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IPC

WattSaver

3LEIC04 – Grupo 03

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1. User and Task Analysis

1.1 Project’s Idea Description

WattSaver is an innovative mobile application designed to minimize energy usage and optimize energy consumption in homes and businesses. By offering detailed monitoring and management of household appliances and lighting systems, the app provides users with real-time insights into their energy consumption.

The app tracks daily energy usage of appliances and lighting, and integrates renewable energy sources such as solar panels to display the amount of energy generated. Through this, users can easily assess their energy footprint and make data-driven decisions.

The app's ultimate goal is to help users lower their energy bills, contribute to a more sustainable environment, and manage their energy sources efficiently.

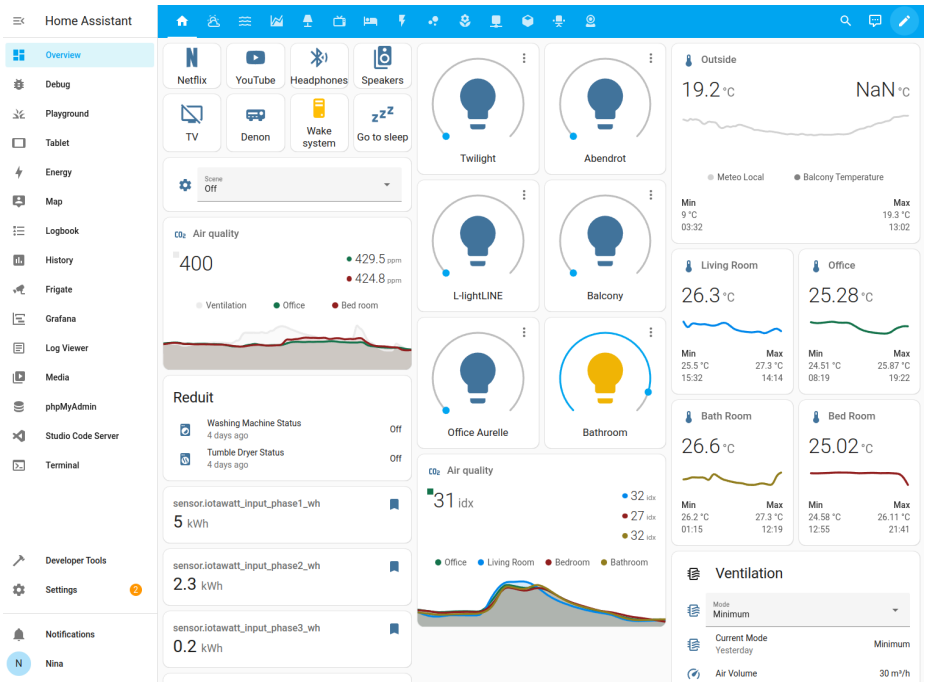
1.2 Related apps

Home Assistant

Home Assistant is a popular open-source platform that provides users with extensive customization and integration options for smart home automation, alongside energy management features.

Its flexibility makes it a powerful tool for those looking to manage various connected devices, however, its usability suffers due to the self-hosting requirement, which can be difficult for users without technical expertise.

As a result, while Home Assistant excels in versatility, it may not be the best fit for those seeking a more straightforward solution.



Google Nest

Google Nest offers a plug-and-play smart home ecosystem that works seamlessly with compatible devices. Its intuitive design and ease of use make it a great option for users looking for a reliable solution, but, since it is a closed system, it lacks compatibility with third-party devices and energy management features.

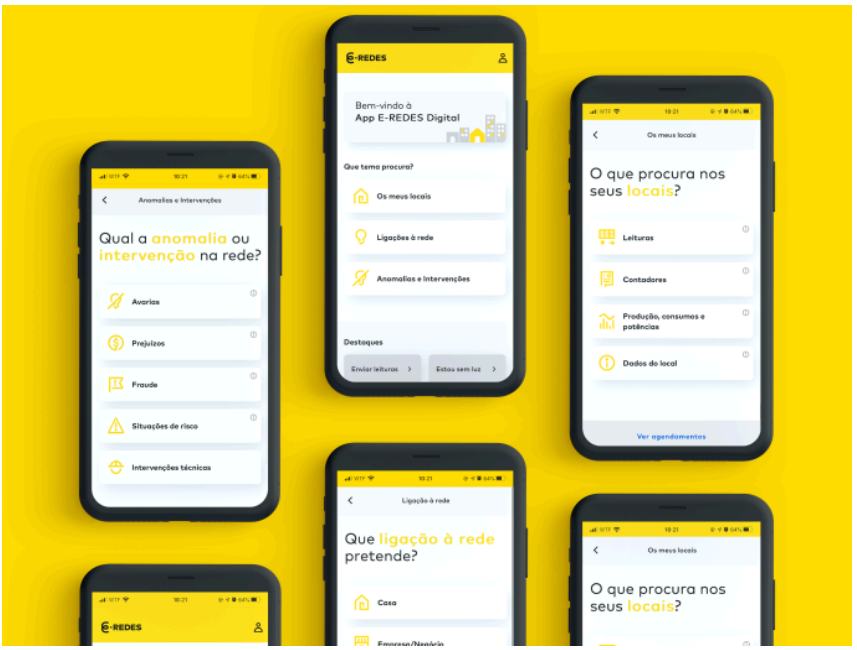
Owl Intuition

OWL Intuition focuses on monitoring energy production and consumption, offering users valuable insights into their energy usage. While it effectively tracks energy metrics. its outdated interface affects the user experience.

Additionally, OWL Intuition does not allow for direct control or management of connected devices, limiting its functionality as a complete energy management solution.

E-Redes App

E-REDES Digital is a user-friendly app designed to help you manage your energy consumption efficiently. It allows you to easily submit your electricity meter readings, report outages and anomalies, access detailed energy usage data, and receive notifications about your consumption. You can also organize multiple consumption sites for better management.


E-REDES
Bem-vindo à
App E-REDES Digital
Que tema procura?
Os meus locais
Ligações à rede
Anomalias e intervenções
Destaques
Enviar leituras
Estou sem luz
Anomalias e intervenções
Qual a anomalia ou intervenção na rede?
Avarias
Prejuízos
Fraude
Situações de risco
Intervenções técnicas
Os meus locais
O que procura nos seus locais?
Leituras
Contadores
Produção, consumos e potências
Dados do local
Ver agendamentos
Ligação à rede
Que ligação à rede pretende?
Casa
E-REDES
Os meus locais
O que procura nos seus locais?

1.3 Questionnaire

What is your age range?

The majority of respondents (66.7%) belong to the age group of 18 to 24 years. However, responses were obtained from all other age groups.

How many people are there in your household?

The majority of respondents belong to a household composed of 3 to 4 people, a relatively high number for the Portuguese context, where the average is 2.4 people per household, according to PORDATA.

Do you have any disability or condition that could affect the use of a mobile application?

The vast majority of respondents (90%) do not have any disabilities that could affect the use of a mobile application. However, some users reported having visual impairments (3.3%) and photosensitive epilepsy (3.3%), which may influence their experience with the application.

How comfortable are you using mobile apps to manage smart devices?

In evaluating comfort with mobile apps to manage smart devices, 40% of respondents rated their comfort level as a 5 (very comfortable), indicating a strong familiarity with app-based management. Additionally, 23.3% rated it a 4, suggesting that most users are generally comfortable with mobile apps. However, 10% rated their comfort as a 3, while 10% rated it a 2, and 16.7% rated it a 1 (not comfortable at all). This indicates a varied level of comfort, with a notable portion of users potentially needing additional support or education to enhance their experience. Overall, the results suggest a solid base of users who are comfortable with mobile apps, which our app can leverage while addressing the needs of less confident users

What smart devices do you have?

The most common smart devices among respondents are lighting (bulbs/LEDs) (36.7%). Other popular devices include fridges(23.3%), plugs(23.3%) and security cameras(23.3%). Less common devices include motion sensors (6.7%), and smart locks (10%). Additionally, some respondents own televisions, computers, robot vacuums , and other smart home appliances.

How important is it to you to reduce your ecological footprint?

Regarding the importance of reducing their ecological footprint, 46.7% of respondents rated it a 5 (very important), indicating a strong commitment to sustainability. An additional 23.3% rated it a 4, suggesting that most users prioritize ecological considerations. Meanwhile, 20% rated it a 3, indicating moderate importance, while 6.7% rated it a 2, and 3.3% rated it a 1 (not important at all). These results demonstrate a significant awareness and concern for environmental impact among users, reinforcing the potential for our app to promote features that support sustainable practices and help users track and reduce their ecological footprint.

Would you be interested in being able to monitor the energy consumption of each device/appliance you own?

The majority of respondents (70%) expressed interest in monitoring the energy consumption of each device/appliance they own, highlighting a strong demand for detailed energy tracking. An additional 20% indicated they might be interested, suggesting a potential to convert this group with the right features and messaging. Only 10% said no, indicating minimal resistance to the concept. Overall, these results emphasize the value of incorporating device-level monitoring into our app, as it aligns with user interest in managing and optimizing their energy consumption.

How important is it to you to reduce your energy costs?

In terms of the importance of reducing energy costs, 43.3% of respondents rated it a 5 (very important), demonstrating a significant focus on financial savings. Additionally, 20% rated it a 4, indicating that many users prioritize cost reduction. Meanwhile, 23.3% rated it a 3, suggesting moderate importance, while 10% rated it a 2, and 3.3% rated it a 1 (not important at all). These results highlight a strong motivation among users to lower their energy expenses, reinforcing the need for features in our app that provide actionable insights and strategies for cost savings.

Do you have solar panels at home?

The majority of respondents (76.7%) do not have solar panels at home, while 23.3% indicated that they do. This reflects a relatively low adoption rate of solar energy solutions among users, suggesting an opportunity to promote the benefits of solar panels for energy management and cost savings. Educating users about the advantages of solar energy could help increase adoption rates and enhance the app's features related to solar integration.

If you have or plan to have solar panels, how important is it to be able to monitor their performance in real-time?

Among those who have or plan to have solar panels, 60% rated the importance of monitoring their performance in real-time as a 5 (very important), indicating a strong desire for active performance tracking. An additional 16% rated it a 4, suggesting that most users recognize the value of real-time monitoring. Meanwhile, 16% rated it a 3, indicating moderate importance, while 4% rated it a 2, and another 4% rated it a 1 (not important at all). These results underscore the significance of incorporating real-time performance monitoring into our app, as it aligns with user expectations and can enhance their overall solar energy experience.

Do you have batteries at home?

The majority of respondents (73.3%) do not have batteries at home, while 26.7% indicated that they do. This suggests a limited adoption of battery storage solutions among users, highlighting a potential market opportunity for promoting the benefits of home batteries for energy management and efficiency. The lack of battery usage could impact our app's features, as integrating battery management and monitoring would be less relevant for a significant portion of users. However, increasing awareness and accessibility of battery solutions could enhance the app's value proposition and user engagement.

If you have or plan to have batteries, how important is it to be able to monitor the charge/discharge speed?

When asked about the importance of monitoring charge/discharge speed for batteries, 48% of respondents rated it a 5 (very important), indicating a strong demand for this feature. An additional 8% rated it a 4, while 32% rated it a 3, suggesting that most users consider it at least moderately important. Only 12% rated it below a 3, with 4% giving it a 2 and 8% a 1. These results highlight the significant interest in charge/discharge monitoring, emphasizing the need for our app to include this feature to meet user expectations and enhance battery management capabilities.

Do you use any system to monitor energy consumption?

The majority of respondents (83.3%) indicated that they do not use any system to monitor their energy consumption, highlighting a significant gap in user engagement with energy-tracking tools. Only 16.7% reported using a monitoring system, suggesting there is considerable potential to educate and encourage users to adopt solutions for better energy management. This underscores the opportunity to develop more appealing and accessible energy monitoring systems.

What system do you use to monitor energy consumption?

There were very few responses to this question, suggesting that this area is underutilized. This indicates a potential market opportunity to develop better, more user-friendly solutions for tracking energy consumption. Two respondents mentioned using the E-REDES website, which lacks advanced features for effective energy management.

What are the biggest challenges you face when trying to manage energy consumption?

The main challenges mentioned in managing energy consumption include feeling forced to use appliances despite wanting to save (e.g., avoiding the heater to save money), not knowing which devices consume the most energy, and the high cost of energy. Some face frustrations with their schedule not aligning with peak solar energy production or struggle to change long-established habits. Others express frustration with the lack of historical consumption data for their smart devices. One response reflects a lack of motivation due to the perception that larger polluters make little effort to reduce their impact.

When purchasing new equipment, what do you take into consideration?

The majority of respondents (76.7%) consider both monetary and energetic impacts when purchasing new equipment, highlighting a balanced concern for cost and energy efficiency. A smaller portion (16.7%) prioritizes only the monetary impact, while 3.3% focus solely on energy. Another 3.3% consider both factors but lean more toward cost. These results suggest that most users are mindful of both financial and environmental factors, with a strong preference for equipment that strikes a balance between cost-effectiveness and energy efficiency.

Would you use an application that made it easier to control your energy expenditure?

The majority of respondents (70%) indicated they would use an application that simplifies energy expenditure control, showing strong interest in such a tool. An additional 20% responded "maybe," suggesting that while they see potential value, they may need more convincing based on features or usability. Only 10% said "no," indicating minimal resistance to adopting the app. Overall, these results

suggest a favorable market for an application focused on energy management, with most users either willing or open to using it.

What features would you find useful?

The most requested feature is observing energy consumption history per device (66.7%), indicating users value insights into past usage. Suggestions to switch energy providers (53.3%) and simulate adding/removing devices (50%) are also popular, reflecting an interest in cost-saving strategies and energy management control. Remote device control (50%) is equally valued for convenience. However, fewer users are interested in suggestions for energy-saving goals (40%) or monetary goals (23.3%), suggesting that direct control and insights are more compelling than specific goal-setting.

1.4 PACT

People

The survey data shows that participants range from young adults (18-24 years old) to seniors (over 54 years old), with the majority falling within the 18-24 age range. Most participants live in households with 4 to 5 people, which could significantly influence energy consumption. In terms of disabilities, most respondents do not have conditions that would interfere with the use of a mobile application, although a small proportion reported visual or cognitive impairments.

Overall, participants are familiar with using mobile applications to manage smart devices, even though most do not currently have smart devices installed in their homes. This presents an opportunity to educate and encourage the adoption of such technologies. Many respondents showed concern for sustainability and expressed interest in reducing their ecological footprint, as well as monitoring and lowering energy consumption to save on electricity costs.

While most do not own solar panels, there is a general acknowledgment of the importance of monitoring renewable energy sources in real-time, suggesting a willingness to adopt sustainable technologies in the future if the benefits are well communicated. This data reveals a young audience, familiar with technology, interested in sustainable practices, and open to adopting solutions that help optimize energy consumption.

Activities

How do people currently monitor their energy consumption?
Most participants do not have a structured system for tracking their energy usage. For those who actively monitor their consumption, the most common method is using the EREDES app to access real-time data and view consumption history. Some also rely on OWL Intuition, which provides automated, real-time monitoring. Additionally, some participants perform manual checks by comparing electricity bills or reading the household meter.

Energy monitoring typically occurs at home outside of work hours, especially in the evenings or on weekends when consumption peaks. The need to manage energy use becomes more pressing during periods of high costs or economic difficulties.

What are the biggest challenges people face in managing energy consumption?

Many people face significant difficulties in managing their energy consumption. High electricity costs often place a substantial financial strain on households, leading to a growing need for better energy management. The rising prices can feel overwhelming, especially when efforts to reduce consumption seem to have little impact on bills.

Making changes to established routines poses another major challenge. Long-standing habits, such as leaving lights on or using appliances inefficiently, can be hard to break. Even when people are aware of the need for change, maintaining consistent energy-saving behaviors requires effort and discipline.

Another issue is the lack of awareness about which appliances or devices consume the most energy. Without clear insights, individuals may focus on changes that have minimal impact while overlooking significant energy drains. Understanding the specifics of energy consumption is essential for making meaningful improvements.

For households with solar panels, the challenge lies in maximizing solar energy usage during peak production times. This is especially difficult when no one is home during the day to take advantage of the energy being generated. Finding ways to store or redirect this energy efficiently remains a persistent concern.

What tasks do users currently perform?

Many users manually review their electricity bills to estimate their energy consumption. This approach provides a general idea but often lacks the detailed insights needed for more informed decisions.

Some participants take manual meter readings and compare these to their bills. This adds a layer of accuracy and verification but can be time-consuming and inconvenient.

Users also attempt to reduce energy consumption by unplugging devices that are not in use. However, this behavior is not always consistent, which limits its overall effectiveness.

Households with solar panels often try to schedule appliance use during daylight hours to make the most of solar energy. This can be difficult, especially when the home is unoccupied during the day, leaving potential energy savings unrealized.

What can be improved?
To better manage energy consumption, participants suggested providing detailed tracking of consumption history over time. This would allow users to gain clearer insights into their energy usage and identify opportunities for improvement.

Another recommendation was to offer suggestions for more economical energy providers based on users' usage patterns. This could help households make cost-effective choices and reduce their energy expenses.

Participants also expressed interest in features that simulate the impact of adding or removing devices. This would enable users to make more informed decisions about their energy use by understanding potential costs or savings in advance.

Context

Physical Environments
Users engage with energy consumption applications in both home and workplace settings, which can vary significantly. Temperature conditions in these spaces often fluctuate based on the season, directly impacting energy usage for heating or cooling.

Most interactions with these applications take place in interior spaces, such as living rooms or kitchens, using mobile devices or computers. These common areas provide convenient access for monitoring and managing energy consumption.

Social Environments

Households often consist of multiple members, which necessitates centralized energy management. While decision-making about energy usage may be shared, the need for coordination among family members is essential.

Energy management is primarily integrated into daily life through smartphones, making these applications convenient and easily accessible for users.

Organizational Context

Users interact with energy providers primarily for billing, consumption, and tariff-related matters. Direct communication is usually minimal and occurs only when issues arise.

Through applications that offer detailed monitoring and adjustments, users are gaining greater control over their energy consumption, allowing for more proactive management.

Technology

Current Tools Used

Users of energy consumption management applications currently utilize various technologies that facilitate monitoring and control of energy usage:

1. **Input**

Input in energy consumption management applications involves several key aspects. Data collection is facilitated through either manual input by users or automatic updates from connected devices.

Interaction with the application occurs mainly through touch commands on mobile devices, with some systems also supporting voice commands via virtual assistants.

Security is also a crucial aspect, particularly when transmitting sensitive energy consumption data.

2. **Output**

Output in energy consumption management applications includes various methods of presenting data. Energy consumption data is displayed through graphs, tables, and visual reports, helping users interpret their usage patterns. Different display methods, such as bar and line graphs, are used to make fluctuations in consumption more easily understandable.

Additionally, some applications provide audio feedback, offering alerts to notify users of significant changes in energy consumption or the operation of connected devices.

3. **Communications**

Communications in energy consumption management applications are essential for efficient operation. Device connectivity plays a critical role, as it allows smart devices such as thermostats, lights, and plugs to be controlled and monitored through the same application.

Moreover, communication speed is vital for providing real-time updates to users. This enables them to quickly adjust their consumption habits, particularly during peak periods when rapid decisions are necessary to optimize energy use.

Additional Features

- **Screen Size**: Most users access applications on smartphones or tablets, requiring optimized user interfaces for smaller screens.
- **User Interface (UI)**: An intuitive UI that allows for easy and quick navigation is vital for technology adoption.
- **Real-Time Systems**: Applications should provide real-time data and feedback, enabling users to make quick decisions about their energy consumption.
- **Security Systems**: Although not commonly found in energy management apps, user safety and data protection are important considerations.
- **User-Friendly Systems**: Applications should be easy to use, allowing new users to start monitoring their consumption without extensive training.

1.5 Personas

Persona 1

Maria is a 22-year-old Junior Consultant from Aveiro who is very familiar with technology, especially mobile apps, which she frequently uses to monitor her smart devices. She owns smart outlets, smart lamps, a smart fridge, and solar panels. Living in a household of four, Maria enjoys helping her family whenever there is an opportunity.

Maria's family faced financial struggles in the past, so she uses these apps to help prevent a recurrence of that situation. Additionally, Maria is a conscientious individual who cares about environmental issues and always strives to make eco-friendly choices in her daily life.

Her main goals are to reduce her family's energy consumption, maximize the use of solar energy, and control her devices remotely. However, Maria faces challenges in figuring out the best times to use her devices to maximize solar power utilization. She also needs to balance the cost and sustainability of her devices with the convenience provided by the app.

Persona 2

António is a 65-year-old retired man from Porto who worked as a construction worker. His job never required working with advanced technology, so he doesn't understand mobile apps very well. He doesn't own any smart devices or solar panels. In his household of three, his main concern is saving money.

António wants to figure out which energy company offers the best rates and switch to that one. To achieve this, he needs to lower the cost of his electricity bills and would benefit from a very simple, user-friendly mobile app to manage energy usage at home.

However, António struggles with technology. Without assistance, he doesn't know how to monitor his power usage effectively.

1.6 Activity Scenarios

This section details hypothetical situations where various users interact with the WattSaver app, providing context for how the app can assist in daily life. These scenarios are designed to reflect real-life challenges and the practical solutions that WattSaver offers.

Scenario 1: Uncovering Energy Waste

Maria notices her electricity bill has been rising in recent months and uses the WattSaver app to find out why. On the app's dashboard, she quickly sorts the devices by energy consumption and discovers that her refrigerator is using much more energy than expected. WattSaver's detailed analysis shows that the fridge's energy usage has increased substantially, indicating a possible malfunction. The app suggests replacing it with a more efficient model or repairing it.

Scenario 2: Family Energy Awareness

António has noticed his electricity bills are high. Curious about why, he uses the WattSaver app and its energy monitoring feature. As he explores the app, he discovers that his energy usage spikes on weekends when his sons visit. The app reveals that their habits like leaving lights on and devices plugged in are causing the extra costs. With this information, António talks to his sons about being more mindful of their energy use and sets up the app to automatically turn off devices after a while. As a result, he successfully reduces his electricity bills.

1.7 Functionalities

This section outlines the key functionalities of the WattSaver app, focusing on the features that make it useful for both individual users and larger households.

Real-Time Monitoring

WattSaver allows users to track their energy consumption in real-time, providing immediate feedback on which appliances are drawing power. This feature is crucial for users who want to optimize their energy use during peak and off-peak hours.

It includes a real-time graphical display of energy usage, notifications for high-consumption appliances, and historical consumption data for analysis.

Energy Savings Suggestions

WattSaver analyzes consumption and suggests ways to reduce energy use, based on past data and user preferences. This feature provides customized recommendations for reducing energy consumption and alerts users about energy-saving opportunities, such as shifting usage to off-peak hours.

Additionally, WattSaver integrates with smart devices to create automated routines that help users optimize their energy usage.

Solar Energy Management

For users with solar panels, WattSaver offers detailed tracking of energy production and consumption, helping them maximize the use of solar energy. It suggests the best times to use energy based on solar production levels.

Key features include real-time solar production tracking, integration with smart devices to efficiently use energy during peak solar production, and notifications about solar performance and maintenance.

Consumption Breakdown by Device

WattSaver provides a detailed breakdown of energy consumption by individual devices or categories, such as heating, lighting, and appliances. This feature enables users to identify the most energy-consuming devices in their homes.

Key features include device-specific consumption tracking, daily, weekly, and monthly reports on energy use, and the ability to compare consumption across different time periods.

Cost Simulation

Users can simulate how changes in energy use and the addition of new devices will affect their electricity bill. This feature is useful for planning future savings or estimating the impact of adding new devices to the household.

Key features include real-time cost estimates based on current energy rates, simulations of potential savings by reducing energy consumption, and alerts about billing changes due to increased or decreased usage.

Integration with Energy Providers

WattSaver connects with local energy providers to help users find the most cost-effective tariffs. This feature ensures users have access to the best energy plans available.

Key features include recommendations for cheaper energy plans, notifications when better plans are available, and a direct connection to switch energy providers.

2. Lo-fi prototype and heuristic evaluation

2.1 Project abridged description

WattSaver is a smart energy management application designed to help users monitor and optimize household energy consumption. The app provides device-level insights, enables control of smart appliances, and integrates with renewable energy systems like solar panels and batteries. Users can track energy usage trends and receive personalized suggestions to improve efficiency and reduce costs.

For Phase II, we prioritized the most critical features: managing smart appliances, monitoring energy consumption with insights, and diagnosing and addressing device issues to address key user needs and usability goals. To do so, the following three tasks were defined to evaluate the core functionalities of WattSaver. The wireflows and mockups presented in the following sections were created to support these tasks and ensure their usability.

The defined tasks are:

Activate the Fridge’s Super Mode

- **Task Description:** Users can activate the fridge’s "Super Mode" to make it cool faster during high-demand periods, providing a temporary boost in performance.

- **Functionality Supported:** Managing smart appliances and energy optimization.

View Daily/Monthly Energy Usage for the Fridge

- **Task Description:** Users can view detailed reports of the fridge's energy usage, either on a daily or monthly basis, to track and analyze consumption patterns. In addition, users can view energy consumption details for the entire house, either globally or broken down by category.
- **Functionality Supported:** Monitoring energy consumption with insightful data.

Analyze Fridge Issues for Proactive Maintenance

- **Task Description:** Users can diagnose potential issues with the fridge, such as abnormal energy usage and device malfunctions.
- **Functionality Supported:** Diagnosing device issues and enabling proactive maintenance.

2.2 Prototype's Wireflow

Main Pages

Our app provides a minimalist (initially, that can change depending on the user's preferences) interface with 3 main pages: Home, Energy, and Devices, as shown below.

The Home page is completely malleable and adjustable by the user. The user can select each widget that he prefers in order to access controllers, information, or simple toggle buttons to be presented on this Home Page.

Moving to the second main Page (Energy dashboard) we can select a specific device through the bottom scrollable bar in order to see its (monthly/daily/annual) consumption not only in Watts consumed but also the representative cost/worth generated in the case of energy generator devices.

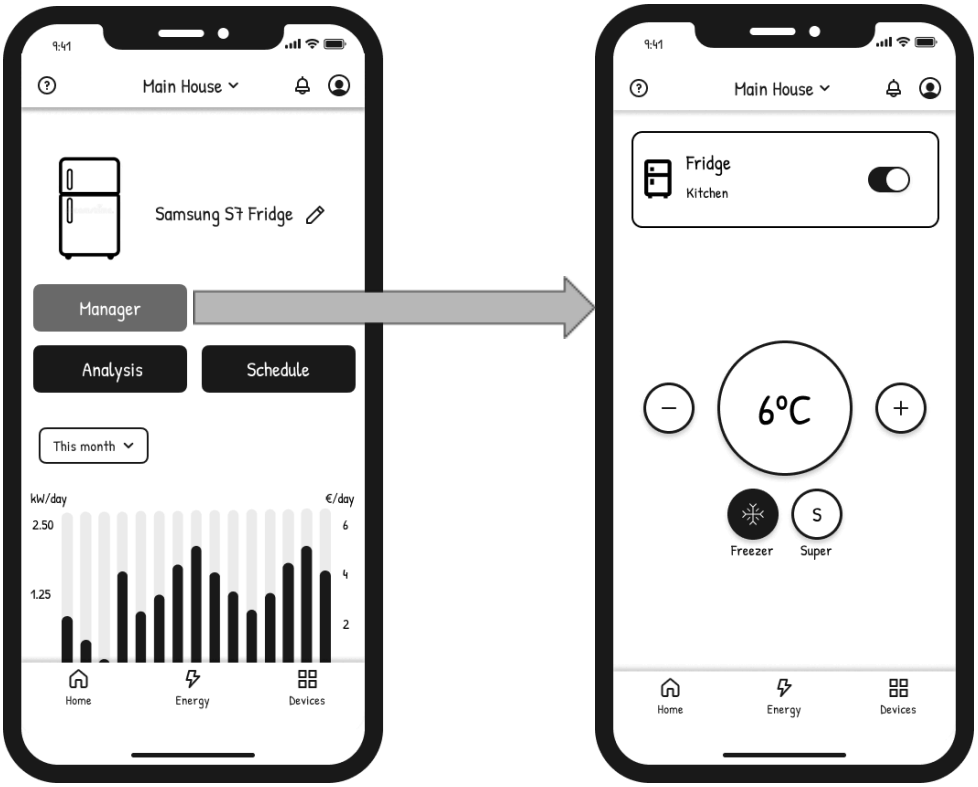
Lastly, we have the Devices Page which is a more technical page where the user can select, search, and browse and can switch between the on/off state of every device and even select it to enter the specific page of each device that will be presented down below.

Devices Wireflow

There are a few ways to access the device page, clicking on its widget (if there's any) in the Home Page or selecting it in the Devices Page. This will get the user into the device's specific page where the Manager, Analysis and Schedule buttons are accessible (we will look into them in a second). As well as in the Energy Dashboard we can also track its consumption in this Page. Let's take a look at the Wireflow of this page:

By selecting the "Analysis" button the user is redirected to a page where a detailed analysis of the device including concerning problems is presented (the app might also suggest ways of addressing the problem). The user also has the option to set a "Schedule" and set a start and end time for the device to turn on and off respectively.

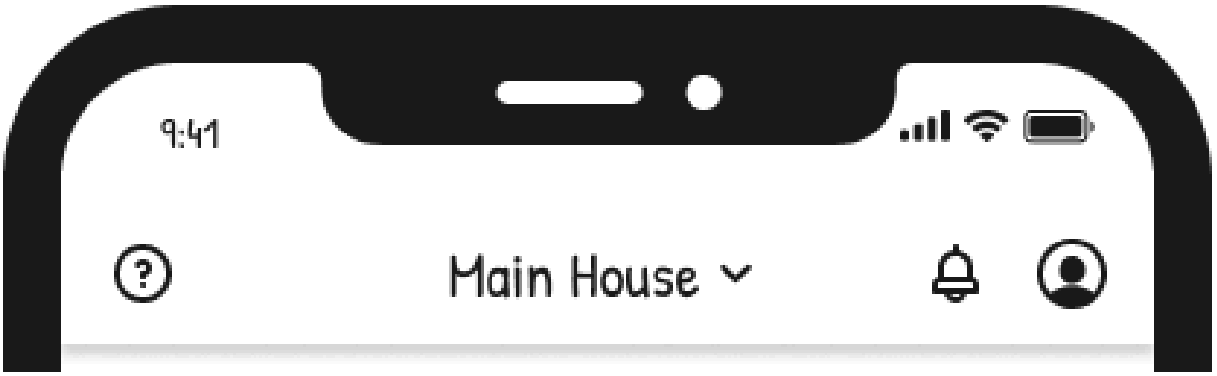
Furthermore, the user can select the “Manager” button:



This button redirects the user to the Manager of the device in question with specific controls and options for each device, for example in the fridge example the user can set the fridge to Freezer or Super mode as well as change its temperature and of course turn it on/off.

Additional features

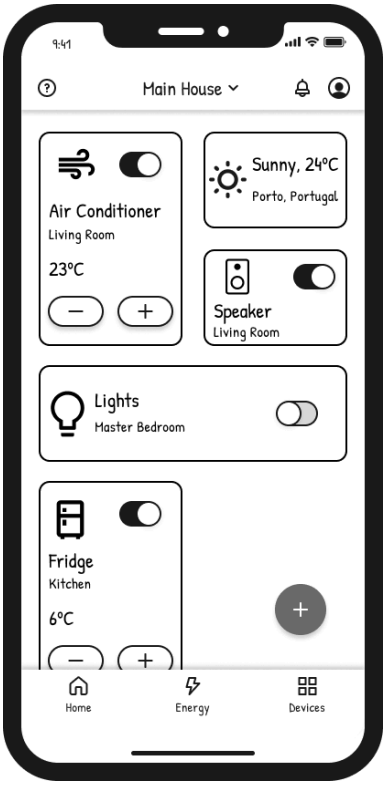
The app also offers some additional features which include the Help/Panic section, selection of the house (so that the user can have multiple houses and be able to control them all in only one app and session), notifications section (that present recent problems and other important aspects in consumption/generation of energy across the selected house) and finally the profile page which redirects the user to its profile page where personal info can be accessed and edited. These buttons are respectively the ones that appear in the top bar of our entire app as shown below:



(Help/Panic section, house selection, notifications and user profile)

2.3 Heuristic Evaluation Results

Evaluation of the Main Page



Regarding the homepage, two heuristics were identified: “consistency and standards” with a severity level of 3, and “aesthetic and minimalist design” with a severity level of 2.

In terms of consistency and standards, it was noted that the widgets lack uniformity in size, orientation, and layouts. For example, some widgets, such as the air conditioner widget, are larger, while others, like the speaker widget, are smaller. Additionally, certain widgets, like the fridge widget, are vertical, whereas others, such as the lights widget, are horizontal, disrupting the visual flow. This lack of uniformity can cause confusion for users.

Regarding aesthetic and minimalist design, it was noted that the excess of information, combined with a dynamic layout that changes over time based on the devices, makes the page appear overly cluttered and difficult to navigate, leading to a frustrating user experience.

Evaluation of the Energy Page

Regarding the energy page, the identified heuristic was "recognition rather than recall," with a severity level of 2.

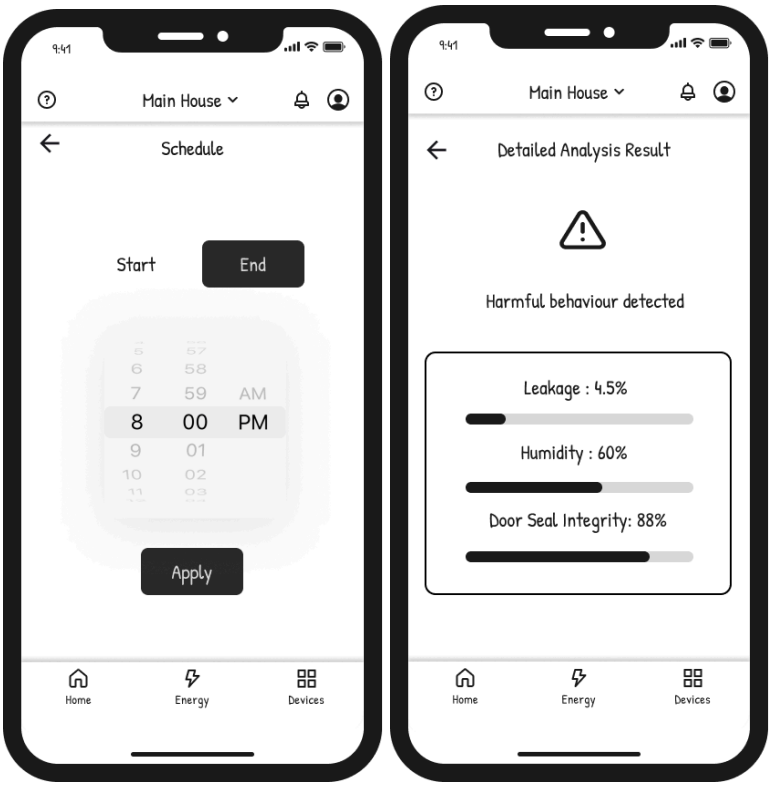
This issue stems from the potential confusion caused by the selection field at the top of the page displaying "Main house," while the scrollable bar at the bottom highlights a specific device. This discrepancy may confuse users and make it unclear that the graph refers to the selected device.

Evaluation of the Device Manager Page

On the Device Manager Page, the identified heuristic is “User Control and Freedom,” with a severity level of 3.

The issue observed is the absence of a "Go Back" button or navigation option. This limitation makes it challenging for users to return to the previous state, disrupting the application's user flow and leading to a less intuitive experience.

Evaluation of the Device Analysis and Device Schedule Pages



On the Device Analysis Page and the Device Schedule Page, the identified heuristic is “Recognition rather than recall,” with a severity level of 1.

The issue arises from the lack of information about the specific device being analyzed on these pages. Providing clear device details is essential to reduce the user’s memory load and improve task clarity. However, since these pages can only be accessed through a specific device page, the severity of this issue is relatively minor.

2.4 Corrections to perform in Phase 3

With the results of the Heuristic Evaluation, we have decided to implement the following changes to our app’s pages:

Main Page

The results determined that the main page was too dynamic and cluttered due to the fact that the addition of each new widget increases the options for the user and the number of choices they can make regarding the widget configuration. This leads to the concern that the user might become confused due to the complexity of the page.

The size, shape, and amount of widgets on this page are fully customizable by the user. Because the layout is entirely up to the user, the page can be as dynamic or streamlined as someone wants, allowing for a design that perfectly suits anyone's needs.

For this reason, we decided that we would not change the main page's layout entirely. Instead, we are going to add some tooltips to help new users understand how the page works so they can make their own customizations, allowing for a layout the user is comfortable with.

Energy Page

In the case of the energy page, we decided that the presence of the device being highlighted in the middle of the page, below the dashboard is enough to combat the problem. Furthermore, the user can change what device's energy info they are seeing by selecting another device in the options below the dashboard.

Device Manager Page

The issue noticed on this page is very simple to fix, we will simply add a "Go Back" button that allows the user to go back to the previous page.

Device Analysis Page

Regarding the Device Analysis page, to combat the confusion the user might have about which device they are analyzing we concluded that this page would need a breadcrumbs navigation system that the user can easily use to never lose that information and to also go back to the device's Device Page.

Due to the same problem, we decided that this system would also need to be implemented in all the other subpages of the Device Page.

3. Hi-fi prototype and user evaluation

3.1 Changes to Parts I and II

Part I

Reorganized most of the contents of the report.

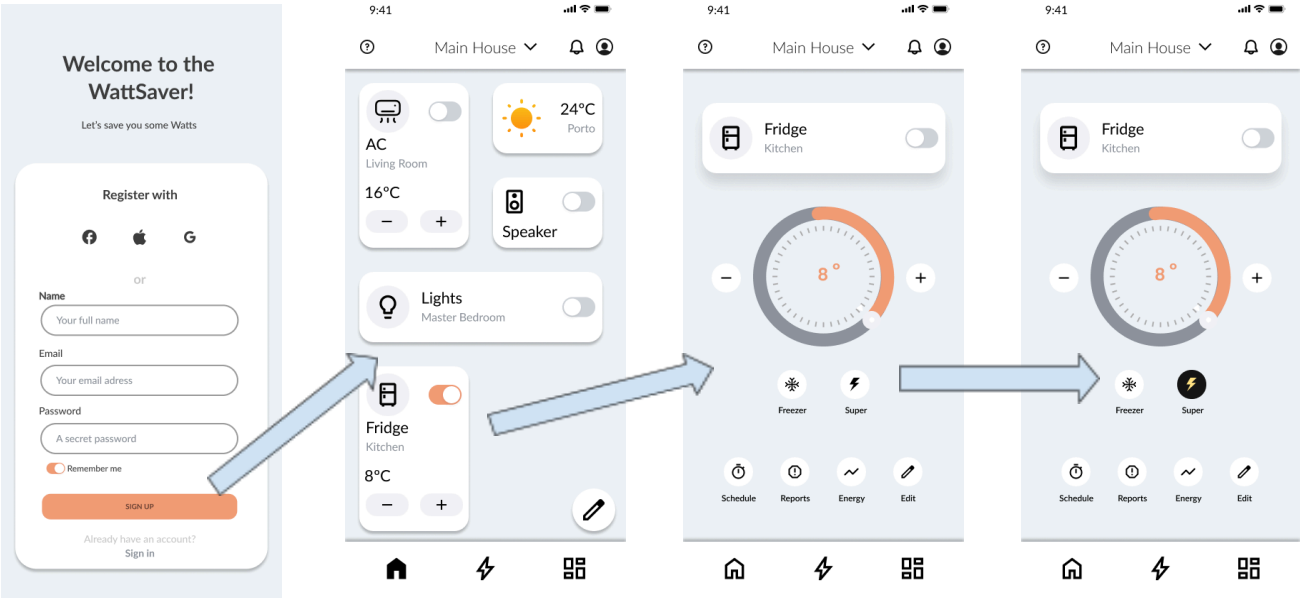
Part II

In section 2.4, we decided that adding a label to the top of the dashboard would not be necessary since the page already shows what device the dashboard is referring to as it highlights the chosen device in the middle of the page, below the dashboard.

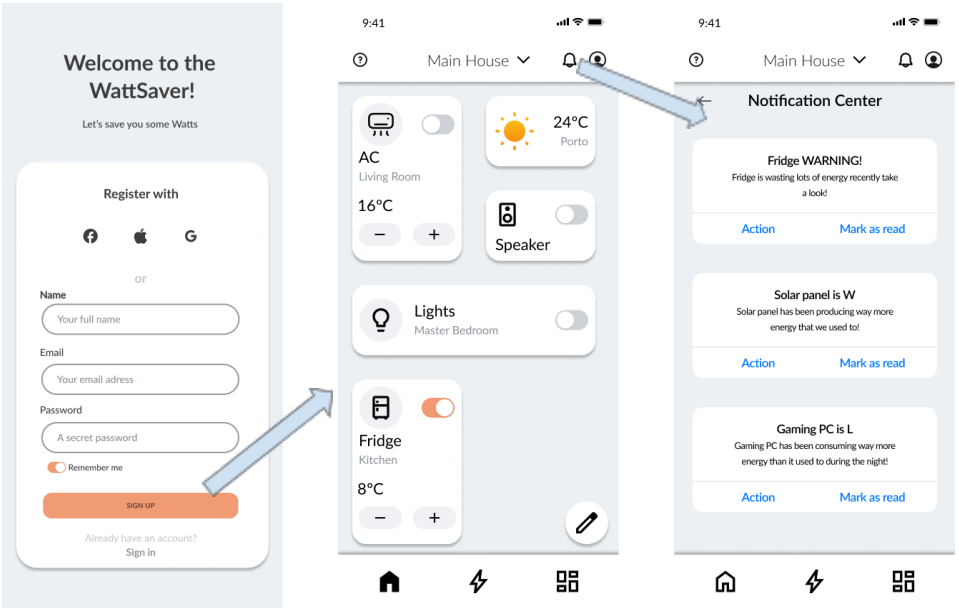
3.2 Prototype's Wireflow

[Live Version of WattSaver]

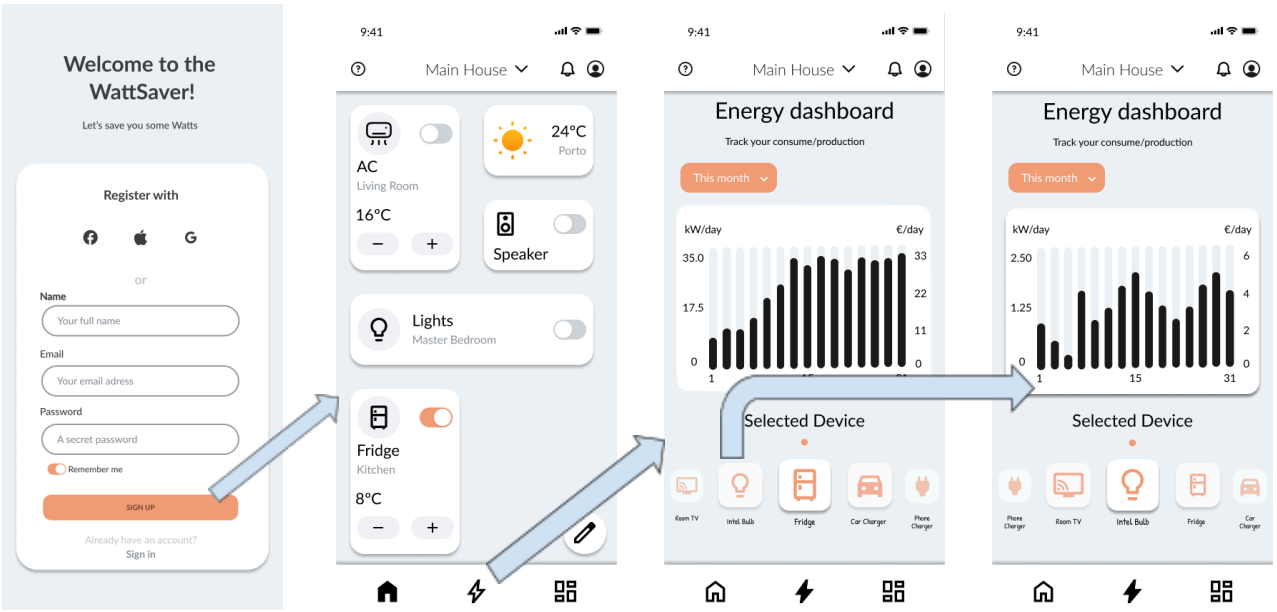
Turn on the Super mode on the fridge



Check what's wrong with the fridge through the notifications



Check monthly energy consumption of Intel Bulb



3.3 User Evaluation Protocol

The objective of the evaluation is to understand the users' vision of WattSaver in regards to usability and efficiency when performing tasks.

To run this evaluation, we integrated our app into Maze and asked users to answer our questions and try to complete the given tasks. The evaluation process consisted of four main parts: firstly, users were asked some general questions such as their age and tech savviness. Next, we gave the users access to the app for an indefinite amount of time to understand how it worked. After that, users can perform the tasks we proposed and in this phase, Maze saves important stats about the users' actions such as misclicks and time to complete. Finally, the users are given some fast satisfaction questions about their experience. All user statistics are saved anonymously.

The users who were chosen to be part of the evaluation were part of a very wide range of ages, from young adults to people above 60, but most of them were below the age of 30. All of them were asked to perform these tasks voluntarily.

We firstly introduced the app, our visions, and the problems we aim to solve with our app to the users. Then we asked them to use our Maze link to perform all of the tasks. Completing the tasks or answering our questions was not mandatory, but most users completed everything.

Task 1 - Turning on the fridge's super mode

In this task, we ask the user to navigate into the fridge's Device Page and to press the Super button which activates the super mode.

Measurements

During the task realization, Maze stores the following statistics:

- Total time to complete the task
- Number of clicks
- Number of errors (misclicks) made

These statistics are used to evaluate the efficiency and efficacy of the app when performing the task. Efficacy is linked to the ratio of misclicks compared to total clicks, increasing when the ratio decreases. Efficiency depends directly on the time it takes to complete the task, meaning that the efficiency increases when the total time decreases. Satisfaction will be evaluated at the end, after the tasks are completed.

Expectations

- Maximum time to complete: 20 seconds;
- Maximum number of errors by a user: 3 errors;
- Maximum number of clicks: 5 clicks.

Task 2 - Checking what is wrong with the fridge through notifications

In this task, the user must use the notifications page to reach the fridge reports.

Measurements

During the task realization, Maze stores the following statistics:

- Total time to complete the task
- Number of clicks
- Number of errors (misclicks) made

Similar to the previous task, statistical analysis will allow us to make conclusions about efficiency and efficacy. Satisfaction will be evaluated in the end.

Expectations

- Maximum time to complete: 20 seconds;
- Maximum number of errors by a user: 3 errors;
- Maximum number of clicks: 6 clicks.

Task 3 - Check monthly energy consumption of Intel Bulb

In this task, the user must go the the Energy Page and switch the view to the Intel Bulb.

Measurements

During the task realization, Maze stores the following statistics:

- Total time to complete the task
- Number of clicks
- Number of errors (misclicks) made

Similar to the previous task, statistical analysis will allow us to make conclusions about efficiency and efficacy. Satisfaction will be evaluated in the end.

Expectations

- Maximum time to complete: 20 seconds;
- Maximum number of errors by a user: 6 errors;
- Maximum number of clicks: 12 clicks.

Satisfaction Questionnaire

In order to evaluate the subjective and qualitative aspects of our app, users are prompted with a quick satisfaction questionnaire after completing every task.

This questionnaire consisted of several affirmations, where the user would select the ones they agree with. These questions were a modified and simpler version of the ones on the SUS (System Usability Scale) where a user is enquired on their opinion of the app, and overall experience.

The questionnaire takes less than 1 minute to answer and all the data gathered is completely anonymous and will be used in order to improve our interface.

3.4 Results

Sample characterization

A total of 21 users were invited to participate in the study. The majority expressed interest in the app, with most being under 30 years old and having some familiarity with technology.

Statistical analysis

Task 1 - Turning on the fridge's super mode

Total time to complete the task

The completion time for Task 1 is characterized by the following statistical measures:

- Maximum Expected Value: 20 seconds
- Mean Completion Time: 12.7 seconds
- Confidence Interval: The mean is estimated to fall within a range of [9.322, 16.078] seconds, with a ±3.378-second margin (representing a ±26.6% variation from the mean).

Given the confidence interval, we can assert that there is a 95% probability that the true completion time for Task 1 will fall within this range, the variation from the mean is also quite reasonable so most likely the value will only go over 20 in very rare scenarios.

Number of Errors

The Number of Errors for Task 1 is characterized by the following statistical measures:

- Maximum Expected Value: 3
- Mean Number of Errors: 0.947
- Confidence Interval: The mean is estimated to fall within a range of [-0.189, 2.084], with a ±1.136 error margin (representing a ±119.9% variation from the mean).

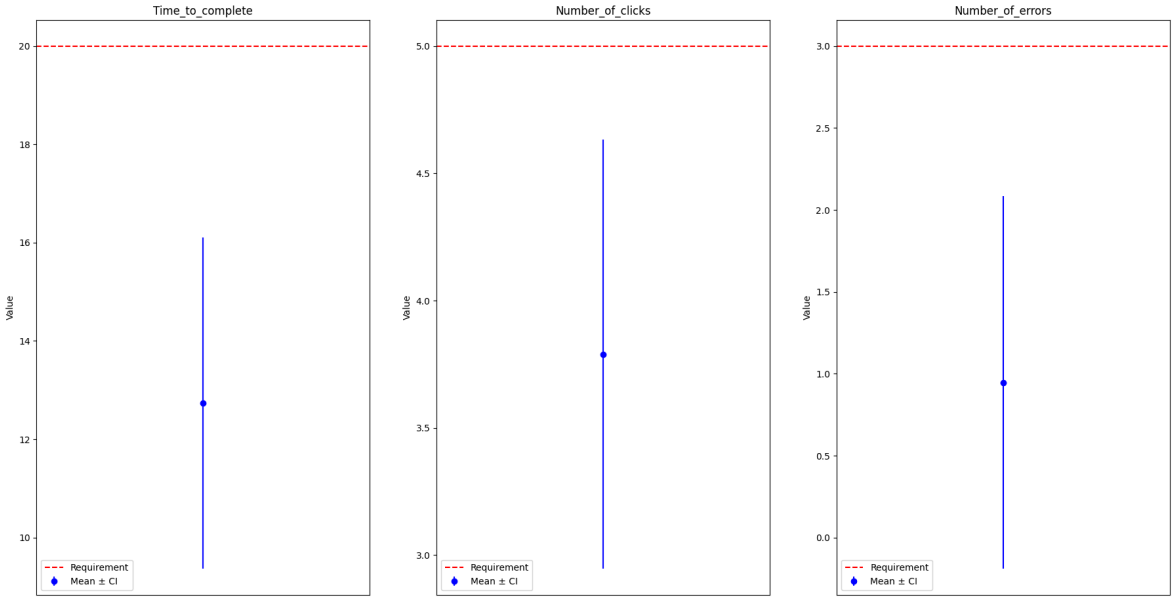
Given the confidence interval, there is a 95% probability that the actual number of errors will fall within this range even though there variation from the mean is quite high.

Number of Clicks

The Number of Clicks for Task 1 is characterized by the following statistical measures:

- Maximum Expected Value: 5
- Mean Number of Clicks: 3.789
- Confidence Interval: The mean is estimated to fall within a range of [2.947, 4.632], with a ±0.842 margin (representing a ±22.2% variation from the mean).

With this confidence interval, there is a 95% probability that the true number of clicks will fall within this range and the variation from the mean is also quite low.



Task 2 - Checking what is wrong with the fridge through notifications

Total Time to Complete the Task

The completion time for Task 2 is characterized by the following statistical measures:

- Maximum Expected Value: 20 seconds
- Mean Completion Time: 13.27 seconds
- Confidence Interval: The mean is estimated to fall within a range of [9.257, 17.277] seconds, with a ±4.01-second margin (representing a ±30.2% variation from the mean).

There is a 95% probability that the true completion time will fall within this range, indicating a reasonably efficient task with small variation.

Number of Errors

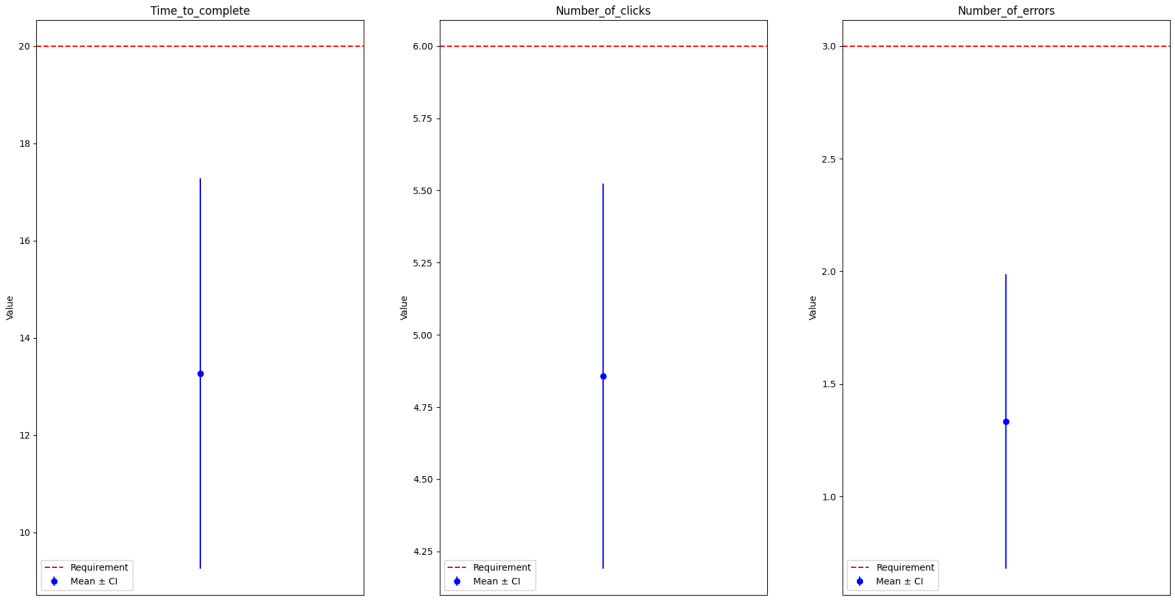
- Maximum Expected Value: 3
- Mean Number of Errors: 1.33
- Confidence Interval: The mean is estimated to fall within a range of [0.680, 1.987] errors, with a ±0.654 error margin (representing a ±49.2% variation from the mean).

With 95% confidence, the actual number of errors will likely fall within this range. The error rate shows some uncertainty, but the task still performs effectively in the vast majority of cases.

Number of Clicks

- Maximum Expected Value: 6
- Mean Number of Clicks: 4.86
- The mean is estimated to fall within a range of [4.19, 5.52] clicks, with a ±0.66 margin (representing a ±13.6% variation from the mean).

The 95% confidence interval suggests the actual number of clicks will fall within this range, indicating that the task requires a reasonable amount of interaction, with manageable variation.



Task 3 - Check monthly energy consumption of Intel Bulb

Total Time to Complete the Task

The completion time for Task 3 is characterized by the following statistical measures:

- Mean Completion Time: 14.75 seconds
- Confidence Interval: The mean completion time is estimated to fall within a range of [10.18, 19.32] seconds, with a margin of ±4.57 seconds (representing a ±31.0% variation from the mean).
- Maximum Expected Value: 20 seconds

The confidence interval indicates a 95% probability that the true completion time will fall within this range, suggesting a moderate level of efficiency for this task. The completion time is within the acceptable requirement of 20 seconds.

Number of Errors

The number of errors for Task 3 is characterized by the following statistical measures:

- Mean Number of Errors: 3.33
- Confidence Interval: The mean number of errors is estimated to fall within a range of [0.72, 5.95] errors, with a margin of ±2.61 errors (representing a ±78.4% variation from the mean).
- Maximum Expected Value: 6 errors

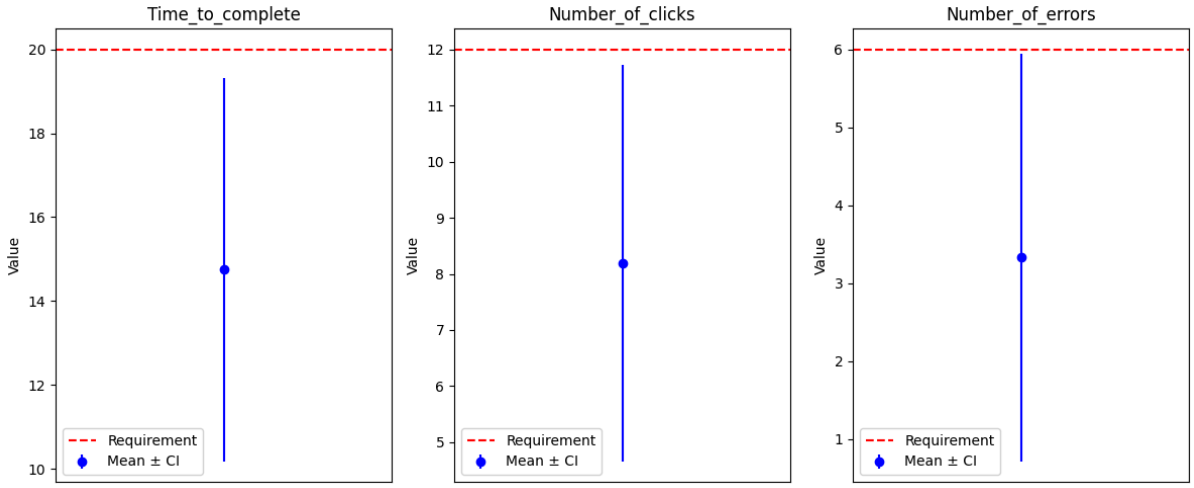
The confidence interval suggests a 95% probability that the true number of errors will fall within this range. Despite some variation, the number of errors remains below the acceptable threshold of 6, indicating task effectiveness.

Number of Clicks

The number of clicks required for Task 3 is characterized by the following statistical measures:

- Mean Number of Clicks: 8.19
- Confidence Interval: The mean number of clicks is estimated to fall within a range of [4.66, 11.72] clicks, with a margin of ±3.53 clicks (representing a ±43.1% variation from the mean).
- Maximum Expected Value: 12 clicks

The confidence interval ensures a 95% probability that the true number of clicks will fall within this range. The task's click requirement is within the acceptable range of 12 clicks, ensuring its feasibility.



Discussion

Overall, the performance across all tasks was acceptable, with results meeting the requirements at a 95% confidence level. However, one notable anomaly was observed in Task 3, where the number of misclicks was nearly double that of the other tasks. This was particularly surprising given that the average completion time for Task 3 was comparable to the other tasks, showing negligible differences.

This discrepancy suggests that while users were able to complete Task 3 in a similar amount of time, the higher rate of misclicks may indicate issues with the task's interface, design, or instructions.

3.5 Conclusion

In conclusion, we believe we successfully created an interface for the app that is both intuitive and user-friendly, catering to the needs of most potential users. Through this process, we gained valuable insights into transforming the original mockups into a concrete design, leveraging user data, surveys, and user testing to guide our decisions.

Ultimately, great UI design revolves around a deep understanding of the user, what they need, what they want, and how best to present our services to them in a way that feels natural and accessible.

4. Annexes

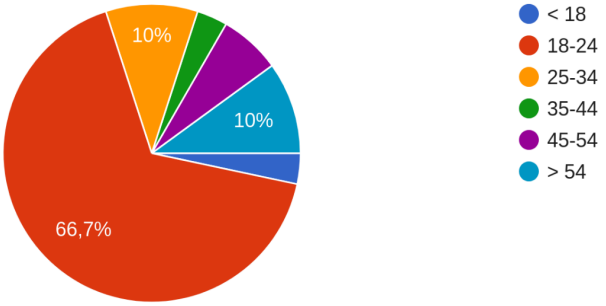
4.1 Questionnaire

https://forms.gle/5UVnRU4umR4WpnxM9

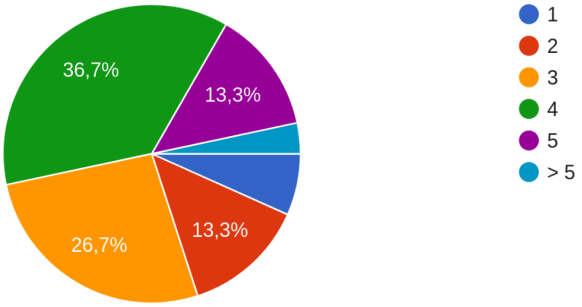
4.2 Summary of results

https://docs.google.com/spreadsheets/d/1g_s1nQfsXvqEg4G4ZU9b1DiqdojwSQ4r_kUCKzwWK78/edit?usp=sharing

Qual é a sua faixa etária?
30 respostas

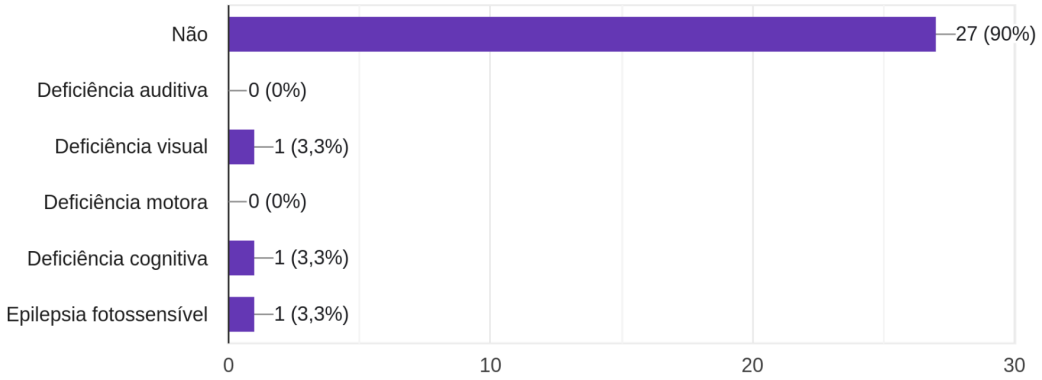


Quantas pessoas existem no seu agregado familiar?
30 respostas



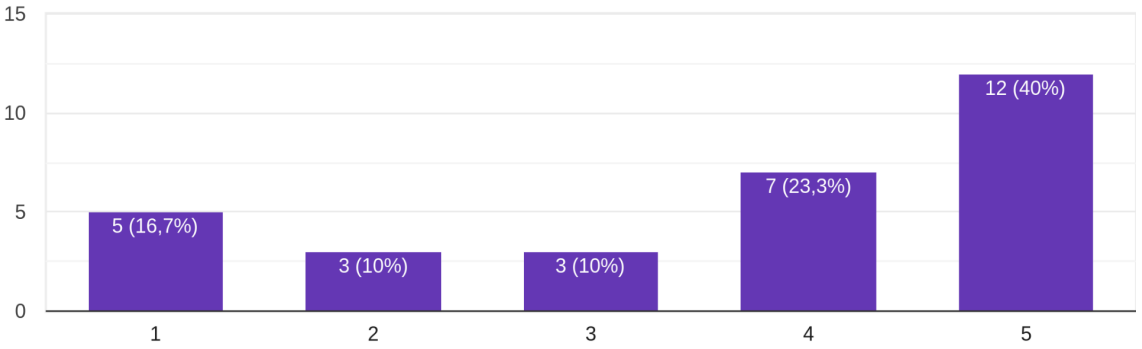
Possui alguma deficiência ou condição que possa afetar a utilização de uma aplicação mobile?

30 respostas



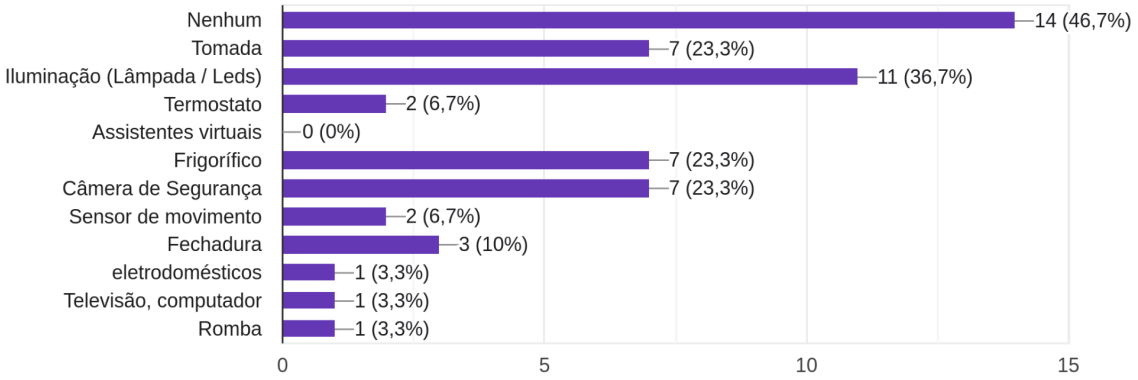
Quão confortável está em utilizar aplicações mobile para gerir dispositivos inteligentes?

30 respostas



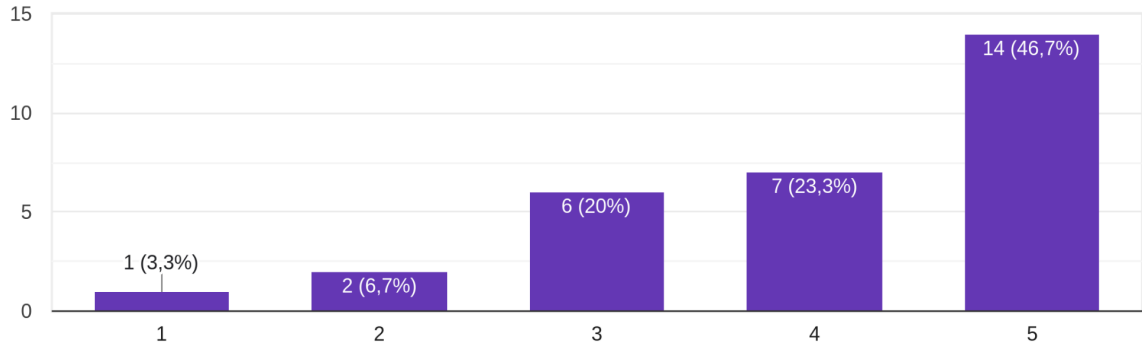
Que dispositivos inteligentes possui?

30 respostas



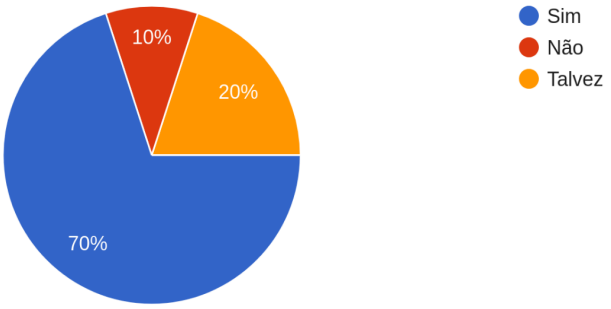
Quão importante para si é reduzir a sua pegada ecológica?

30 respostas



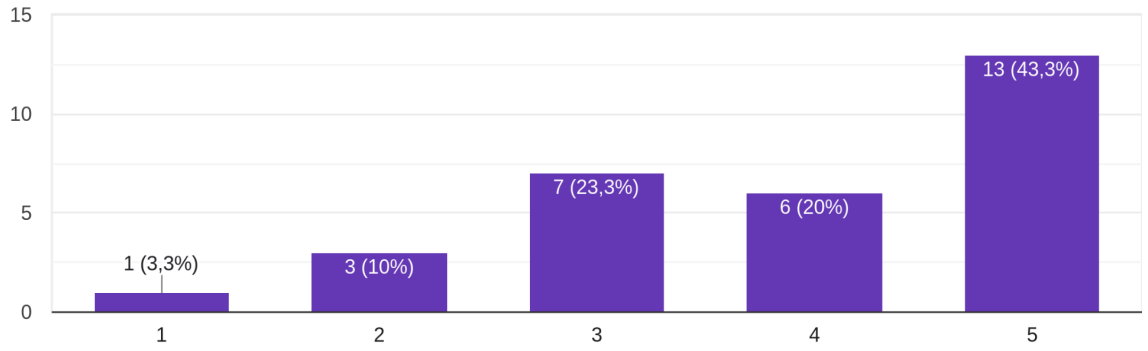
Estaria interessado em poder monitorizar o consumo de energia de cada dispositivo / eletrodoméstico que possui?

30 respostas



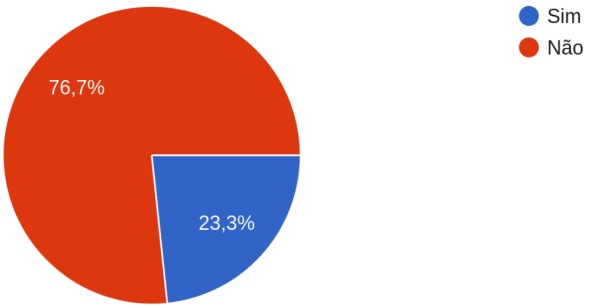
Quão importante é para si reduzir os seus gastos com energia?

30 respostas



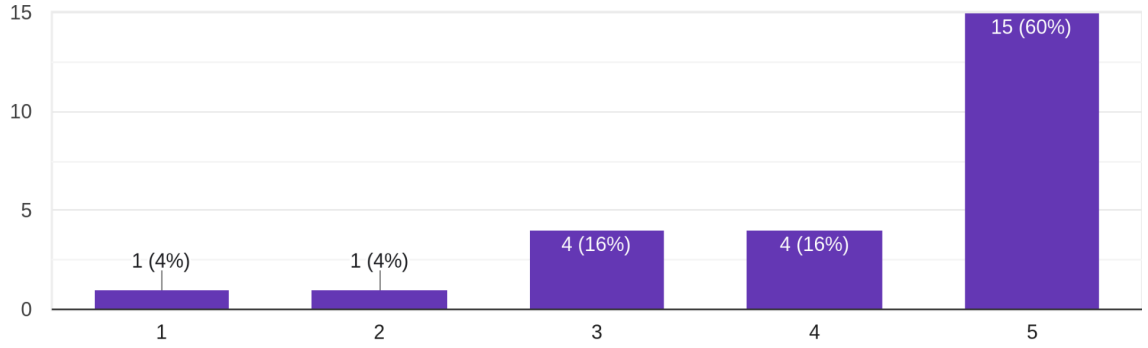
Possui painéis solares em casa?

30 respostas



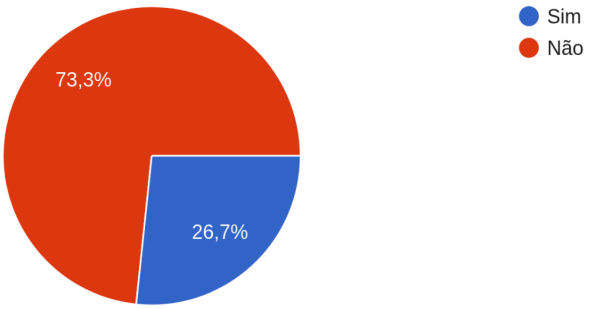
Caso tenha ou planeie ter painéis solares, quão importante é poder monitorizar a sua performance em tempo real?

25 respostas



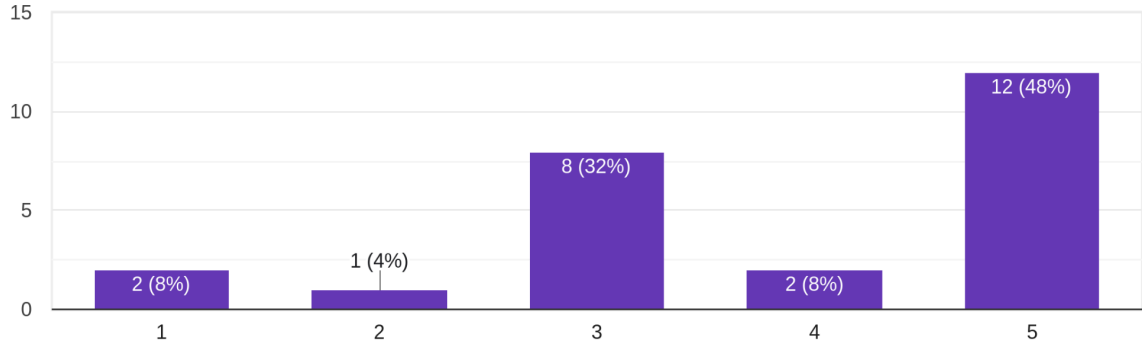
Possui baterias em casa?

30 respostas



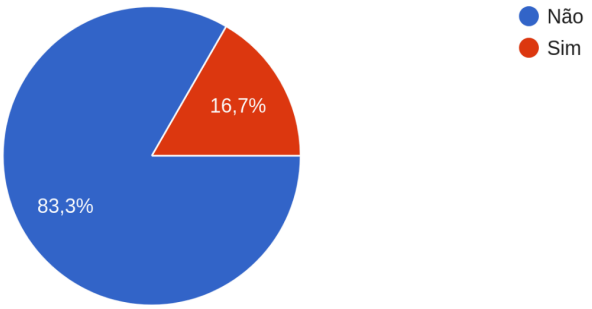
Caso tenha ou planeie ter baterias, quão importante é poder monitorizar a velocidade de carga / descarga?

25 respostas



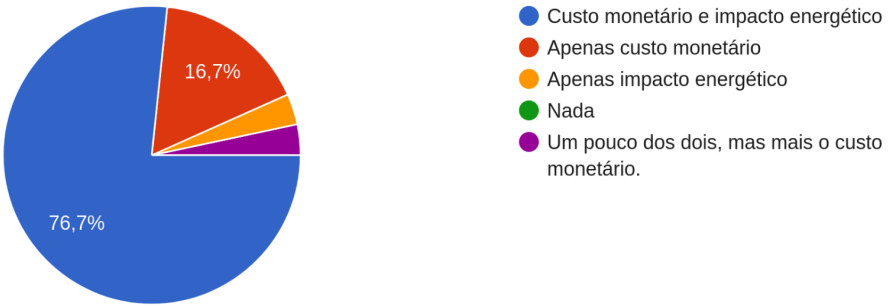
Utiliza algum sistema para acompanhar o consumo de energia?

30 respostas



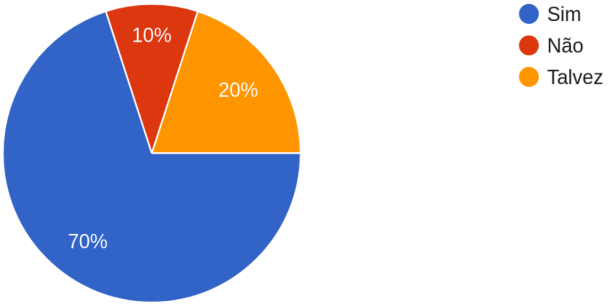
Na compra de um novo equipamento, o que tem em consideração?

30 respostas



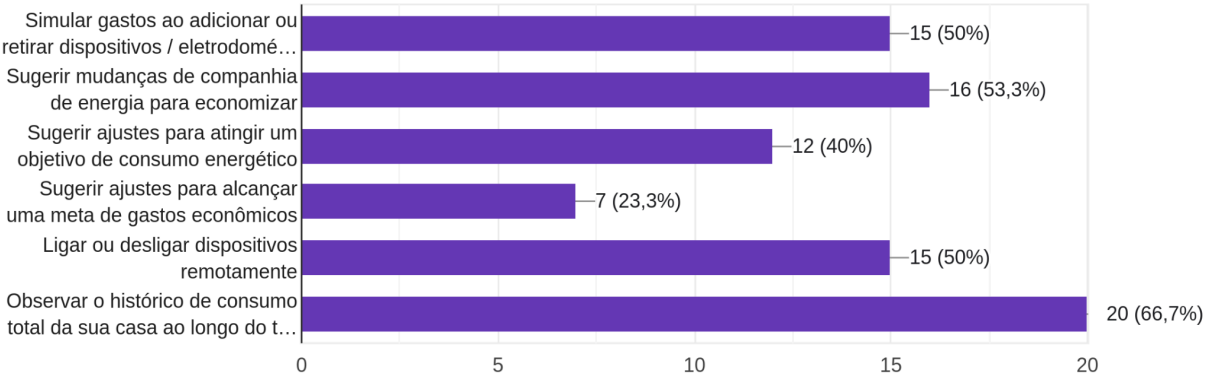
Usaria uma aplicação que facilitasse o controlo dos seus gastos energéticos?

30 respostas



Quais destas funcionalidades considera útil? (Selecione no máximo 3)

30 respostas

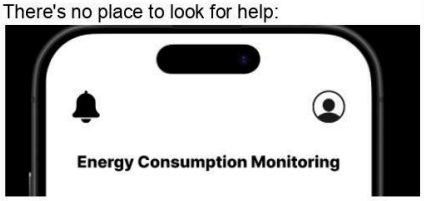
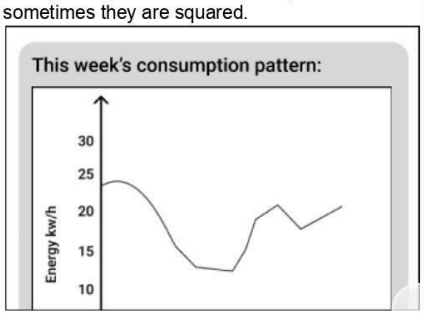


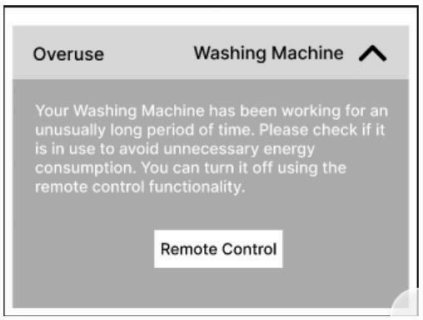
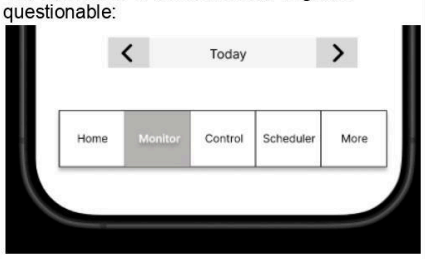
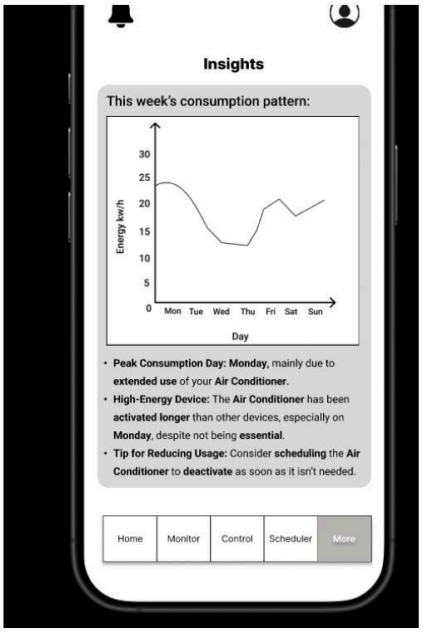
4.3 Sent Heuristic Report

HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC04 - 12/11/2024 - Thiago Sobral
Group evaluated: 04 - LumiNest
By group: 03

Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	There's no place to look for help: 	10	1
2	The card shape is not consistent. Sometimes the cards are rounded, and sometimes they are squared. 	4	2

			
3	The aesthetics of the bottom bar might be questionable: 	8	2
4	More page is vague and the name “more” is not technical:	2	2
			
5	There isn’t a button to exit some pages, like the profile page. Clicking the navigation bar to leave the profile doesn’t feel right.	3	3


Profile
Username: Placeholder
Email: Placeholder
Edit
Logout
Home
Monitor
Control
Scheduler
More

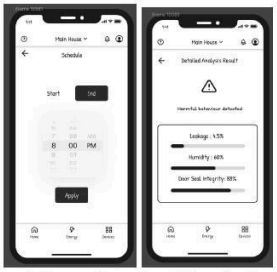
4.4 Received Heuristic report

HCI Winter Semester 2024 - 2025

Heuristic Evaluation Report

Class Nr.: LEIC04 - 12/11/2024 - Thiago Sobral
Group evaluated: 03 - WattSaver
By group: 07

Problem #	Issue (include screenshot)	Heuristic(s)	Severity (1-4)
1	 The design is not consistent, because there is a lot of information that is being displayed with different layouts, making it hard to understand at a first glance.	4	3
2	 There should be a back button to make sure the user can easily return to the previous state in case he advanced by mistake.	3	3

3	 For a home page, it feels bloated and unpleasant to look at due to the many different items with inconsistent shapes and layouts, all clustering the page.	8	2
4	 There is no information about the device we are dealing with on these two pages. Providing this information is crucial to reduce the user's memory load and clarify the task. However, since these pages are only accessible through a device page, this issue is relatively minor.	6	1
5	 It isn't clear what this dashboard is referring to. This is the energy tab main page and on top of the screen there's the title "Main house", but below the graph there's a panel with a list of devices with one selected, making it confusing which data is being displayed. The device page also features a similar graph, adding to the confusion.	4	2

4.5 WattSaver Live Version

https://www.figma.com/proto/znUlYVgjC6hZv3puRubRMY/IPC-WattSaver?node-id=287-3007&p=f&t=V4gH3QmPGKCdlBX3-1&scaling=scale-down&content-scaling=fixed&page-id=262%3A3706&starting-point-node-id=262%3A3815&show-proto-sidebar=1