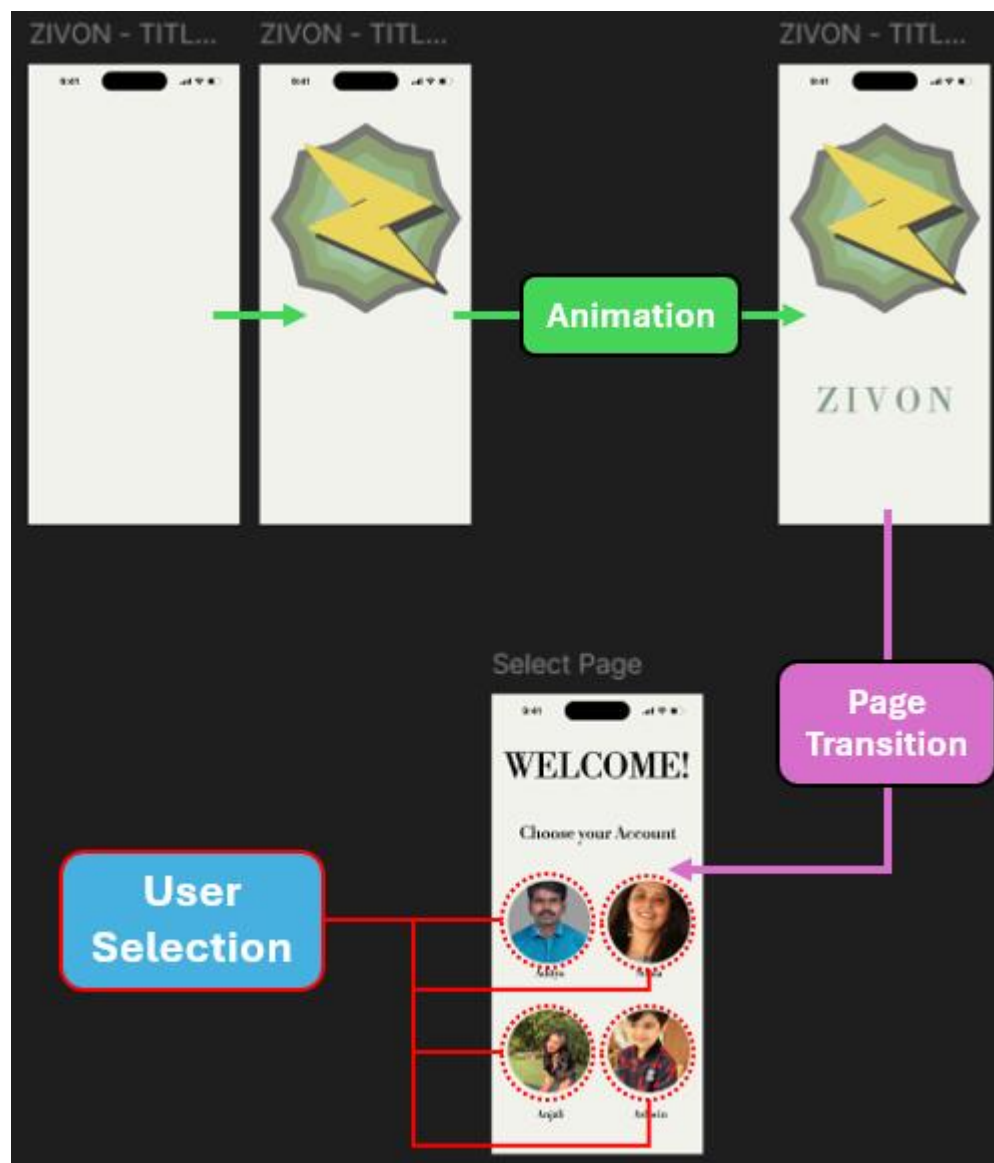


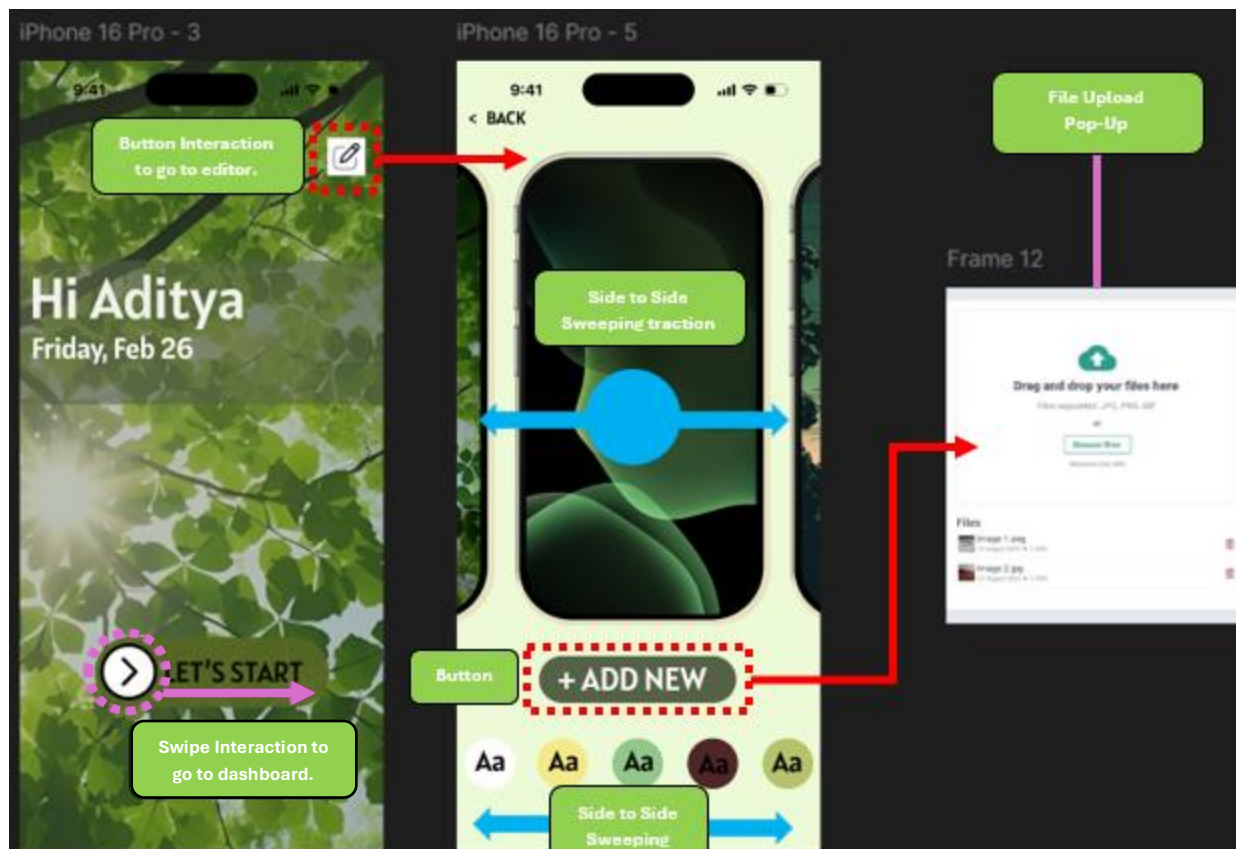
Figure 8 - App Structure

4.c. App Content and Navigation



The app starts with the logo of the app and the name of the app. Color choices were based on psychological associations, with the green being chosen to associate the app with environmental friendliness, with the addition of a yellow lightning bolt to have an association to the energy conservation aspect. The light background with the simplistic font and logo design gives the app a clean look with a sense of minimalistic utility.

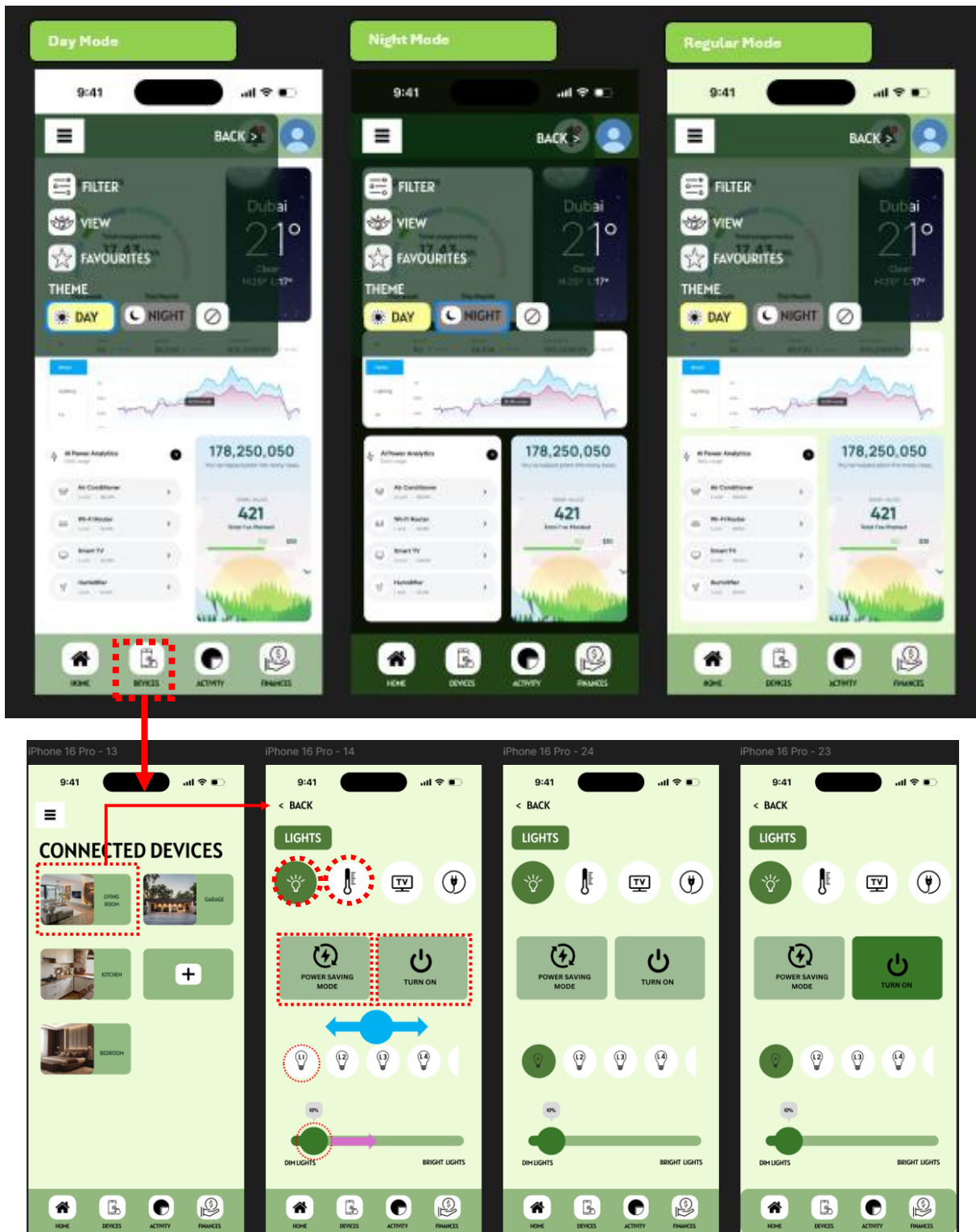
This transitions into the user select page, where all profiles from within the family are displayed. Depending on the user's device, certain accounts can be locked, preventing the children from accessing the parent's application features while allowing the parents to monitor the activity of the children. Selecting the different profiles allows the user to go to the respective dashboards.



A common feature available to all users of the app is customizability, where users can change font types, font colors, sizes, backgrounds for texts, and image backgrounds, with an option to upload images and select custom font settings aside from provided settings.



Other shared features and interactions revolve around basic app functions, such as checking notifications, changing the app theme, and logging in and out of profiles.

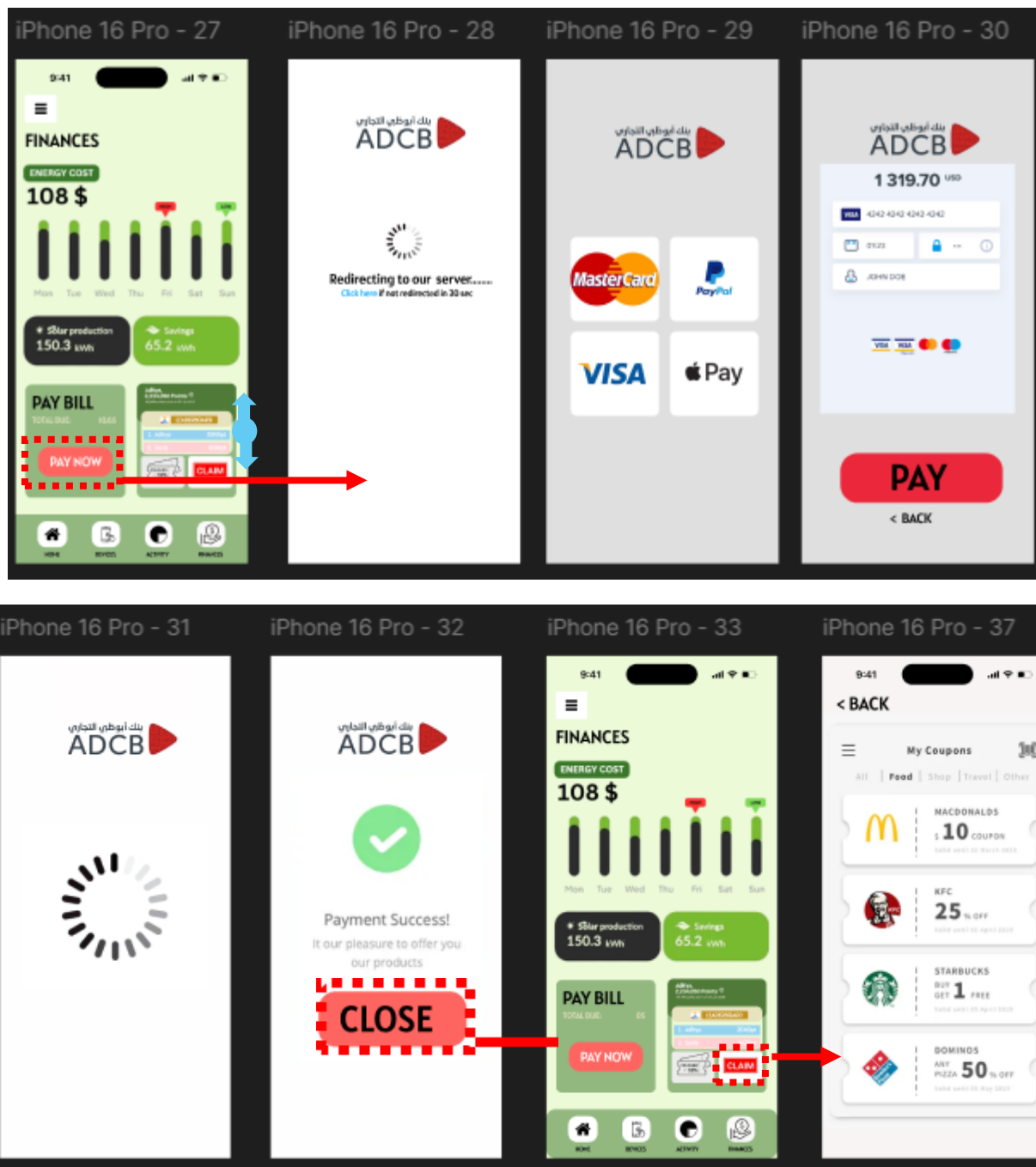


Further interactions allow for the use of features involving IoT. In this case, the control of lights, air conditioning, and different appliances within different rooms of the house. Users are provided with the option to turn devices on or off and to utilize power saving modes in order to decrease electricity consumption.

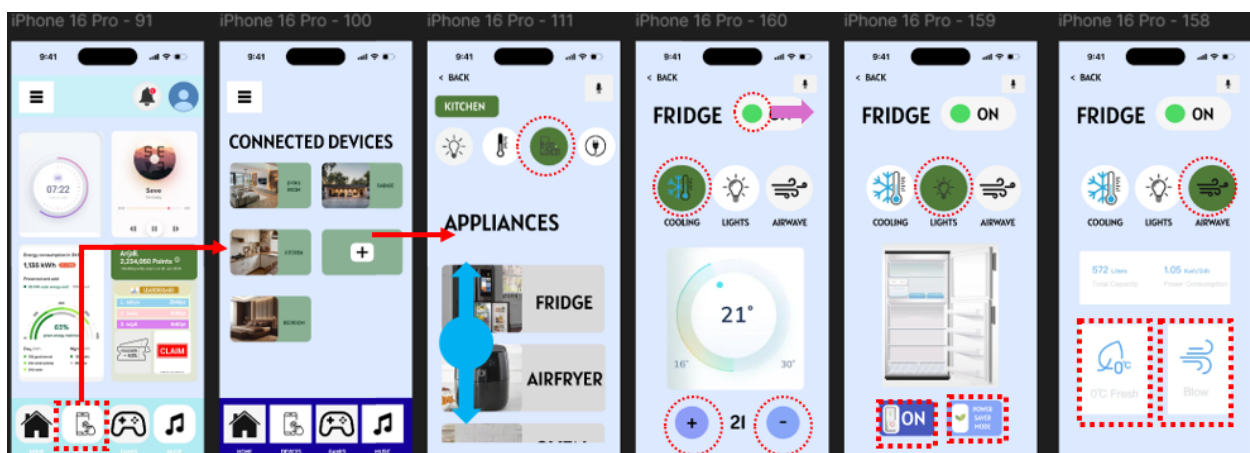
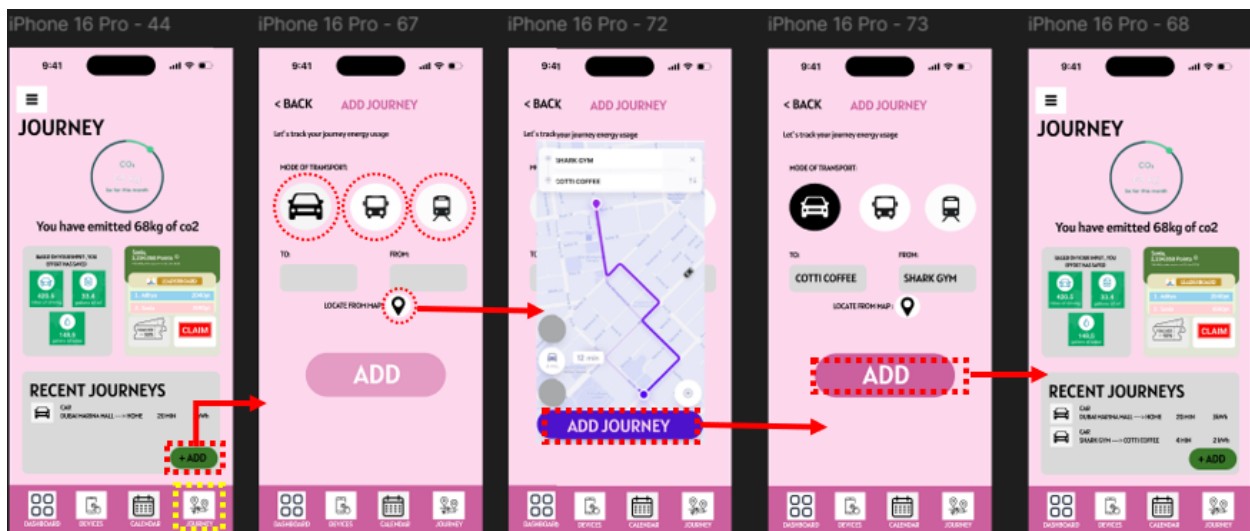
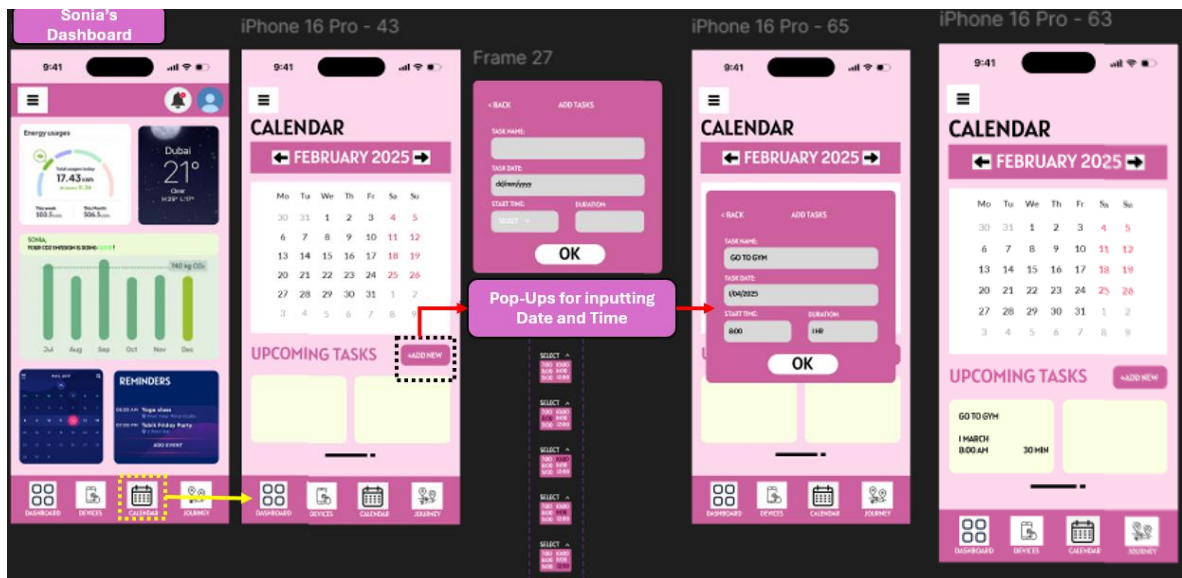
Here, a demonstration can be seen for the gamification and motivation system utilized by the app to increase user education and effectiveness of the application's purpose. When the user switches off certain devices, they are rewarded with points. These points differ based on the specific devices being used, calculated by an algorithm that utilizes how much energy and money is being saved, with the amount of points being added to a personal and group collective seen in a leaderboard, which provides more motivation while encouraging the entire family to become more energy efficient.

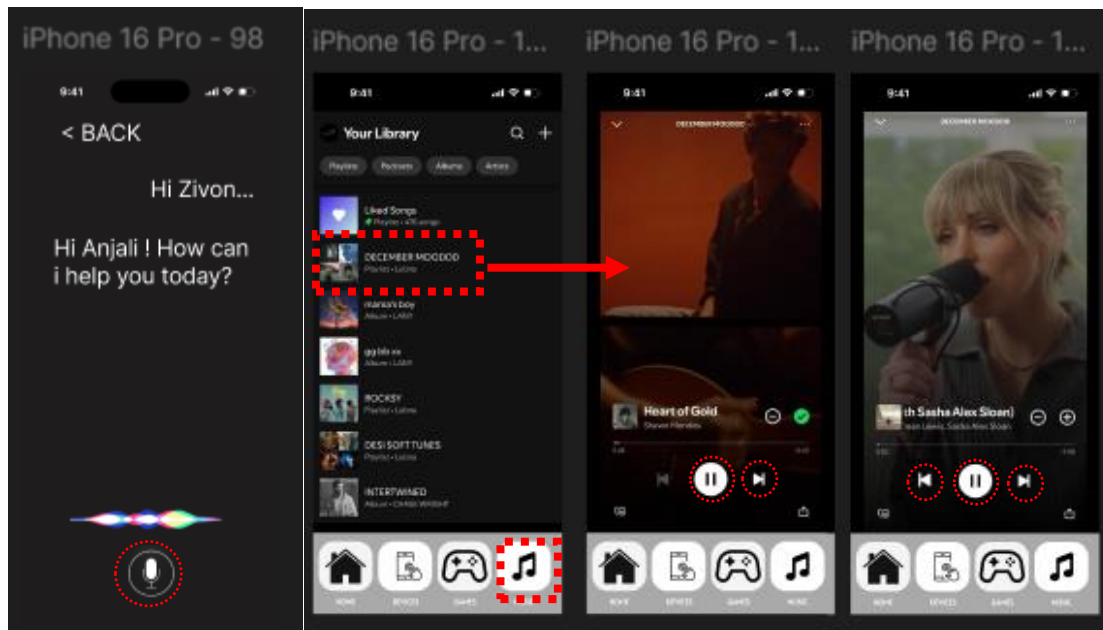
These gamified elements allow for greater user engagement and allow for energy-saving habits to be learnt more effectively by all members of the family.



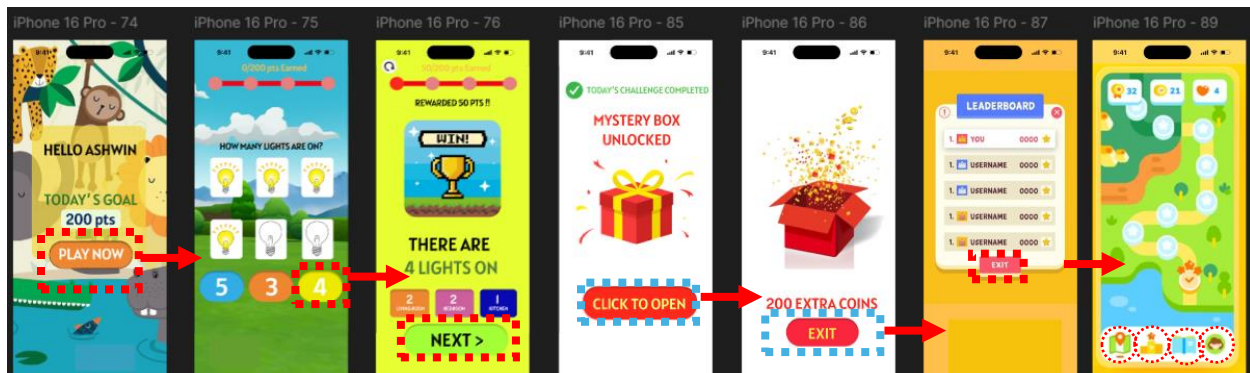


Given the different use cases and features provided in the application, the different tasks based on each user result in a varied dashboard, with the types of tasks being chosen by the user.





One of the features for accessibility is the use of a virtual assistant, with users being able to click a microphone logo and speak to help encourage a user-friendly system. Additionally, the system allows users to play music from the app to encourage positive associations with the application.



Further features implement child-friendly and engaging gamification tactics based on user age.

4.d. UI/UX Design Considerations

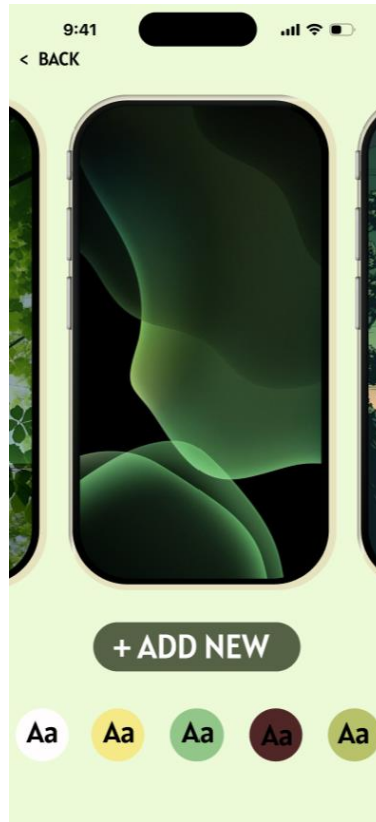


Figure 9 - Customization Screen

One main feature shared with all users of the app is the high customization of color, font, and design preferences. This was done to ensure high accessibility while allowing a more personal touch for all users.

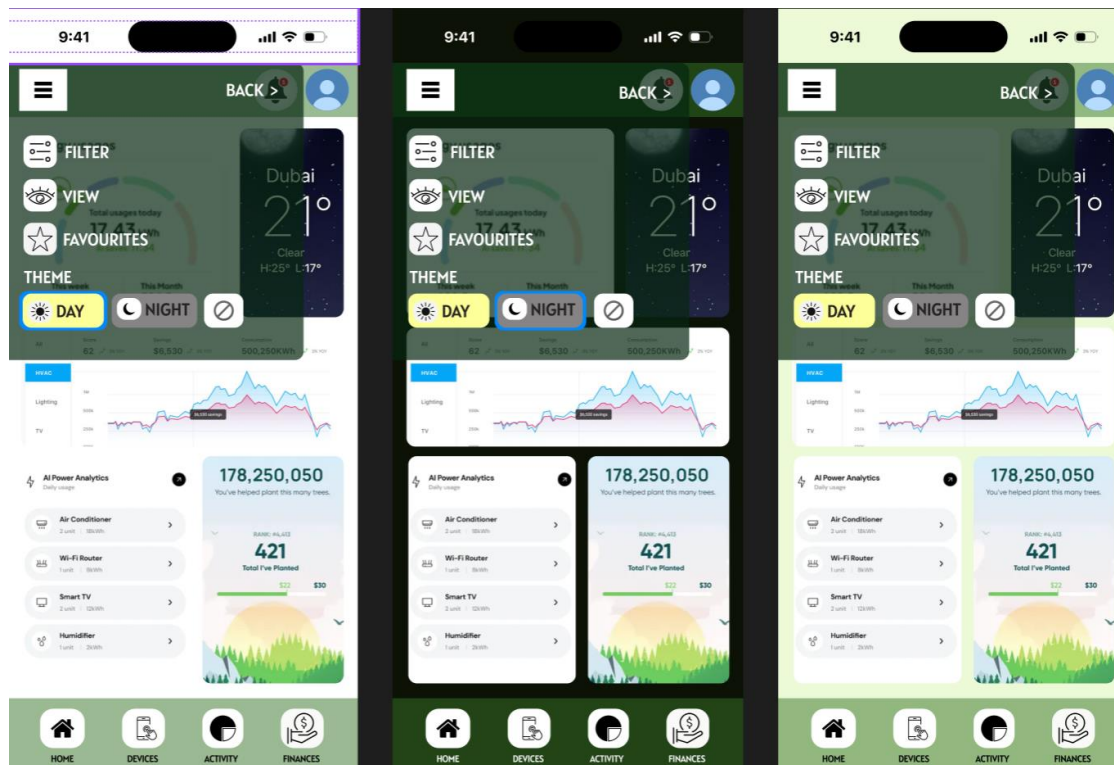
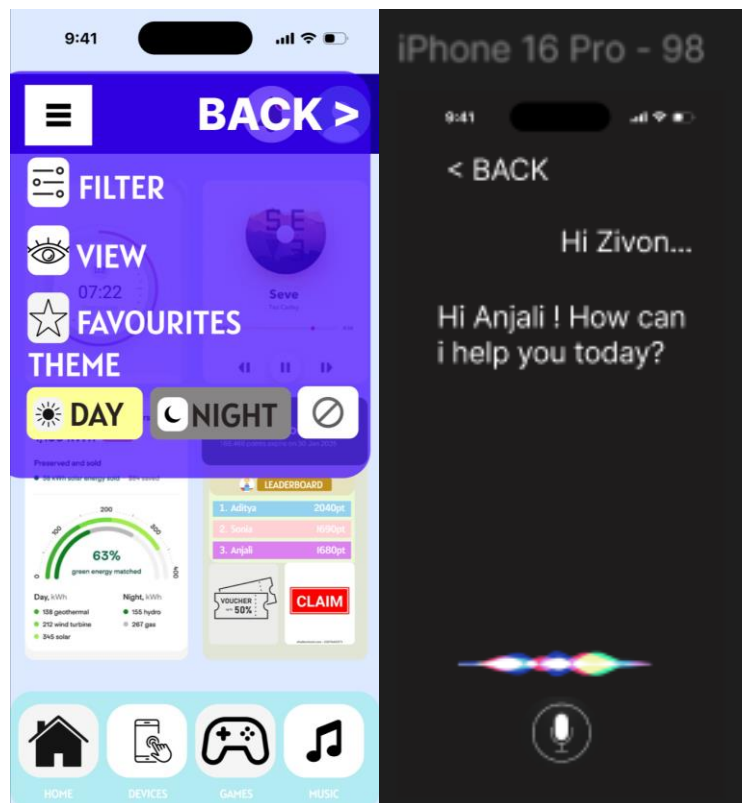


Figure 10 - Different Vision Modes: Light Mode, Dark Mode, Custom (in order)

The app allows the user to choose between a night mode, that changes the background to be dark and to make it easier on the eyes to read, a day mode that makes it brighter to make it easier to see in bright conditions, and a custom mode that allows them to choose their own background based on their personal aesthetic.



Anjali's Dashboard

Anjali, a member of the family, has visual impairment issues, and in consideration of that, Anjali's dashboard has bigger font and icons to enhance readability. Anjali is able to benefit from the text and background customization feature the most, given she can adjust to her preferences and her level of blindness. Furthermore, she utilizes the voice command option to allow her to control devices within her house, allowing for better compatibility and greater ease of use, especially since the app integrates this function with other features the user utilizes in daily life.

4.e. Gamification & Multimodal Interactions

The app contains gamification aspects to encourage energy conservation among the family. This includes a point system, as mentioned previously, which encourages the desired behaviors.

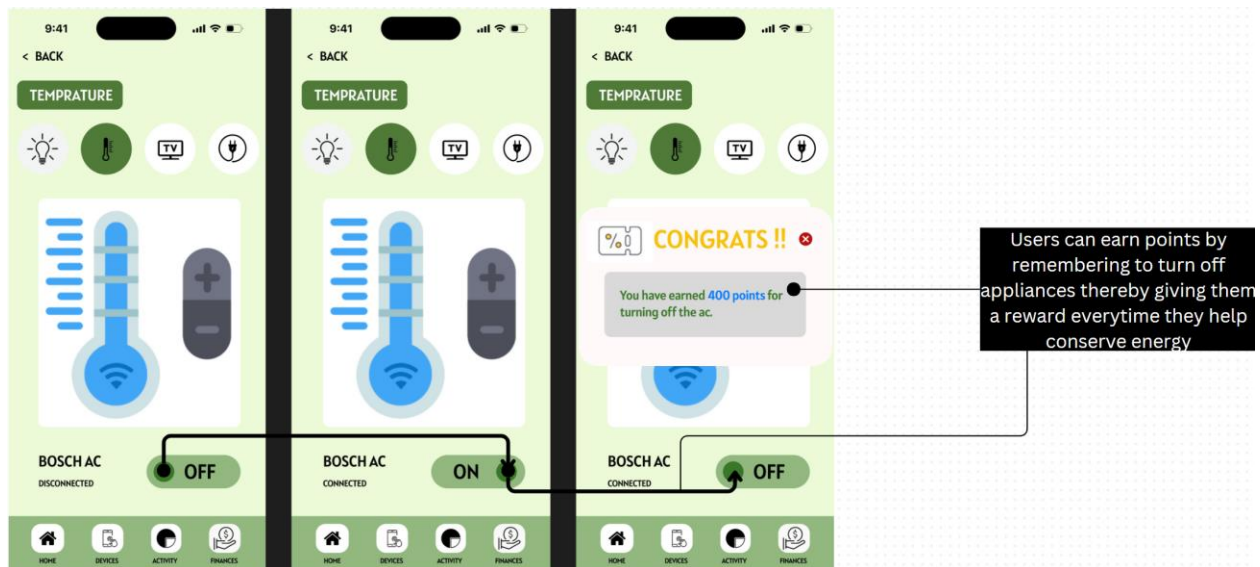


Figure 11 - Point System

The users of the app can earn points through the app by turning off unused appliances, saving energy in the house, helping cut down their carbon footprint, and costing them less in their energy bills. The app contains a leaderboard that tracks points of all the members of the family based on energy efficiency, with the ability to trade them for external rewards.

The app also includes an actual game directed at children, but open to all members of the family, being a quiz with simple questions focused on energy conservation. Points are earned for correct responses, allowing the child to feel more involved in energy saving actions.

Figure 10 shows one of the questions present in the quiz game, this particular question asking the user how many light bulbs are on and presents a certain screen if they get the answer wrong. Wrong answers award no points but an opportunity to try the question again, with a rewards screen confirming their right answer.

Given the simplistic nature of the game, it is more focused on educating children on the little things they can do to conserve energy, while the leaderboard gives all members of the family, regardless of age, to participate in a fun and friendly competition of who can get the most points, and families can decide on a prize for whoever saved the most amount of energy, if they so choose.

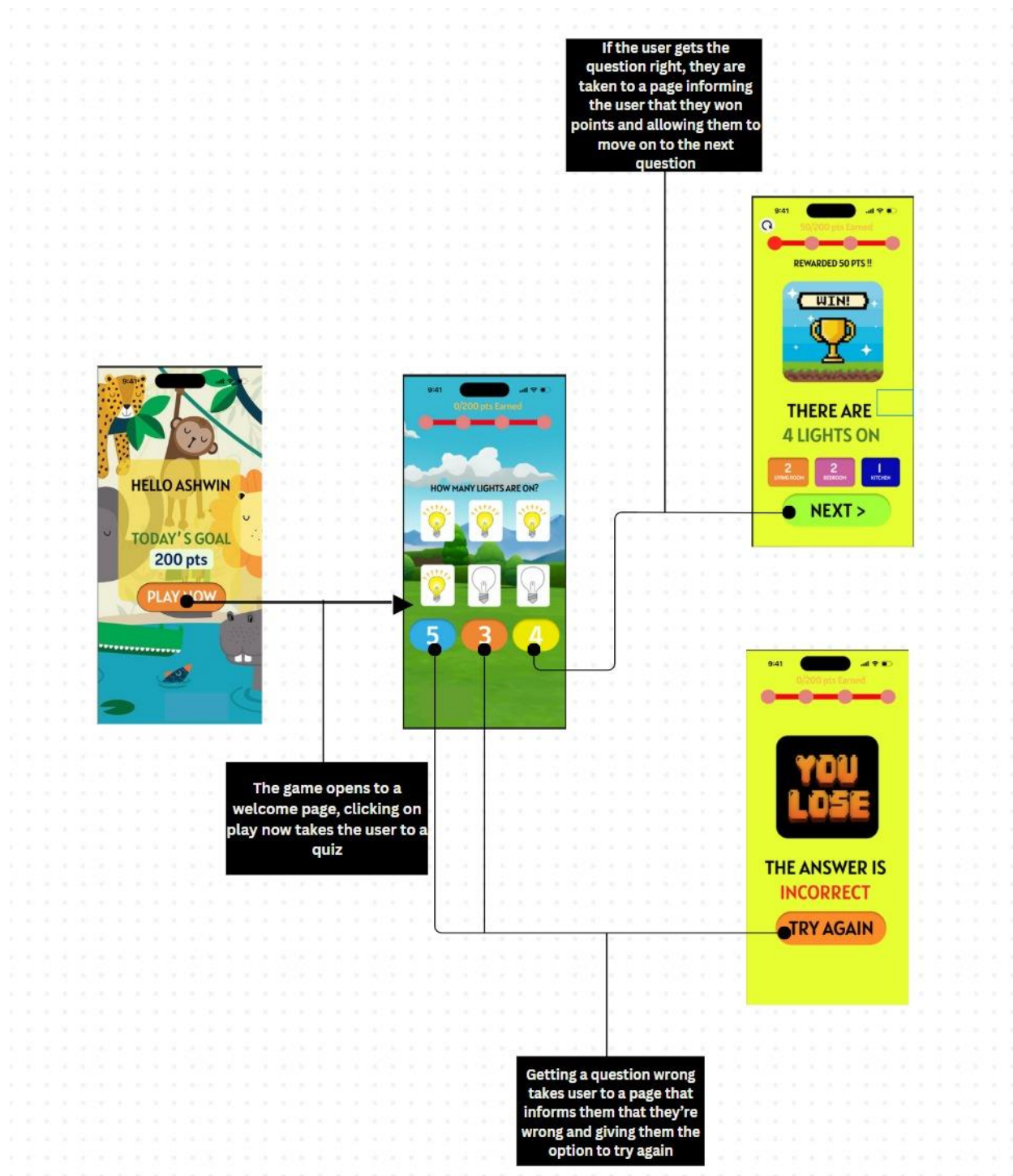


Figure 12 - In-built Game System

5. Conclusion

In conclusion, this energy-saving “Zivon” app prototype incorporated key concepts learned from our course, such as designing low-fidelity storyboard and converting it to interactive and clickable high-fidelity prototype designs. The app designed included both vertical and horizontal user flows. Overall, this project helped us understand the importance of applying UX/UI principles to create a functional, engaging, and user-friendly app that meets the diverse needs of all users.

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