

Faculty of Engineering of the University of Porto



Eco-Neighbours

Join the Green Challenge: Compete, Connect, Conserve!

Report

Human-Computer Interaction (IPC)

Class 5, Group 2

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I. Part I - User and Task Analysis

I.1. Introduction

As part of the Human-Computer Interaction 2024-2025 unit, we need to develop a novel user interface (UI) for mobile/web app. Therefore, in this first phase we will focus on analyzing users and tasks. The objective of this phase is to deeply understand the needs, behaviors and preferences of the users who will interact with the proposed application. This understanding will guide the design of a UI that supports users in tasks such as monitoring energy consumption, reducing usage, and managing smart appliances.

I.2. Welcome To Eco-Neighbour

Eco-neighbors is an innovative app that turns sustainability into an exciting and interactive experience for communities. Designed to promote eco-friendly habits, the app encourages you to actively engage with your neighbors in fun, competitive challenges that promote environmental awareness and positive change. Whether it's reducing energy consumption, recycling, or conserving water, you can complete a variety of eco-friendly tasks and earn points for your efforts, all while contributing to the health of the planet.

With Eco-Neighbors, you can easily track your sustainability score, monitor your progress, and compete with others to see who can claim the coveted title of "Most Sustainable Home." The app also functions as a social platform, allowing you to share valuable eco-friendly tips, ideas and tricks with your neighbors, encouraging creativity and collaboration in your community.

I.3. Related Apps/Services



App that educates and mobilizes your people to take action toward your company's sustainability goals. JouleBug offers a variety of challenges, tips, and activities that encourage users to reduce energy consumption, minimize waste, and make greener choices on a daily basis.



Mobile app that shows you how much energy your home and individual devices are consuming in real time. It helps you find ways to save money and reduce your carbon footprint, by offering personalized insights.



OhmConnect is an app that rewards users for saving energy by reducing electricity consumption during peak demand times, known as "OhmHours" or "AutoOhms." By cutting back energy use during these periods, users help prevent blackouts and lower reliance on fossil fuel power plants. In return, they earn points that can be redeemed for cash, prizes, or charitable donations.



Home Energy Monitoring System that works with utilities and smart devices to provide users with information on their energy usage, track trends, and reduce energy consumption.

I.4. Questionnaire highlights

The study targeted users interested in energy conservation, encompassing a diverse group of homeowners, renters, and community members of various age groups. Participants were asked to provide feedback through a structured questionnaire, which focused on their awareness of energy consumption, their engagement in eco-friendly challenges, and the app's features that allow users to compare their energy usage with that of their neighbors.

A total of 42 respondents completed the questionnaire, offering valuable insights into user preferences, behaviors, and attitudes toward energy usage. These responses helped to shed light on how participants interact with the app and how it can be further tailored to encourage sustainable habits within communities.

How old are you?

 Copiar

42 respostas

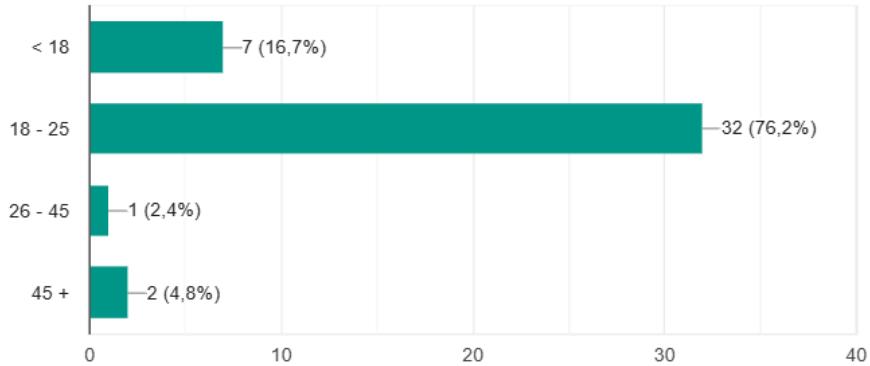


Figure 1- Age rates

Through the extracted data we realized that the main interests of these age groups are:

- **< 18** - lower awareness of energy consumption but may be interested in gamified experiences and peer comparisons
- **18- 25** - shows a moderate understanding of energy-saving practices and is likely to be in a transitional phase, such as moving away from home, starting college, or entering the workforce; interested in energy-saving challenges, especially if they include social aspects and tangible rewards.
- **26- 45** - More likely to own homes and be conscious of energy consumption for both financial savings and environmental concerns; may appreciate data-driven insights and comparisons to their neighbors.
- **+ 45** - May be less engaged with technology but are generally concerned about financial implications and environmental impact; more interested in the practical benefits of tracking energy usage.

In addition to this information, through the questionnaire we realized that the fact that the population receives notifications about their consumption levels is one of the most accepted ideas.

How helpful do you find the app's notifications or alerts about high energy usage?

 Copiar

42 respostas

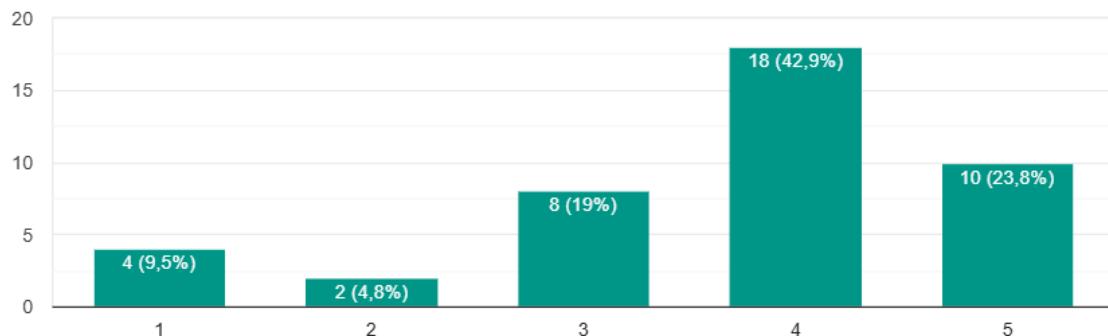


Figure 2- Responses about the idea of notifications on the app

I.5. PACT Analysis

I.5.1 People

Co-Neighbors targets a diverse range of users based on age groups, each with different levels of engagement with sustainability and technology.

Wide user base (teenagers to 45+), with differing motivations for engagement (social, financial, environmental). The app must accommodate varying levels of tech comfort and environmental consciousness.

I.5.2 Activities

The app offers a variety of activities focused on encouraging sustainability through competition, social interaction, and practical actions:

- **Eco-Friendly Challenges:** Users participate in sustainability competitions, such as reducing energy consumption, recycling, or conserving water. These tasks promote eco-friendly habits through **gamified challenges** and **neighborhood rankings**.
- **Tracking Energy and Resource Usage:** The app enables users to track their **energy, water,**

and recycling performance. It offers real-time data and historical insights on individual and neighborhood consumption patterns.

- **Sharing Tips and Ideas:** Users can post and share eco-friendly tips, encouraging creativity and collaboration within their community. This fosters a sense of engagement through social media-like interaction.
- **Points and Rewards:** The app incentivizes users with a point system based on completing eco-friendly tasks, which can be exchanged for rewards or badges, adding a **competitive element** to sustainability.

1.5.3 Contexts

The app will be used in various environments, depending on the target age group and user lifestyle:

- **Home:** For most users (especially homeowners), energy and water tracking will likely occur within the home environment, where they can directly apply the app's suggestions.
- **Social/Community Environment:** Users will engage in activities that involve neighbors and community members, participating in challenges, and sharing tips. The **social context** of the app is crucial for fostering a collaborative, competitive atmosphere.
- **School/Workplace:** For younger users (especially <18 and 18-25), the app may be used in school or workplace settings, where peer interaction and challenges can be an additional motivator.
- **Cultural Context:** Different communities may prioritize sustainability practices differently. Co-Neighbors should be flexible in supporting various eco-friendly activities, taking local culture and environmental focus into account.

1.5.4 Technologies

Co-Neighbors is a **mobile app** with features focused on accessibility, gamification, and data analysis. The app will include the following technological aspects:

- **User Interface:** A simple, visually engaging UI that caters to a broad range of users,

including those with lower tech-savviness (especially for the 45+ age group). A simple and easy navigation is essential.

- **Real-Time Data Monitoring:** The app integrates with home energy monitoring systems (e.g., smart meters) and water tracking devices to provide real-time consumption data.
- **Social Features:** Users can compete with neighbors and share eco-friendly tips. This builds a **community-driven environment** that all users will find appealing.
- **Gamification:** The app's **points system** and **leaderboards** foster a sense of competition and achievement, motivating all user groups, but especially appealing to younger audiences.
- **Cross-Platform Support:** The app will be available on **iOS and Android**, with potential integration with **wearables** or **smart home devices**.

I.6. Personas

I.6.1. Jakub Kowalski



Age: 25

Education: Vocational School Degree

Occupation: Electrician

Family: Two toddler brothers

Location: Kraków, Poland

Tech proficiency: Average

Archetype: Hands-on Problem Solver

Pragmatic

Frugal

Resourceful

Figure 3- Jakub

"Why not find better ways to manage what we've got?"

Narrative/Lifestyle:

Jakub leads a practical life, taking pride in managing his household hands-on. Since his brothers were born, he's become more connected to his neighborhood and enjoys engaging in

community energy-saving challenges with them. Jakub values spending time with his brothers, whether on trips or working on home projects. Conscious about money, he prefers cutting expenses through small changes. He's particularly interested in tools that help him compare his energy usage to neighbors and respond to high consumption alerts, as it helps him stay on budget and connect with both his brothers and the community.

Objectives/Needs:

- Reduce electricity and heating bills to maintain financial independence.
- Simple, easy-to-use tools for daily energy management.
- A clear view of home energy use for better decision-making.
- Teach his brothers about conserving resources.
- Connect his family with the neighborhood.

Frustrations/Pain Points:

- High winter utility bills with reluctance to spend upfront to fix them.
- Dislike for overly complex tech.
- Frustration when energy cuts don't lead to noticeable savings.
- Difficulty finding low-cost, practical energy-saving tips.

1.6.2. Emilia Rinaldi



Age: 16

Education level: Middle school

Work/ occupation: High school student

Family: Single child

Location: Bologna, Italy

Technology proficiency: Average

Preferred devices: Smartphone, tablet, smart TV

Archetype: The "Budget-Conscious Daughter"

Collaborative

Organized

Thoughtful

Figure 4- Emilia

"I like to think that being mindful in little ways can lead to a big difference in life"

Narrative/Lifestyle:

Emilia is a 16-year-old high school student, and as an only child, she takes on more responsibility around the house to help her parents manage things. Though she's not very tech-savvy, Emilia appreciates apps that help her organize her schoolwork and household tasks more easily. She's budget-conscious and always looking for ways to reduce household expenses, especially energy bills, to support her family. Emilia enjoys discussing energy-saving tips with her friends and is motivated to adopt small eco-friendly habits to benefit both her family's budget and the environment. She likes the idea of making her home more energy-efficient, knowing it will help her parents and reduce their bills.

Objectives/Needs:

- Emilia wants to help her parents by cutting down on monthly expenses, particularly household utility bills.
- She prefers technology that fits easily into her daily life and is simple to use without requiring much effort.
- Gaining more insight into how her family's energy is used could help her feel more in control of her family's budget.
- She cares about the environment and wants her family to adopt responsible energy habits, even if it's small steps like turning off lights or using less water.

Frustrations/Pain Points:

- Emilia often finds that the family's utility bills are inconsistent, making it hard to help her parents plan the monthly budget.
- She doesn't want to waste time learning how to use complicated apps or gadgets that don't offer immediate, visible benefits.
- She feels there isn't enough straightforward advice on how to make simple, effective changes at home to reduce energy consumption without expensive investments.
- Emilia gets frustrated when small changes she makes at home don't lead to noticeable savings or improvements in energy efficiency.

1.7. Activity scenarios

1.7.1. Jakub Kowalski

After a long day at work, Jakub sits down with a cup of tea and opens **EcoNeighbour** on his phone. He's curious about how his household's energy consumption compares to others in the area. He's surprised to see that his home is using more electricity than his neighbors, especially during the evening. The app recommends turning off unnecessary lights and setting timers for

electronic devices. Jakub decides to give it a try, setting a good example for his toddler brothers by turning off lights and gadgets when not in use.

1.7.2. Emilia Rinaldi

Emilia finishes her morning writing session and takes a break. She opens **EcoNeighbour** to check how her family's energy use compares to others in her neighborhood. She notices that her electricity usage is slightly above average compared to nearby households. Curious, she digs deeper into the app's suggestions and finds simple tips like unplugging unused appliances and adjusting the thermostat. Motivated, she shares the insights with her parents over dinner, encouraging them to be mindful of small habits that can make a difference.

1.8. Functionalities

User Management

- *The app should enable users to:*
 - Log in using their email or social media accounts.
 - Create a new user account by providing personal information (name, age, address).
 - Reset their password if forgotten.

Energy Usage Tracking

- *The app should enable users to:*
 - Input their energy consumption data manually or sync with smart meters.
 - View detailed visualizations of their energy usage over time.
 - Set and track personalized energy-saving goals.

Comparison Features

- *The app should enable users to:*
 - Compare their energy usage with that of neighbors or similar households.
 - View metrics and benchmarks for energy consumption based on user demographics.
 - See historical data to understand their consumption trends relative to the community.

Challenges and Competitions

- *The app should enable users to:*
 - Participate in neighborhood-wide energy-saving challenges.
 - Join seasonal challenges that encourage specific energy-saving actions (e.g., reducing heating in winter).
 - Track their progress in these challenges through a leaderboard feature.

Notifications and Alerts

- *The app should enable users to:*
 - Receive notifications for high energy usage alerts.
 - Get reminders for actions they can take to reduce energy consumption based on their current usage.
 - Set preferences for how often they receive these notifications..

Social Features

- *The app should enable users to:*
 - Share their energy-saving achievements on social media.
 - Invite friends or neighbors to join challenges or competitions.
 - Select who has access to their energy usage data.

Educational Resources

- *The app should enable users to:*
 - Access articles, tips, and resources on energy-saving techniques.
 - Receive personalized recommendations based on their energy usage patterns.

Rewards and Recognition

- *The app should enable users to:*
 - Earn rewards (badges, points, discounts) for participating in challenges and achieving energy-saving goals.
 - Claim rewards in collaboration with local businesses and services that promote energy efficiency.
 - View a summary of their rewards status and achievements within the app.

User Support

- *The app should enable users to:*
 - Access a help section with FAQs, troubleshooting tips, and customer support options.

- Provide feedback or report issues regarding app functionality.
- Connect with other users for peer support and sharing best practices in energy conservation.

2. Part 2 - Lo-fi prototype and heuristic evaluation

2.2. Project Overview

Eco-Neighbors is an interactive, gamified app that promotes eco-friendly habits and community engagement. Users participate in fun challenges to reduce energy consumption, recycle, and conserve water while competing for titles like "Most Sustainable Home." The app fosters collaboration by enabling neighbors to share eco-tips and ideas, making sustainability a shared, rewarding experience.

2.2.1. Functionalities and Tasks

This section highlights the three chosen functionalities of the Eco-Neighbors app and their tasks, evaluated using usability criteria:

- **Efficacy:** Accuracy of task completion with minimal errors.
- **Efficiency:** Time or steps required to complete a task.
- **Satisfaction:** User experience ratings to ensure ease and enjoyment.

The tables below detail each functionality, its tasks, and usability requirements.

1. Compare Energy Usage with Neighbors or Similar Households

Usability Requirement	Functionality	The app will allow users to compare their energy usage with that of their neighbors or households in a similar context (e.g., within a chosen radius).
	Task	The user selects a dropdown option to view the energy consumption statistics of households within a specified radius or that are similar to theirs in terms of size, location, etc.
	Efficacy	No more than 2 errors on average during task completion.
	Efficiency	The task should be completed within

		approximately 3 minutes.
	Satisfaction	The user should rate satisfaction at an average of 4 out of 5.

2. Set and Track Personalized Energy-Saving Goals

	Functionality	Users will be able to set personalized energy-saving goals, either by selecting from pre-defined goals or by creating their own. They will also be able to track their progress.		
	Tasks	1. The user selects an energy-saving goal from a list of recommendations provided by the app.	2.The user sets a custom energy-saving goal, such as reducing monthly energy consumption by a specific percentage.	3.The user scrolls through the app to view their progress on all active energy-saving goals.
Usability Requirement	Efficacy	No more than 1 error on average.	No more than 8 errors on average.	An average of 1 error.
	Efficiency	The task should take under 2 minutes.	The task should take around 6 minutes.	The task should be completed in under 2 minutes.
	Satisfaction	The user should rate satisfaction at 4 out of 5.	The user should rate satisfaction at 4 out of 5.	The user should rate satisfaction at 5 out of 5.

3. Participate in Neighborhood-Wide Energy-Saving Challenges

	Functionality	The app will allow users to participate in neighborhood-wide energy-saving challenges, where users can join and contribute to communal sustainability efforts..
	Task	The user clicks on a “participate” button to join a community energy-saving challenge.
Usability Requirement	Efficacy	No more than 2 errors on average.
	Efficiency	The task should be completed in under 3 minutes.
	Satisfaction	The user should rate satisfaction at 5 out of 5.

2.3. Prototype's Wireflow

2.3.1. Prototype- Task 1

Compare Energy Usage with Neighbors or Similar Households

The user selects an option from a dropdown menu to view energy consumption statistics of similar households or those within a specified radius. This allows them to compare their energy usage with nearby homes and make more informed decisions about their consumption.

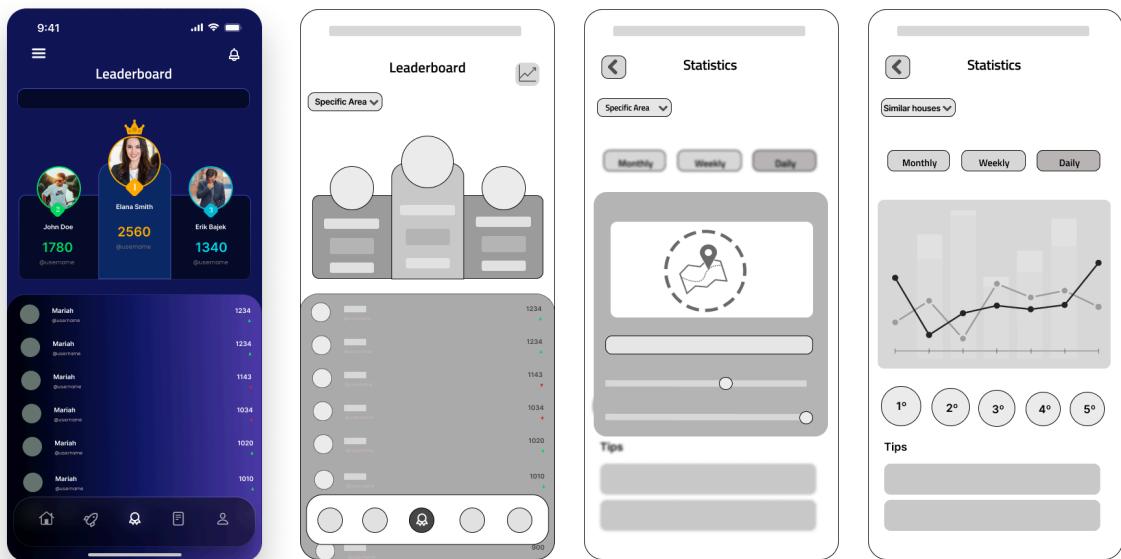


Figure 1- Leaderboard

2.3.2. Prototype- Task 2

Set and Track Personalized Energy-Saving Goals

The user selects from a list of energy-saving goals recommended by the app, which are tailored to their energy consumption patterns and preferences. These recommendations are designed to be achievable and impactful, providing users with clear starting points to reduce their energy usage.

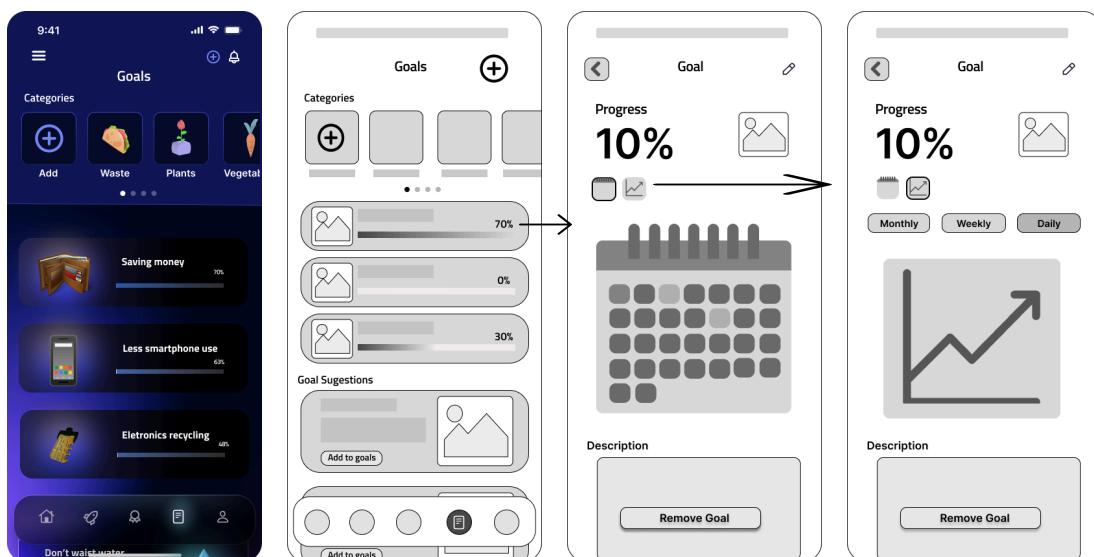


Figure 2- Goal visualization

The user manually inputs their own personalized energy-saving goals, allowing for greater flexibility and customization. This feature is ideal for users with specific objectives that may not align with the app's pre-defined recommendations.

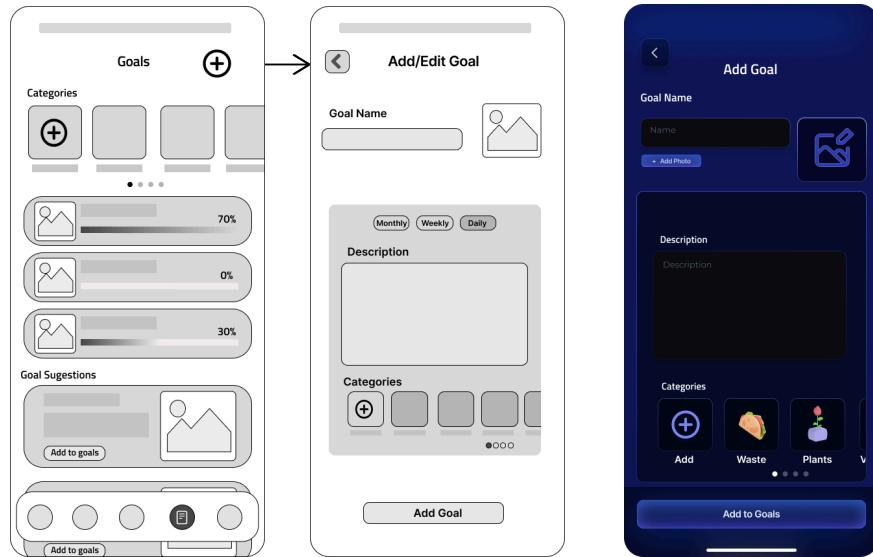


Figure 3- Add/Edit Goal

The user can add categories to organize their goals and easily scroll through the app to view the progress of each goal. This allows for better tracking and management, providing a clear overview of achievements and areas for improvement.

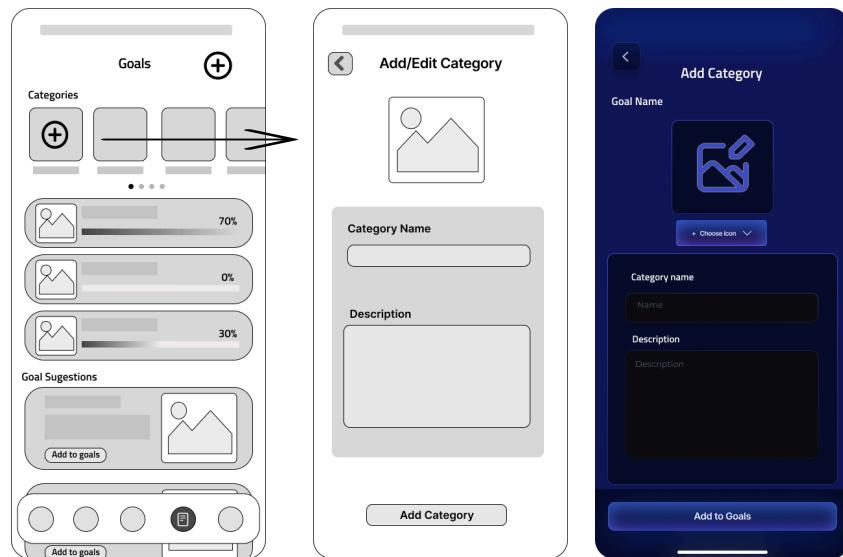


Figure 4- Add Category

2.3.3. Prototype- Task 3

Participate in Neighborhood-Wide Energy-Saving Challenges

The user clicks on a "Participate" button to join neighborhood-wide energy-saving challenges. By doing so, they become part of a community initiative to reduce energy consumption. After joining, the user can view challenge details, track their contributions, and see the neighborhood's collective progress, fostering engagement and collaboration.

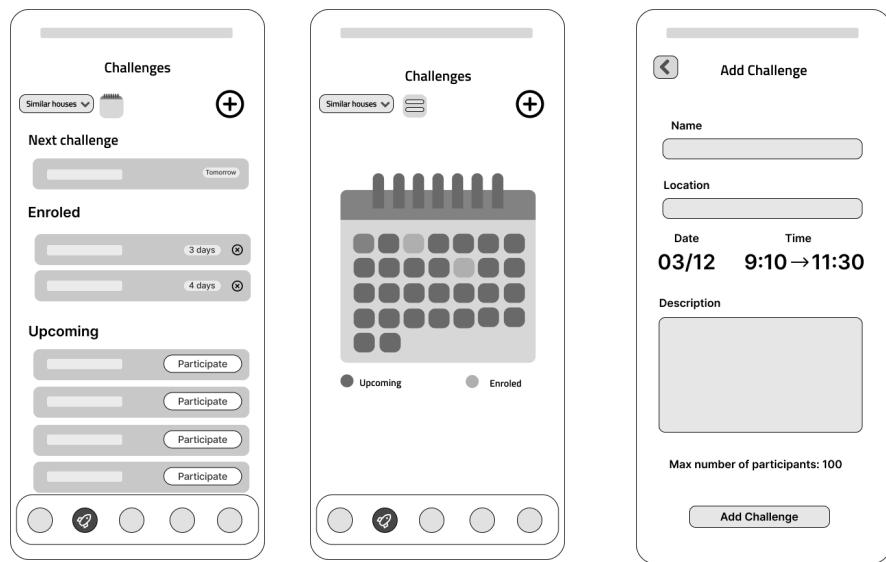


Figure 5- Create a Challenge

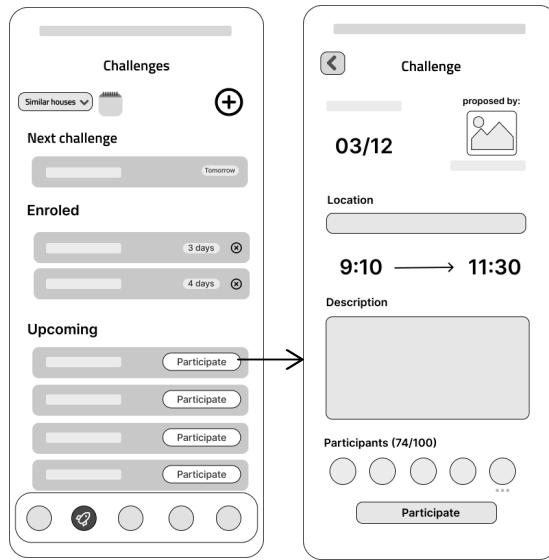
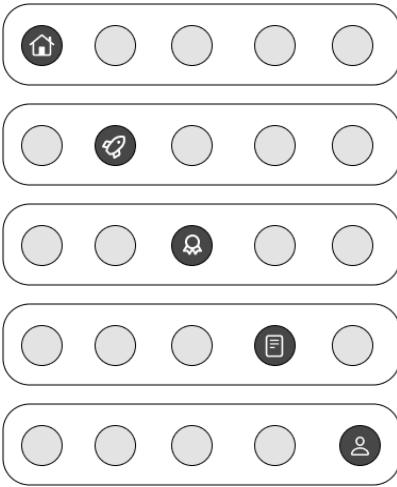


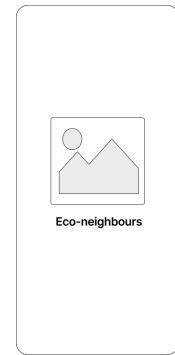
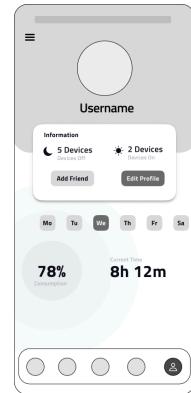
Figure 6- Participate on a Challenge

2.4. Heuristic Evaluation Results

Based on the received evaluations, some usability issues were highlighted, with each problem associated with one or more heuristics and a severity rating. Some issues, however, stemmed from misunderstandings of the wireframe nature of the prototype, so these points will be clarified. Any issues considered significant for usability will be addressed during the design refinement phase, rather than being dismissed as misunderstandings.

Issue	Clarification
Monochromatic Application (Visually Confusing)	The evaluation mentioned the app being visually confusing due to its monochromatic design. However, it is important to note that wireframes are typically designed with minimal colors and simple visual elements to focus on layout and functionality, not final visual design. The lack of color was intentional for this stage, which may have led to confusion.
Navigation Icons from the Footer Menu Are Only Visible if You Are on That Page	This issue relates to the footer navigation menu's behavior, where icons are only visible when users are on the specific page associated with them. However, this may be a misinterpretation of the wireframe design. In the wireframe, interactive icons were intentionally left out on some pages to focus on key tasks. 

Many Static Buttons (No Interactions, Error Popups, or Warning Popups)	The evaluation mentions static buttons such as "Add Friend" and "Edit Profile," which do not trigger interactions, error popups, or warnings. However, this is consistent with the wireframe prototype's limitations. Only the core interactions related to the app's main functionalities (e.g., energy-saving tasks) were clickable, while other less-relevant buttons (such as in the profile) were not clickable in this early stage of the design.
Navigation Confusion Due to Elements Without Text or Icons	In wireframes, elements are often represented with minimal labeling to emphasize structure and layout. Full labels and icons will be added in later design phases.
Missing splash screen showing the app's name or logo, which could hinder brand awareness and the initial user experience	The wireframe did include a splash screen; however, the simplicity of the wireframes and the focus on functionality may have caused confusion. We plan to make the splash screen more prominent in future iterations, ensuring it effectively introduces the app to new users.
The order of time periods (daily, weekly, monthly, yearly) in the statistics section was confusing	Aspect to improve
Footer Navigation Icons with No Labels	Aspect to improve



The average severity of all the issues is approximately **1.83**. This suggests that most issues are moderate in severity, with some lower-impact issues.

The most common and important heuristics identified from the evaluations were:

- **Visibility of System Status (#1):** Users need clear feedback about the app's status, such as interactive buttons and well-organized information.
- **Match Between System and the Real World (#2):** Use familiar language and structures. Navigation icons should be labeled, and information should follow a logical order.
- **Error Prevention (#5):** The system should prevent errors by offering clear feedback and

ensuring button functionality is easy to understand.

2.5. Corrections to perform in Phase 3

Based on the evaluations received, the following key corrections will be made in Phase 3 to enhance usability:

Navigation and Labeling: Labels will be added to the bottom navigation icons, and the time periods in the statistics section will be reordered for clarity (Daily, Weekly, Monthly, Yearly).

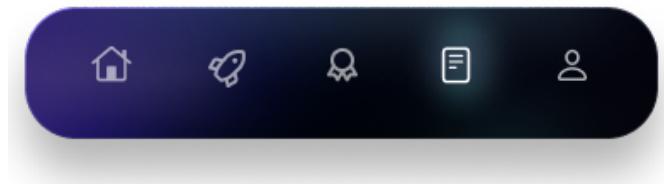


Figure 7- Tab bar- Before

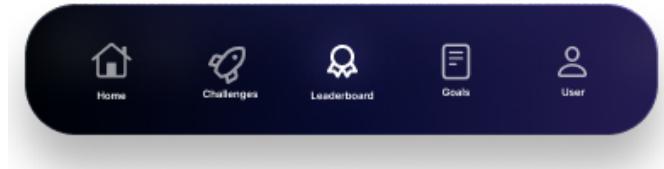


Figure 8- Tab bar- After

Simplify Interaction: Ambiguous elements will be clarified with text labels or tooltips, making the app easier to navigate and understand.

2.6. Wireflow Extra Features

On the homepage, users can control their appliances or entire rooms by turning them on or off. They can also manage energy usage limits for each room and view detailed consumption statistics for individual appliances or rooms.

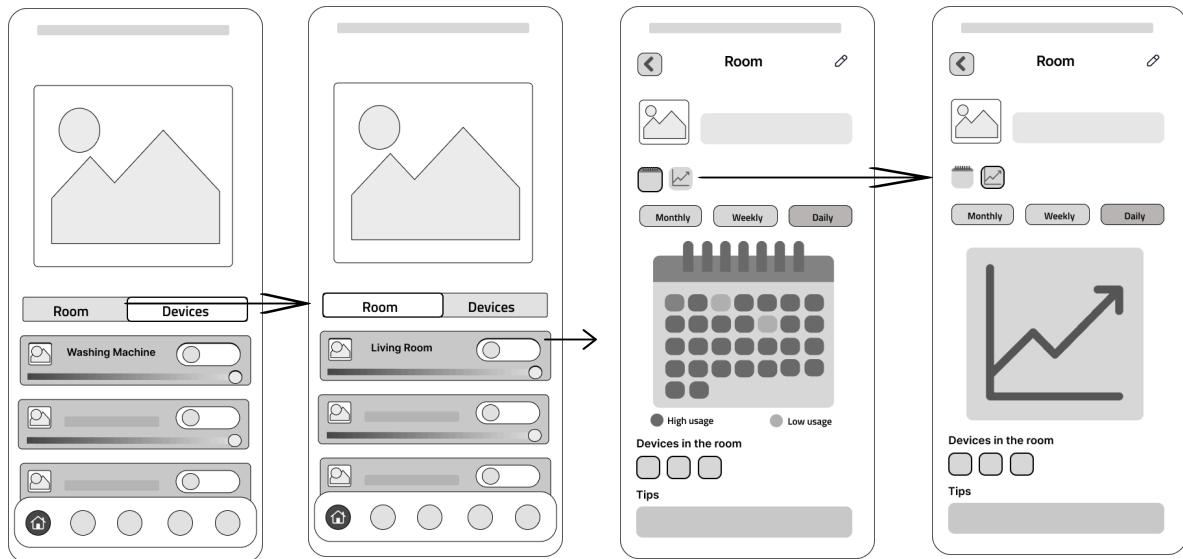


Figure 9- Homepage and room page



Figure 9- Homepage-> Hi-fi Prototype

3. Part 3 - Hi-fi prototype and user evaluation

3.2. Lo-Fi Prototype

3.2.1. Prototype- Task 1

Compare Energy Usage with Neighbors or Similar Households

Users can select an option from a dropdown menu to view energy consumption statistics of similar households or those within a chosen radius. This feature enables them to compare their energy usage with nearby homes, helping them make more informed decisions about their consumption.



Figure 1- Leaderboard

The area can also be specified to reveal detailed statistics and access a leaderboard, enabling comparison of energy usage with others in the selected region.

3.2.2. Prototype- Task 2

Set and Track Personalized Energy-Saving Goals

The app offers a selection of energy-saving goals based on the user's consumption habits and preferences. These tailored recommendations are practical and designed to make a meaningful impact, giving users clear, actionable steps to reduce their energy consumption.

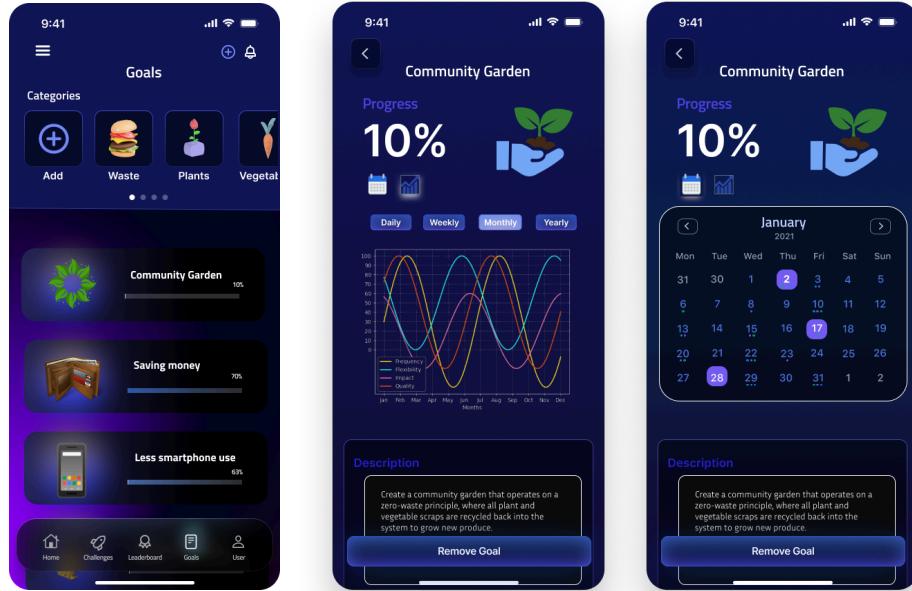


Figure 2- Goal visualization

Users can manually enter their own energy-saving goals, offering greater flexibility and customization. This feature is especially useful for those with unique objectives that don't align with the app's predefined recommendations.

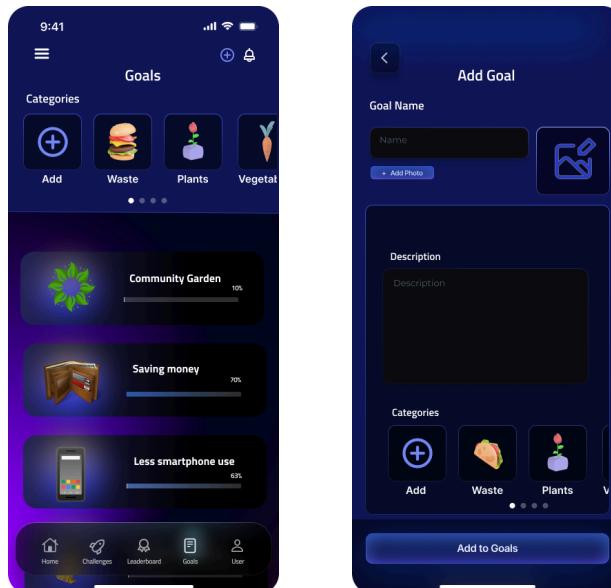


Figure 3- Add/Edit Goal

Users have the option to create categories for their goals, making it easier to organize and manage them. With a simple scrolling feature, they can quickly check the progress of each goal, offering a clear view of their achievements and highlighting areas where improvement is needed.

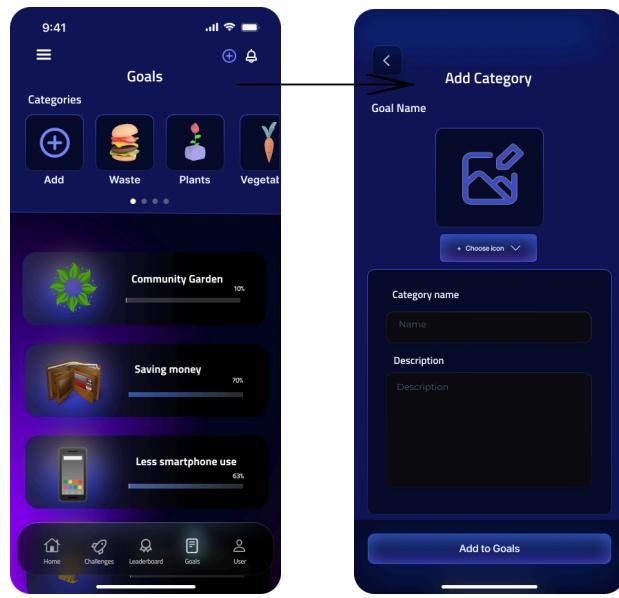


Figure 4- Add Category

3.2.3. Prototype- Task 3

Participate in Neighborhood-Wide Energy-Saving Challenges

By clicking the "Participate" button, the user joins neighborhood-wide energy-saving challenges, becoming part of a community effort to reduce energy consumption. Once joined, they can view challenge details, track their contributions, and monitor the neighborhood's collective progress, promoting engagement and collaboration.



Figure 5- Create a Challenge

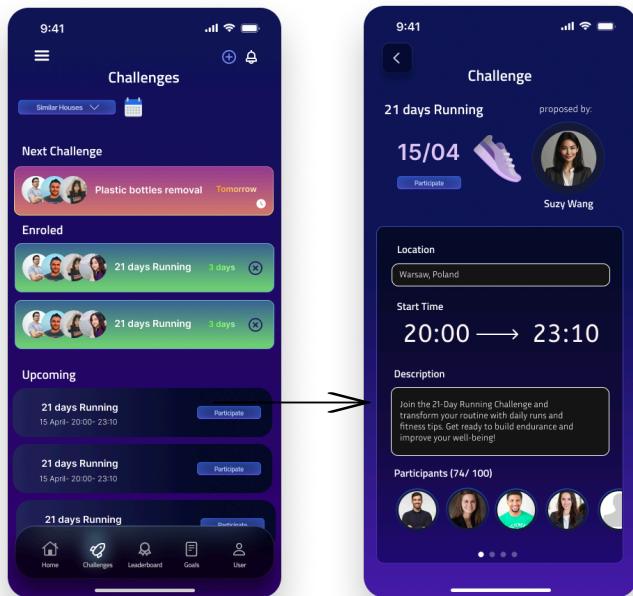


Figure 6- Participate on a Challenge

3.2.4. Prototype- Extra Task

Energy management of appliances and rooms



Figure 7- Control the air conditioning temperature

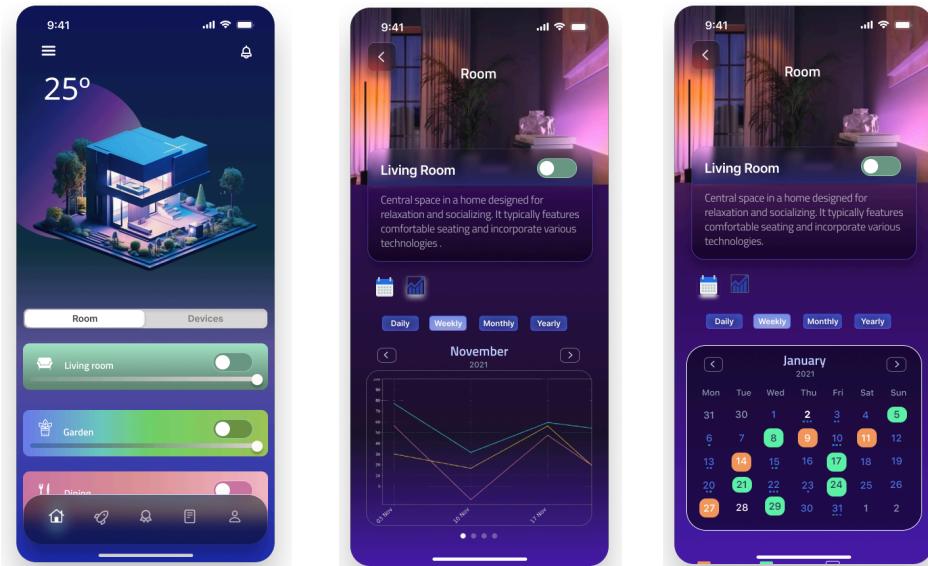


Figure 8- Regulate the equipment and energy used in the room

[Link to prototype:](#)

<https://www.figma.com/proto/iaYO6EELC7zaLLJxhJA2ZT/IPC?node-id=519-773&t=FN04XnK4Q8RrBOBZ-1&scaling=scale-down&content-scaling=fixed&page-id=0%3A1&starting-point-node-id=244%3A925&show-proto-sidebar=1>

3.3. User evaluation protocol

The user evaluation was conducted following a structured protocol to ensure consistency and reliability of the results:

1. Participants:

- A total of 32 participants were recruited.
- Participants were selected to include a mix of ages, genders, and technical proficiency levels to ensure diversity.

2. Tasks Evaluated:

- Task 1: Compare energy usage with neighbors or similar households.
- Task 2: Set and track personalized energy-saving goals.
- Task 3: Participate in energy-saving challenges via a "participate" button.

3. Data Collection:

- **Quantitative Metrics:**
 - Efficiency: Measured as the time taken to complete each task (in seconds).
 - Efficacy: Count of errors or missclicks during task execution.
 - Satisfaction: Measured on a scale of 0-5 using a post-task survey.
- **Qualitative Feedback:**
 - Participants provided comments and insights during debriefing interviews.
 - Observations of user behavior during task performance were recorded.

4. Procedure:

- Each participant was given a brief introduction to the prototype and its purpose.
- Participants performed the three tasks in a randomized order to minimize bias.
- After completing each task, participants filled out a satisfaction survey and answered open-ended questions about their experience.

5. Ethical Considerations:

- Participation was voluntary, and informed consent was obtained.
- Data was anonymized to protect participant privacy.

3.4. Results

3.4.1. Sample characterization

The sample for our evaluation was drawn from a diverse group of individuals, including family, friends, and acquaintances, spanning various age groups and backgrounds. This approach ensured that a broad spectrum of perspectives and experiences were represented, providing valuable insights into the usability and effectiveness of the task.

The sample consisted of 32 individuals, aged 18–25 (53%), 26–35 (28%), 36–45 (9%), 46–60 (6%), and 60+ (3%). This distribution allowed us to capture insights from both younger and older generations.

Gender representation was balanced, with 53% of participants identifying as female and 47% as male. Additionally, participants' levels of knowledge and familiarity with the task varied:

Beginners (31%): These participants, representing 10 individuals, had no prior experience with our application and were testing it for the first time.

Intermediate (44%): This group, comprising 14 individuals, had some familiarity with the application. They had either provided feedback during earlier stages of development or participated in previous task testing.

Advanced (25%): This group included 8 individuals who were highly familiar with the application. They had been deeply involved in multiple stages of testing providing frequent feedback and often task testing .

This broad range of expertise ensured that the evaluation addressed usability challenges for individuals with different levels of experience.

By characterizing users based on these demographic and skill-related factors, we were able to identify how different subgroups interacted with the task, providing deeper insights into its overall usability and accessibility.

3.4.2. Statistical analysis

3.4.2.1. Prototype- Task 1

In the task of comparing energy usage with neighbors or similar households, the analyzed data includes **Efficiency (Time in Seconds)**, **Efficacy (Number of Missclicks)**, and **Satisfaction (0-5 Scale)**.

- **Efficiency (Time in Seconds):** The times to complete the task varied from 40 to 80 seconds, with the most frequent time being 55 seconds. The median was 55.0, the first quartile (Q_1) was 50.0, and the third quartile (Q_3) was 65.0. The mean was 58.13 seconds, with a standard deviation of 13.31, indicating considerable variation in task completion times.
- **Efficacy (Number of Missclicks):** The number of missclicks varied from 0 to 5, with the most frequent value being 1 missclick. The median was 2.0, Q_1 was 1.0, and Q_3 was 3.0. The mean was 2.22 missclicks, with a standard deviation of 1.43, showing a moderately dispersed distribution of errors among participants.
- **Satisfaction (0-5 Scale):** Participants' satisfaction had an average score of 4.13, with most ratings concentrated around 4. The median was 4.0, Q_1 was 4.0, and Q_3 was 5.0, with a standard deviation of 0.62, suggesting that most participants had a positive experience, with some variation.

Statistical Analysis:

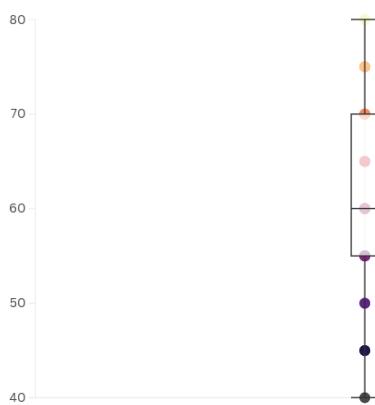
- **Student's t-test (Comparison of Means):** The comparison between **Efficiency** and **Efficacy** showed a statistically significant difference, with a t-statistic of 14.58 and a p-value less than 0.0001 (significant at $\alpha = 0.05$). This indicates that efficiency and efficacy represent different measures, with the differences in completion times not being related directly to missclicks.
- **Confidence Interval (95%):** For **Efficiency**, the confidence interval for the mean was between 53.07 and 63.18 seconds, suggesting that the true mean efficiency is likely to fall within this range. For **Satisfaction**, the interval was between 3.87 and 4.38, indicating that satisfaction is generally high, with slight variability in user experience.
- **Pearson's R Correlation:** The correlation between **Efficiency** and **Satisfaction** was $r = 0.18$, with a p-value of 0.32, indicating a weak and non-significant positive correlation,

suggesting no strong relationship between faster task completion and satisfaction. The correlation between **Efficacy** and **Satisfaction** was $r = -0.12$, with a p-value of 0.49, also not statistically significant. This suggests that the number of missclicks is not significantly dependent on satisfaction.

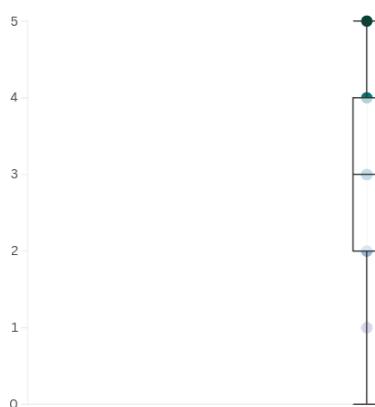
Discussion

The analysis shows that **Efficiency** and **Efficacy** exhibit distinct performance patterns and are statistically different. **Satisfaction** is within a good range (mean = 4.13), with confidence intervals suggesting a generally positive user experience, though with some variability. The correlations indicate that factors other than efficiency and efficacy may contribute to satisfaction. Improvements focusing on usability refinements could enhance the overall user experience more effectively.

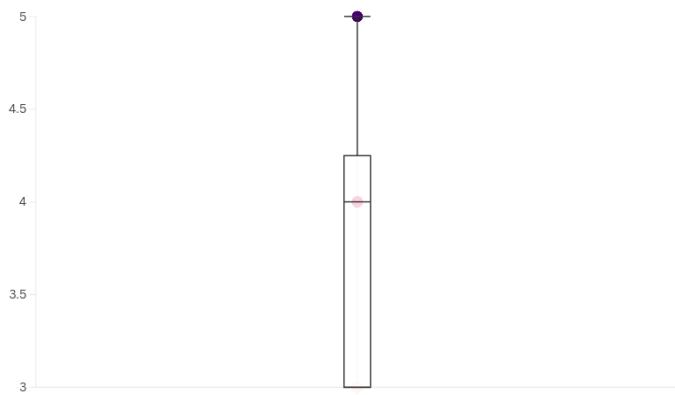
Efficiency (seconds to complete the task)



Efficacy (clicks)



Satisfaction (0-5)



3.4.2.1. Prototype- Task 2

For the task of setting and tracking personalized energy-saving goals, the analyzed data includes **Efficiency (Time in Seconds)**, **Efficacy (Number of Missclicks)**, and **Adjusted Satisfaction (0-5 Scale)**.

- **Efficiency (Time in Seconds):** Task completion times ranged from 30 to 80 seconds, with the most frequent time being 50 seconds. The median was 50.0, the first quartile (Q_1) was 43.75, and the third quartile (Q_3) was 65.0. The mean time was 53.13 seconds, with a standard deviation of 13.51, indicating moderate variation in how long it took users to complete the task.
- **Efficacy (Number of Missclicks):** The number of missclicks ranged from 0 to 4, with the most frequent value being 0. The median was 1.0, Q_1 was 0.0, and Q_3 was 2.0. The mean number of missclicks was 1.28, with a standard deviation of 1.23, suggesting that most participants made only a few errors during the task.
- **Adjusted Satisfaction (0-5 Scale):** Participants rated their satisfaction between 3 and 5, with the most common rating being 4. The median was 4.0, Q_1 was 4.0, and Q_3 was 5.0, with a mean of 4.19 and a standard deviation of 0.58. This suggests that overall satisfaction was high, though with some variability.

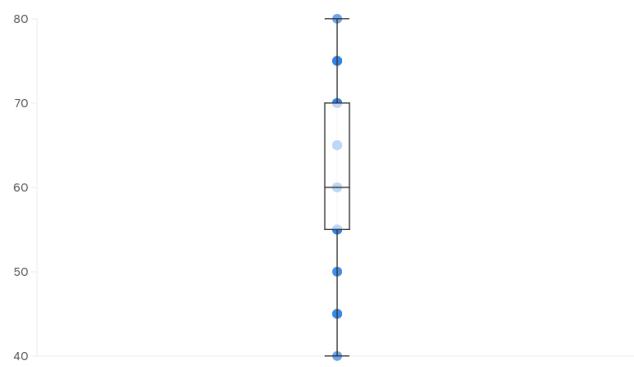
Statistical Analysis:

- **Student's t-test (Comparison of Means):** The adjusted **Satisfaction** data showed a t-statistic of 1.79 and a p-value of 0.083. This result is **not statistically significant** at $\alpha = 0.05$, indicating that while satisfaction was above the benchmark mean of 4.0, the difference was not statistically substantial.
- **Confidence Interval (95%):** The confidence interval for **Adjusted Satisfaction** was between 3.97 and 4.40. This indicates that the true mean of adjusted satisfaction is likely to fall within this range. The lower bound (3.97) is close to the benchmark satisfaction of 4.0, showing a generally positive result with some variation.
- **Pearson's R Correlation:**
 - The correlation between **Efficiency** and **Adjusted Satisfaction** was $r = -0.83$, with a p-value of 4.79×10^{-9} , which is **statistically significant**. This suggests a strong negative relationship, meaning that faster task completion (shorter times) is strongly associated with higher satisfaction.
 - The correlation between **Efficacy** and **Adjusted Satisfaction** was $r = -0.81$, with a p-value of 1.47×10^{-8} , also **statistically significant**. This shows that fewer missclicks are strongly linked to higher satisfaction.

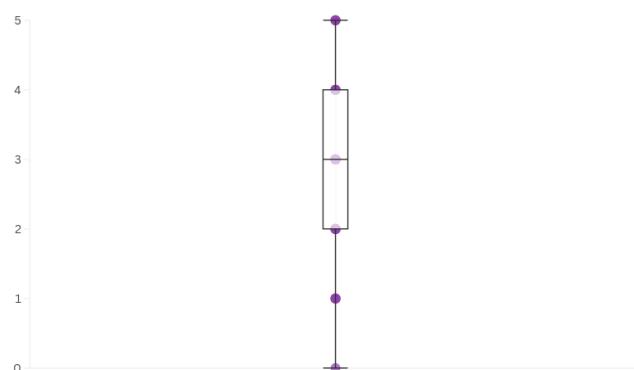
Discussion

The analysis indicates that **Adjusted Satisfaction** has a mean of 4.19, which is a positive outcome but not significantly higher than the benchmark of 4.0. Statistical tests reveal a strong negative correlation between both **Efficiency** and **Efficacy** with satisfaction, meaning that quicker task completion and fewer errors are closely tied to better user satisfaction. Confidence intervals further suggest that the adjusted satisfaction is within the acceptable range. Overall, the data points to improved performance and user experience, with faster and more efficient task completion being strongly linked to higher satisfaction levels.

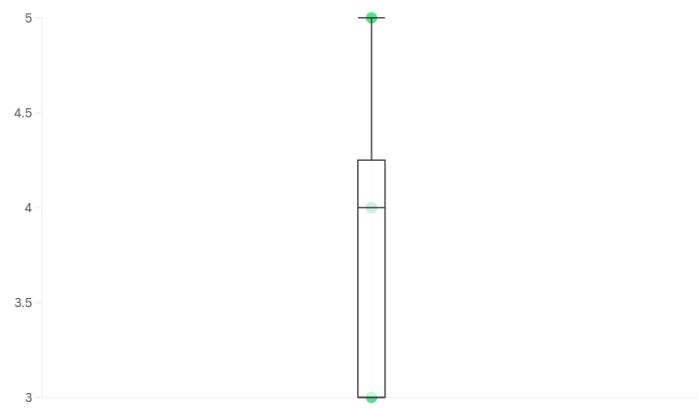
Efficiency (seconds to complete the task)



Efficacy (clicks)



Satisfaction (0-5)



3.4.2.3. Prototype- Task 3

For the task where users click on a "participate" button to take part in challenges, the data consists of **Efficiency (Time in Seconds)**, **Efficacy (Number of Missclicks)**, and **Satisfaction (0-5 Scale)**.

- **Efficiency (Time in Seconds):** Task completion times ranged from 20 to 50 seconds, with the most frequent time being 30 seconds. The median was 40.0 seconds, Q_1 was 30.0, and Q_3 was 45.0. The mean time was 37.66 seconds, with a standard deviation of 8.93, showing moderate variation in how long it took users to click the "participate" button.
- **Efficacy (Number of Missclicks):** The number of missclicks ranged from 0 to 3, with the most frequent value being 0. The median was 1.0, Q_1 was 0.0, and Q_3 was 2.0. The mean number of missclicks was 1.22, with a standard deviation of 1.08, suggesting that most participants made few errors while attempting to participate.
- **Satisfaction (0-5 Scale):** Participants rated their satisfaction between 3 and 4, with the most common rating being 4. The median was 4.0, Q_1 was 3.0, and Q_3 was 4.0. The mean satisfaction was 3.63, with a standard deviation of 0.48. This suggests a generally positive but slightly lower level of satisfaction compared to the benchmark.

Statistical Analysis:

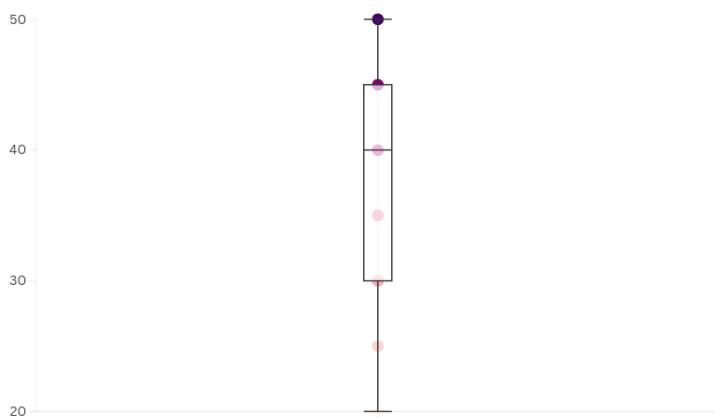
- **Student's t-test (Comparison of Means):** The satisfaction mean was 3.63, with a t-statistic of -4.31 and a p-value of 0.00015. This result is **statistically significant** at $\alpha = 0.05$, indicating that the satisfaction level is significantly lower than the benchmark satisfaction of 4.0.
- **Confidence Interval (95%):** The confidence interval for **Satisfaction** is between 3.45 and 3.80. This suggests that the true mean of satisfaction is likely to fall within this range. Since the interval is below the benchmark of 4.0, there is room for improvement in user satisfaction.
- **Pearson's R Correlation:**
 - The correlation between **Efficiency and Satisfaction** was $r = 0.52$, with a p-value of 0.002, which is **statistically significant**. This indicates a moderate positive correlation, meaning that faster task completion is associated with slightly higher satisfaction.

- The correlation between **Efficacy** and **Satisfaction** was $r = 0.34$, with a p-value of 0.060, which is **not statistically significant** at $\alpha = 0.05$. This suggests a weak positive relationship between fewer missclicks and higher satisfaction, but it does not meet the threshold for statistical significance.

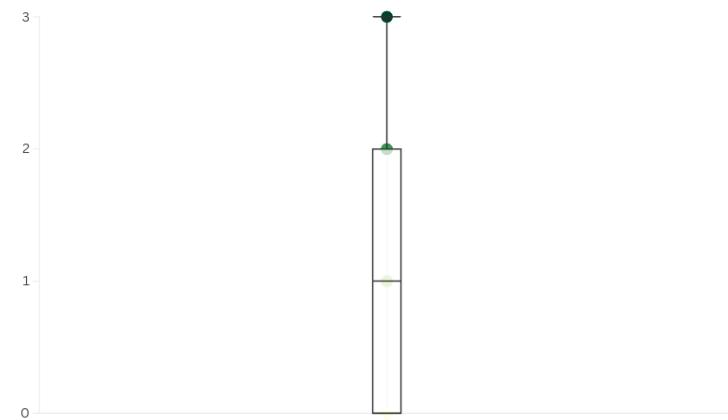
Discussion

The task's efficiency and efficacy measures remain within acceptable ranges, with completion times and missclicks being manageable. However, **Satisfaction** shows a mean of 3.63, which is statistically significantly lower than the benchmark of 4.0. This indicates that the user experience could be improved. The analysis suggests that quicker participation is linked to slightly higher satisfaction, but the relationship between fewer missclicks and satisfaction is weak and not statistically significant. Overall, improvements to the user interface or task flow could help enhance satisfaction levels.

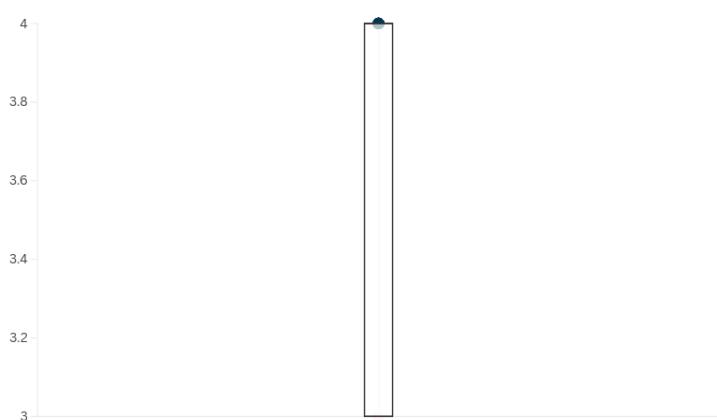
Efficiency (seconds to complete the task)



Efficacy (clicks)



Satisfaction (0-5)



3.5. Conclusion

The evaluation of the Eco-Neighbours application provided a comprehensive understanding of its usability, effectiveness, and areas for improvement. By combining quantitative metrics such as task efficiency, efficacy, and satisfaction with qualitative feedback from interviews and observations, we obtained valuable insights into user experiences across a diverse demographic.

The results highlighted the strengths of the application, including its ability to engage users through gamification and its potential to foster eco-friendly habits within communities. Users appreciated the app's innovative features, such as real-time energy tracking, personalized goal-setting, and participation in community challenges. These elements would not only encourage sustainable behaviors but also strengthen the sense of community among participants.

However, the analysis also revealed areas needing refinement. Certain tasks exhibited lower satisfaction levels, indicating that improvements in interface design, task flow, and clarity of information could enhance the user experience. Issues such as navigation confusion and insufficient feedback mechanisms were identified as key areas to address in future iterations of the application.

In summary, the Eco-Neighbours app shows significant promise in promoting environmental sustainability and engaging users in meaningful ways. By addressing the identified usability challenges and integrating user feedback, the app can further enhance its impact, offering a more seamless and satisfying experience for users of all ages and levels of expertise with the possibility of evolving into a highly effective tool for fostering eco-friendly communities.

4. Annexes

4.1. Questionnaires

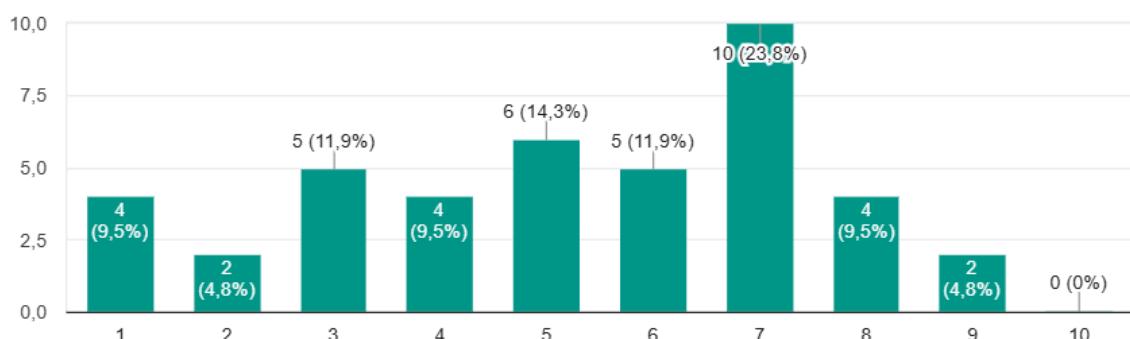
- i. How old are you?
- ii. On a scale from 1 to 10, how much do you know about energy saving?
- iii. Are you conscious about your energy consumption?
- iv. How often do you track your energy consumption?
- v. How would you feel about comparing your energy usage with that of your neighbors or other households?
- vi. How likely are you to participate in neighborhood or community-wide energy-saving challenges?
- vii. Would rewards or recognition incentivize you to participate in community challenges to reduce energy consumption?
- viii. Would you find it useful to compare your energy usage against households of similar size or composition?
- ix. How helpful do you find the app's notifications or alerts about high energy usage?
- x. How likely are you to take action after receiving an alert that your energy usage is higher than usual?
- xi. Would seeing your overall environmental impact encourage you to adopt more eco-friendly practices?
- xii. How helpful would peer advice be in helping you reduce your energy consumption?
- xiii. How valuable is it for you to understand seasonal energy usage trends in your home?
- xiv. How likely are you to act on an alert that your energy usage exceeds similar households?
- xv. How likely are you to set and actively pursue energy goals if the platform provided personalized tips?

4.2. Summary of results

On a scale from 1 to 10, how much do you know about energy saving?

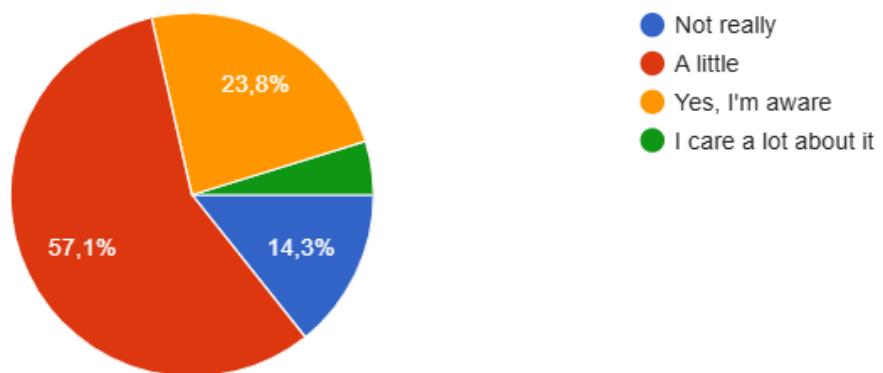
 Copiar gráfico

42 respostas



Are you conscious about your energy consumption?

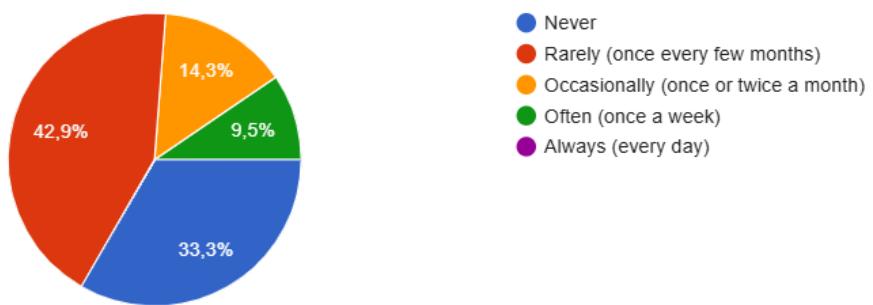
42 respostas



How often do you track your energy consumption?

Copiar gráfico

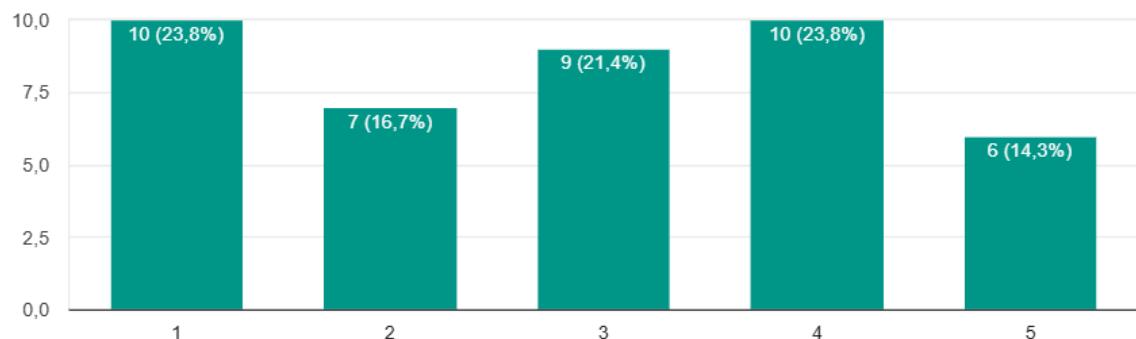
42 respostas



How would you feel about comparing your energy usage with that of your neighbors or other households?

Copiar gráfico

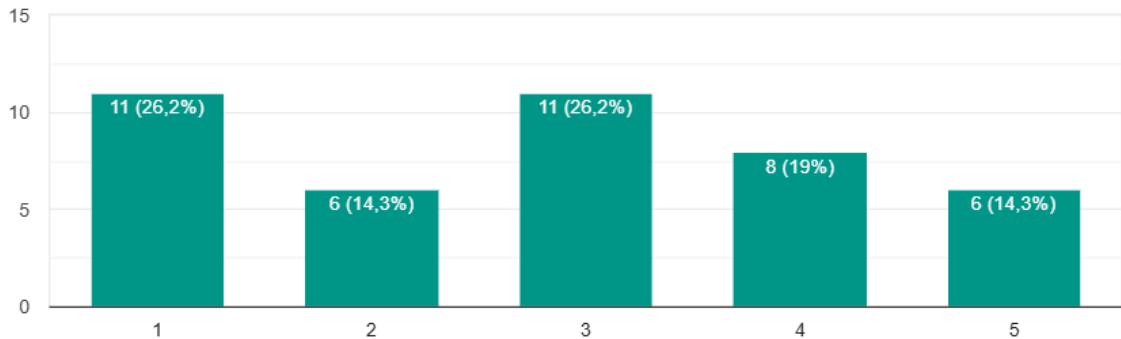
42 respostas



 Copiar gráfico

How likely are you to participate in neighborhood or community-wide energy-saving challenges?

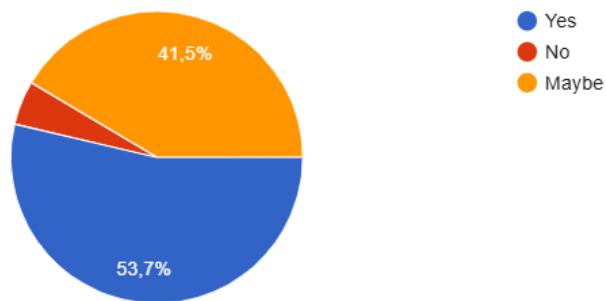
42 respostas



Would rewards or recognition incentivize you to participate in community challenges to reduce energy consumption?

 Copiar gráfico

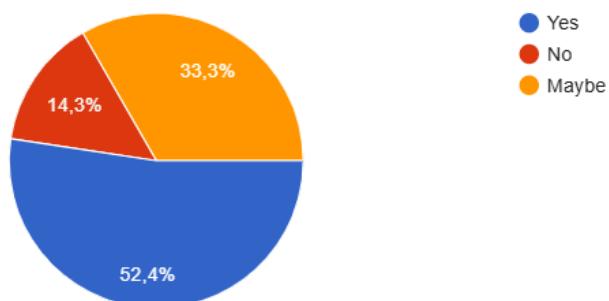
41 respostas



Would you find it useful to compare your energy usage against households of similar size or composition?

 Copiar gráfico

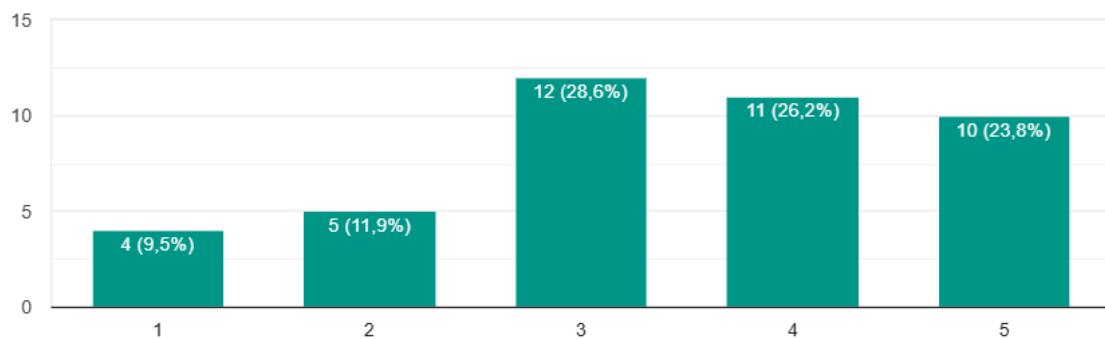
42 respostas



How likely are you to take action after receiving an alert that your energy usage is higher than usual?

 Copiar gráfico

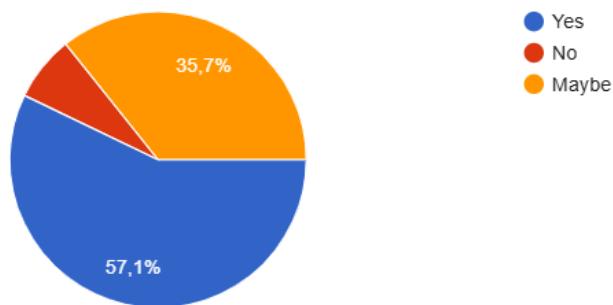
42 respostas



Would seeing your overall environmental impact encourage you to adopt more eco-friendly practices?

 Copiar gráfico

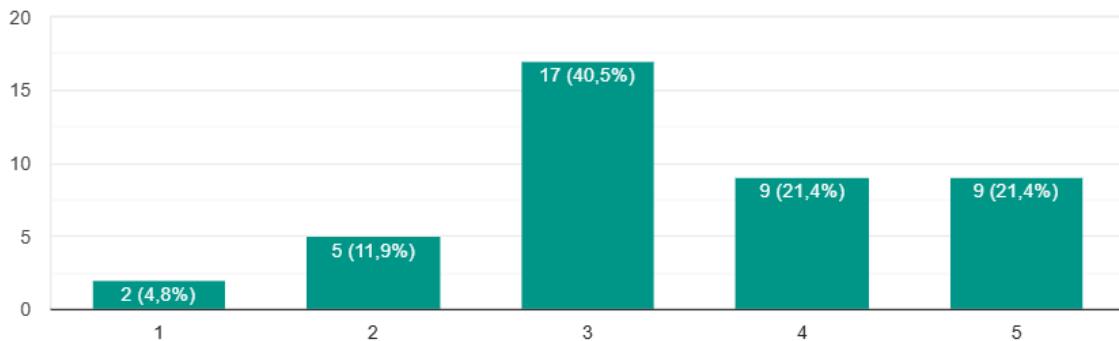
42 respostas



How helpful would peer advice be in helping you reduce your energy consumption?

 Copiar gráfico

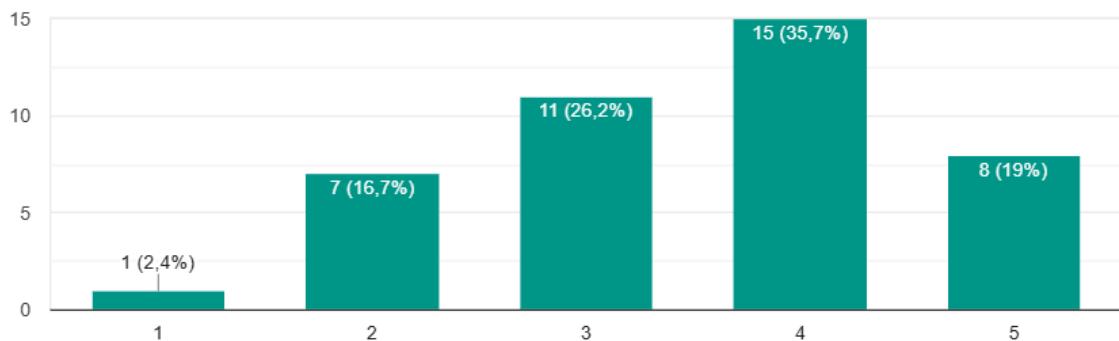
42 respostas



How valuable is it for you to understand seasonal energy usage trends in your home?

 Copiar gráfico

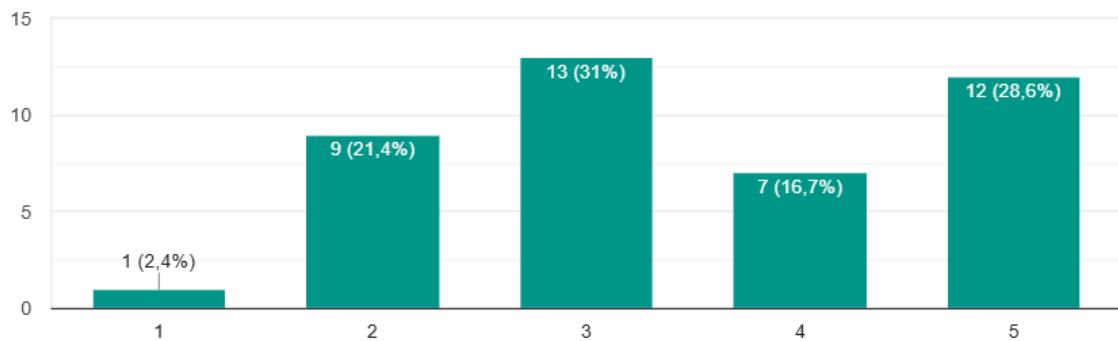
42 respostas



How likely are you to act on an alert that your energy usage exceeds similar households?

 Copiar gráfico

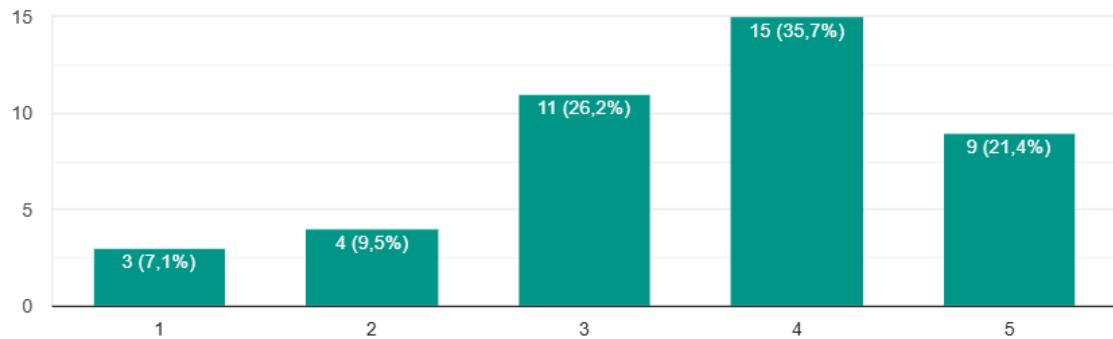
42 respostas



How likely are you to set and actively pursue energy goals if the platform provided personalized tips?

 Copiar gráfico

42 respostas



4.3. Heuristic Evaluation

4.3.1. Heuristic Evaluation Report sent to Group 3

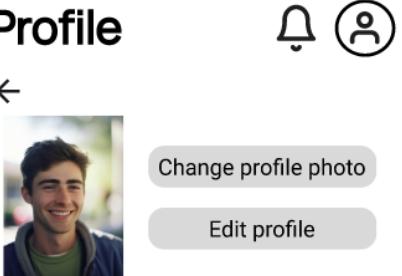
HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC05 - 14-11-2024 - Bruno Cunha

Group evaluated: O3 - Sinergia

By group: O2

Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	<p>“Change profile photo” could be the same option as “Edit profile”. That would lead to improved user efficiency and reduce visual load and error since, in this energy-conscious app, profiles are not the main focus and therefore frequent profile photo changes are unlikely.</p> 	8	1
2	<p>Turn on/off is counter-intuitive. Users are more used to “on” being a darker color and to the right, where “off” is to the left and lighter. Here it appears to be the opposite.</p> 	2	2

	<p style="text-align: center;">Washing Machine</p> <div style="background-color: #f0f0f0; padding: 10px; border-radius: 5px;"> <p style="margin: 0;">Turn on/off</p> </div>		
3	<p>“Delete Account” should have additional confirmation that the user does in fact want to delete their account. If an user error occurs their account will be lost with no chance for recovery.</p> <div style="background-color: #f0f0f0; padding: 10px; border-radius: 5px;"> <p style="margin: 0;">Notifications</p> </div> <div style="background-color: #f0f0f0; padding: 10px; border-radius: 5px;"> <p style="margin: 0;">Delete Account</p> DELETE </div>	5, 9	4
4	<p>02h 0.5kWh</p> <p>04h 2.0kWh</p> <p>08h 1.5kWh</p> <p>10h 2.5kWh</p> <p>12h 1.0kWh</p> <p>It's missing “06h” breaking the natural and logical order of the hours of the day. It may also be unnatural and counter-intuitive to start the day at “02h” and skip the odd hours.</p>	2	1
5	<p>The font size disparity between titles and body text, along with insufficient emphasis on clickable items, reduces visibility and makes it harder to distinguish interactive elements from informational content, affecting the clarity of the information.</p> 	1, 4	1

	(For example "Day", "Week" ... has the same text size and thickness as the kWh, where kWh is only informational and their difference in size to the title is quite significant.)		
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4.3.2. Heuristic Evaluation Report sent to Group 2

HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC05 - 14-11-2024 - Bruno Cunha

Group evaluated: 04 - Zeno

By group: 02

Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	Lack of consistency in color palette and font style across the interface, causing visual and cognitive dissonance.	4	1
2	Frames and icons lack clear visual cues indicating if they are clickable or merely informational, leading	6, 1	3

	<p>to user confusion.</p> 		
3	Insufficient documentation or guidance on how to use the application, resulting in a steep learning curve for users.	10	3
4	The help icon's destination is unclear; it is unknown where users will be taken or what type of assistance they will receive. 	9,1	3
5	The vehicle page is overloaded with information, creating a cluttered layout that overwhelms users.	8,5	2

4.3.3. Heuristic Evaluation Report made by Group 1

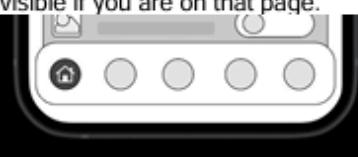
HCI Winter Semester 2024 - 2025

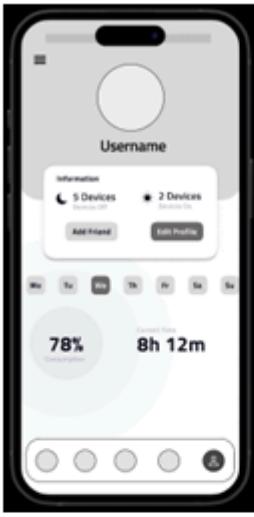
Heuristic Evaluation Report

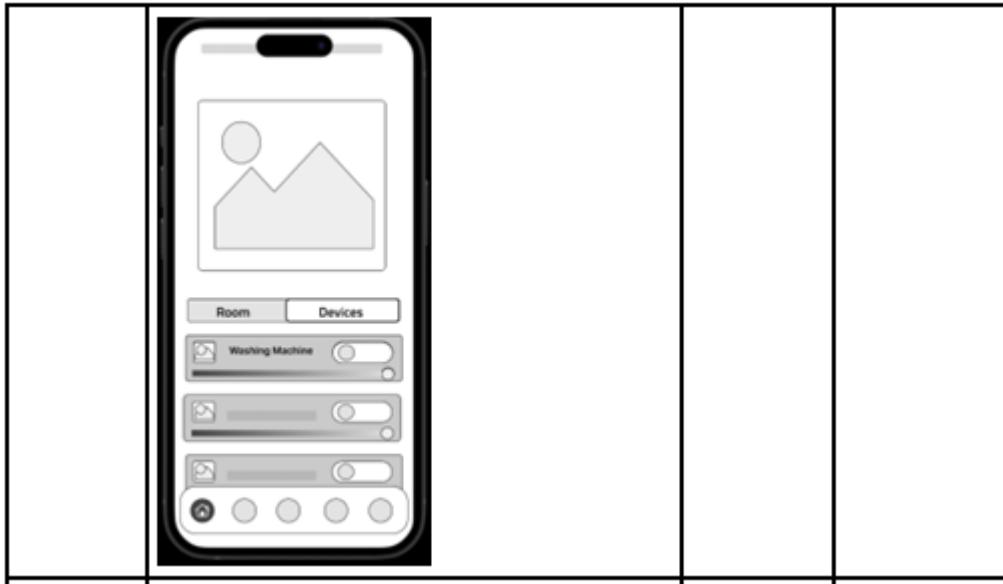
Class Nr.: LEIC0506 – 14.11.24 - TeacherName

Group evaluated: 02 – Eco-neighbours

By group: 07

Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	Monochromatic application. Visually confusing. 	8	3
2	Navigation icons from the footer's menu are only visible if you are on that page. 	6, 7	1
3	Many of the buttons are static on pages such as the one below. They do not produce interactions, error popups, or warning popups. For this example: <ul style="list-style-type: none">• Add Friend• Edit Profile• Days of the Week Are purely static.	5, 9	2

			
4	Navigating through the app is confusing since there are too many elements with no text or icons. A beginner user could have difficulty performing a task when he doesn't know where each feature is. 	10	2
5	Many elements do not have text, which complicates understanding what they are supposed to do or mean. (Likely due to mockup style, but not properly explained or mentioned during presentation).	8	1



4.4.4. Heuristic Evaluation Report made by Group 7

HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC05 - 14/11/2024 - Bruno Miguel Almeida Cunha

Group evaluated: 03 - Eco-neighbours

By group: 01

Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	Because the bottom navigation bar simply has icons and no labels, it might be challenging for users who are not accustomed with the program to grasp its features right once. Users are forced to play with each symbol in order to grasp its purpose due to the lack of labeling, which can be inconvenient and less effective. 	4	1
2	The time periods (monthly, weekly, and daily) are listed in the statistics section in a different order than what would be obvious to consumers. "Daily, weekly, monthly, yearly" would be the required structure in order to follow a natural evolution and its scrollable to the right. Confusion and navigational difficulties might result from the existing arrangement.	2	1
3	There is no first splash screen for the application that displays the name or logo. For new users, who might not know which application they have accessed, this could lessen the initial experience and impede instant brand awareness.	8	1