ElectroCap Mid-Program Pitch Deck

Intelligent Post Box:
A remote monitoring solution for residential buildings

TÉCNICO LISBOA

Team

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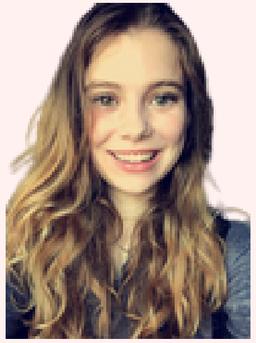
Advisors and Mentor

Coordinator:
Prof. Duarte Mesquita e Sousa

PhD Program in Electrical and Computer Engineering



Mentor:
Miriam Demasi

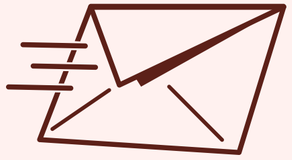
Master’s in Energy Engineering and Management

Problem Definition

Managing post box access and tracking incoming mail can be challenging.

Missed deliveries

Unnecessary trips to the mailbox



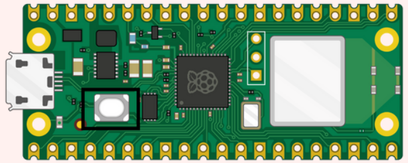
Issues with lost or stolen mail

No effective system to remotely track the status of their post boxes

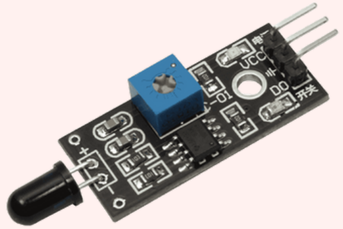
Lack of real-time monitoring

Many postal services and residents are looking for **innovative** ways to improve mail delivery and tracking, creating an opportunity for an intelligent, automated system.

Technological solution

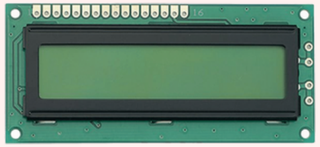


Raspberry Pi Pico W - Microcontroller that controlls the camera and smart lock.



Infrared sensor - Checks if there is a letter or package in the mailbox.

3*4 keypad module - For opening the door.

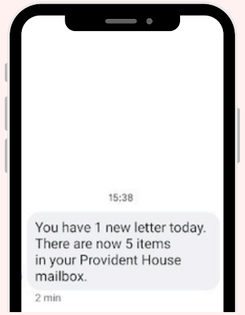


LCD Display - Shows the password, delivery instructions .

The PIR motion sensor - Detects movement by sensing infrared radiation changes

OV2640 Camera - Identifies the delivery, safety purpose.

GPRS GSM SIM800L module - Wireless communication



Application with notification system

Plan A

12V DC solenoid electric lock
Step down converter

Plan B

Servo motor

Plan C

Electromagnetic Solenoid

Project Costs

Plan A

With the door lock system → **194,29 €**

Plan B

With servomotors instead of the door lock system → **161,49 €**

With servomotors but without wood → **89,59 €**

Plan C

With solenoids instead of the door lock system → **178,13 €**

With solenoids but without wood → **106,23 €**

Competitors and previous work

COMPETITORS

- Super e-Technology Services Limited;
- The Safety Letterbox Company LTD;
- Handover;
- ShipRite;
- Locky;

PREVIOUS WORK

- Parcels Boxes

Our project is different from the others in terms of:

PRICE

Cheaper because of the simpler materials

ENERGY

Consumption is lower because of the materials used

OPTIONS

The customer can choose whether they want a complete box, just the camera and sensors or just the camera added or just the sensor.

Solution requirements

Mail Delivery Detection

The system reliably detects mail delivery to individual post boxes and sends real-time notifications via a mobile app. These alerts include delivery timestamps and mailbox status updates, ensuring residents remain informed without the need for frequent physical checks.

Low Maintenance

Hardware featuring self-diagnostic sensors and modular smart locks minimizes battery replacements and manual repairs while emphasizing affordability through cost-effective materials, scalable pricing, and low maintenance costs.

Battery efficiency

Components designed for 12–24 months on a single charge minimize upkeep, while weather-resistant construction—with durable materials and protective coatings—ensures reliable performance under extreme conditions (-20°C to 50°C, humidity, rain, or dust).

Technical challenges

- **Hardware Challenges**

1. Ensuring sensors detect varying mail sizes, weights and materials accurately;
2. Battery life must last 12-24 months on a single charge;
3. The hardware must perform reliably in extreme conditions (-20°C to 50°C, humidity, physical wear);
4. Compatible with existing mailboxes for seamless retrofitting without significant structural modifications.

- **Software Challenges**

1. Realtime updates despite possible unstable connections;
2. Intuitive interface for all skill levels as well as multilingual support;
3. Secure and reliable updates without disrupting usability.

- **Communication challenges**

1. Reliable wireless connection, even in highly populated zones with congestion and interference;
2. Seamless data synchronization between sensors, cloud servers and mobile app;
3. Managing bandwidth efficiently to avoid delays or performance bottlenecks.

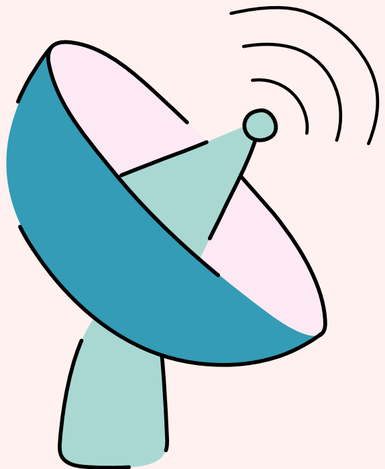
- **Scalability challenges**

1. Supporting hundreds to thousands of users in a single building, without compromising performance or responsiveness;
2. Cloud infrastructure capable of handling growing amounts of data.

Partners

Some companies that we would like to work with are:

- CTT (Correios de Portugal);
- Other private courier companies;
- Smart home and IOT companies;
- Security companies;
- Telecommunication providers, to ensure more reliability in the systems such as network connectivity and cloud services;
- Hardware manufacturers, to have good sensors and smart locks.



Testing and validation metrics

Functional

Requirement Coverage, Defect Detection Rate, Pass/Fail Rate

Perfomance

Response Time, Throughput, Scalability

Perfomance

Task Completion Rate: Percentage of packages successfully detected and notified; Percentage of times where the smart lock opens.
Time on Task: Time taken to send a notification since a new package is detected.

Division of labor (I)

Ludmylla Wonsoscky

Eletronics Engineer

- Circuit Design and Programming
- CAD - 3D Modeling
- Mailbox Prototype Design

Carolina Lopes

Eletronics Engineer

- Application Design
- System Integration
- Mailbox Prototype Design

Chencheng Liu

Hardware-Software Integration Engineer

- Communication Between Systems
- Hardware Programming
- Sensor and Lock Testing

Division of labor (II)

Beatriz Moreira

Front-end Developer

- Website Development
- Blog Updates
- Application development

Sofia Nunes

Back-end Developer

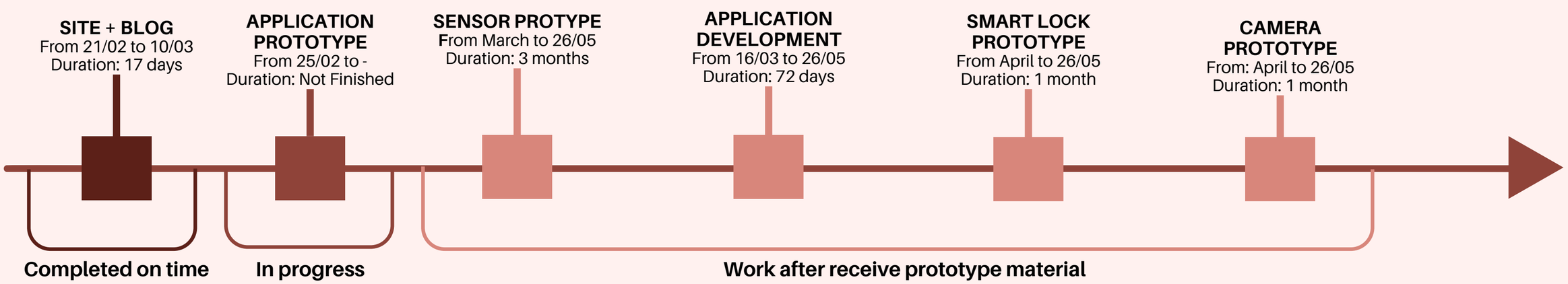
- Application Development and Design
- Notification System
- Database Development

Pedro Yin

Eletronics Engineer

- Hardware Design
- Hardware Development
- Mailbox Tester

Original schedule



- Completed
- In Progress
- Behind Schedule

Achieved results

For this project, we selected the Raspberry Pi Pico W as the main microcontroller based on several key factors:

→ A **low-cost** solution was essential for economic viability. Pico W offers a much lower price than alternatives like the ESP32

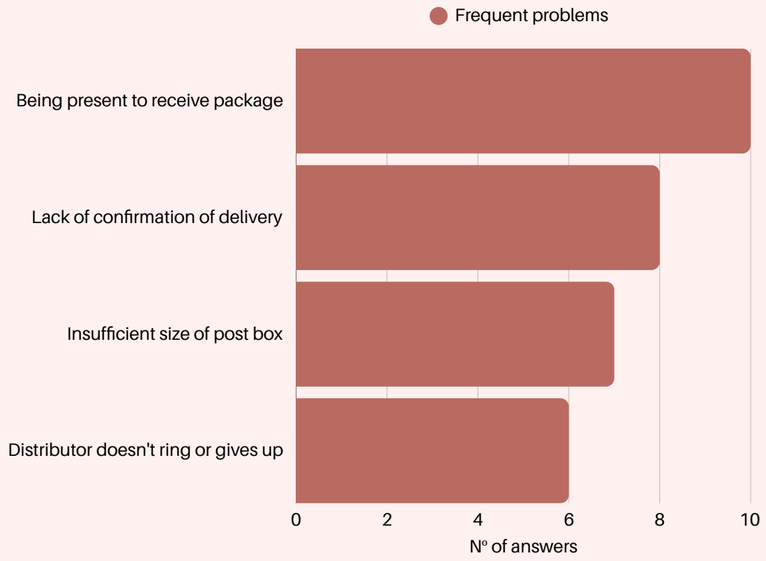
→ It has built-in **Wi-Fi**, sufficient for sending delivery notifications to the recipient's mobile app.

→ Take a photo of the delivered parcel
→ Potentially identify the parcel
→ Send the image to the recipient via the app
→ Adds **security** and user convenience

→**Low power consumption** makes it ideal for lowering total power usage for sustainability and autonomy

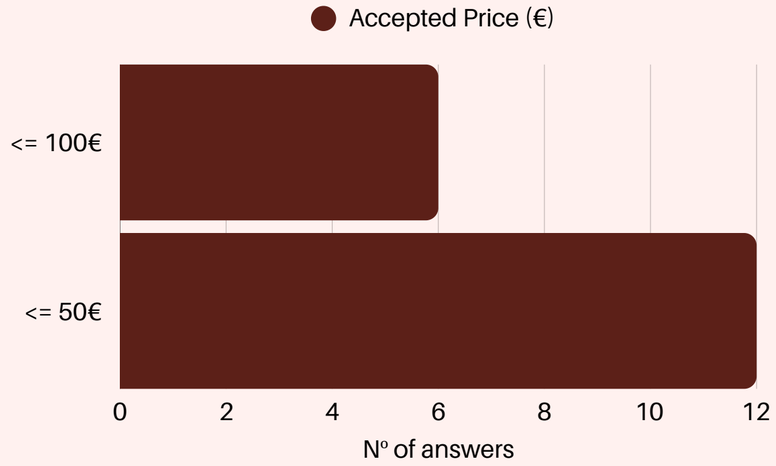
Interviews through Forms

We created a form to collect more opinions about the problems with the current delivery system and to find out which parts of our solution are valued. Here are some of the responses we received:

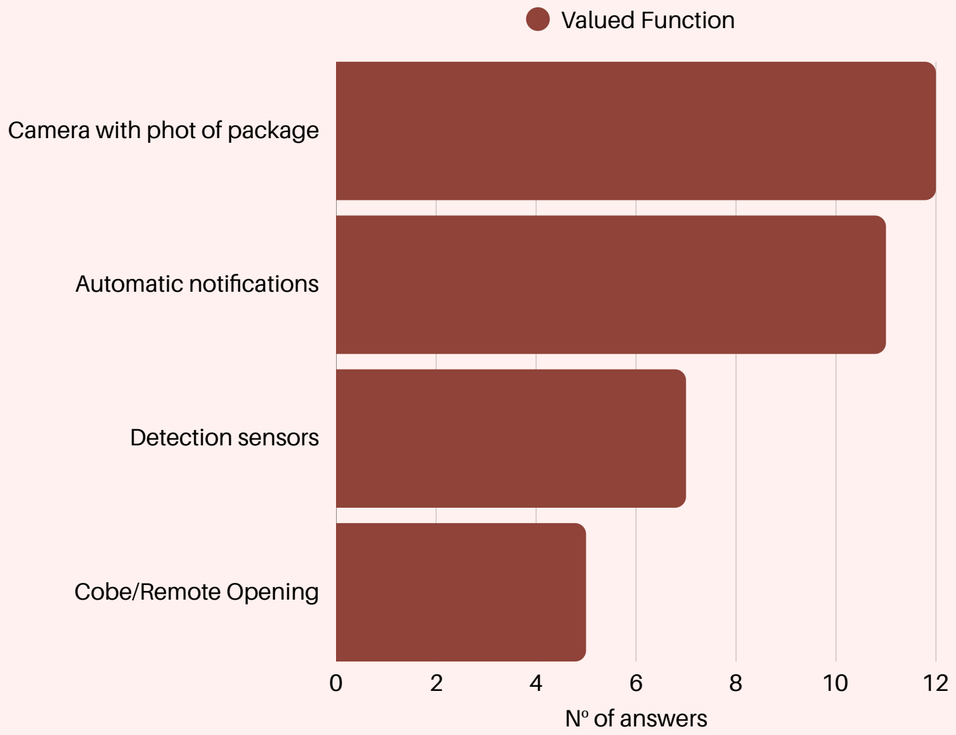


We believe our project will help solve the problems in the graphic on the left, either directly, by having a delivery box for packages, or inderectly, by not being necessary staying at home.

In order to know what would be the accepted price to pay for our project, we presented two options of price ranges. The most voted oprion was the up to 50€ one, as seen in the chart on the right.



Interviews through Forms

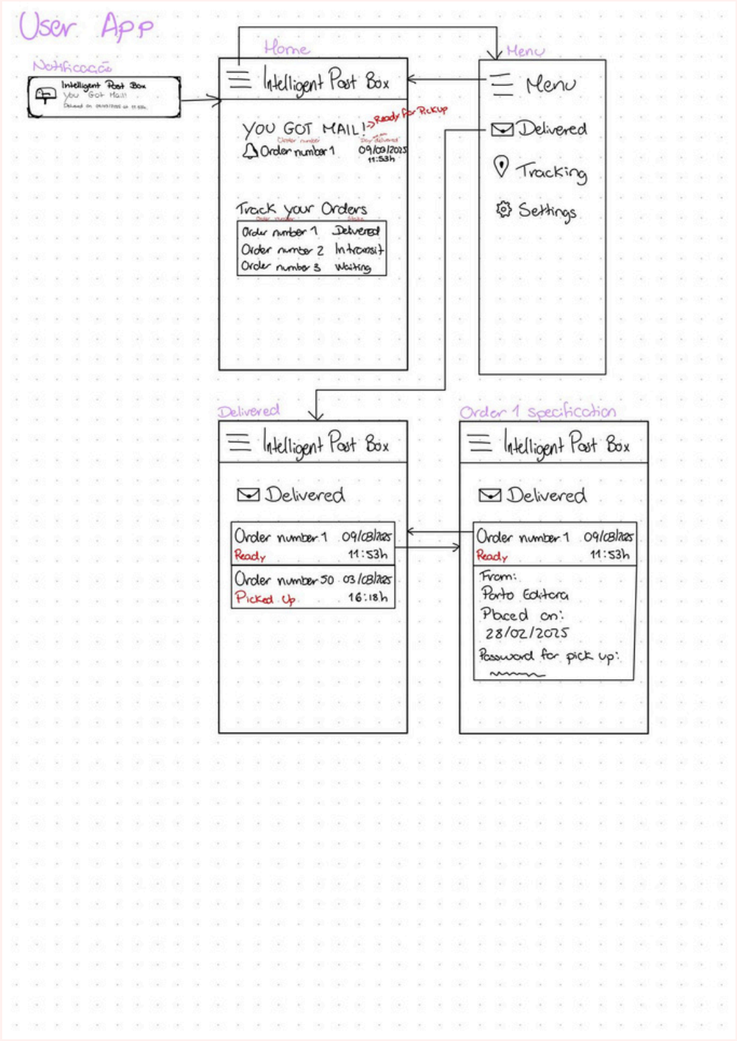


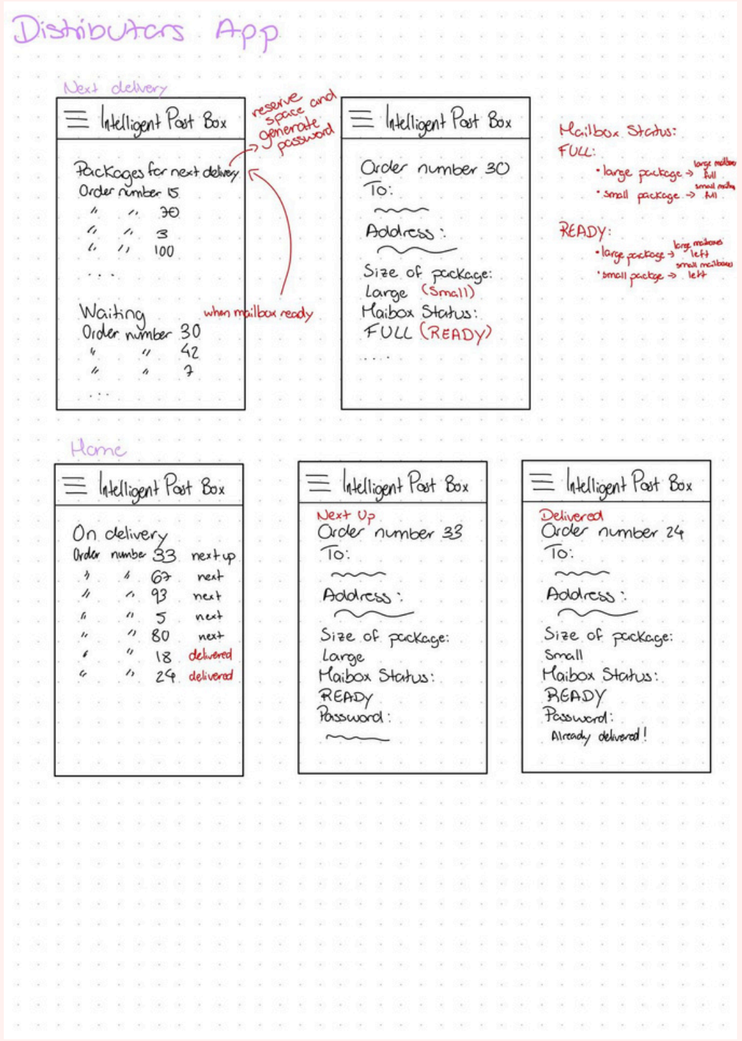
When asked what functions they valued the most in our project, the camera, that takes a photo of the received package, and the notification system, that alerts the user when a package has arrived, were the most valued ones.

The sensors, to detect when mail has arrived, and our opening solution through a code were less valorized.

With this information, when developing our solution, we will prioritize the most valued functions without disregarding the other ones.

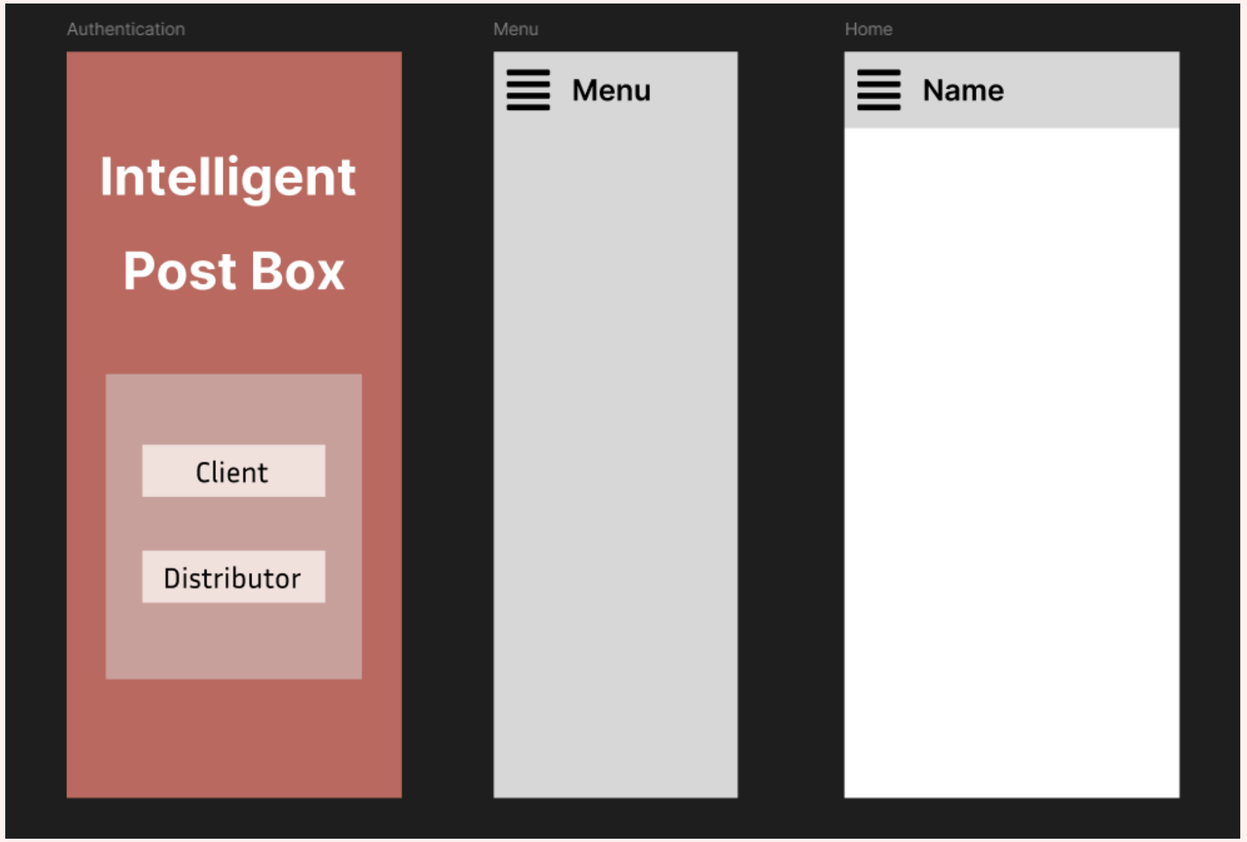
Application storyboard





We drew the storyboard for the two different views of the app, in order to do the application prototype in Figma. This is how we envision our final application.

Application prototype (in Figma)

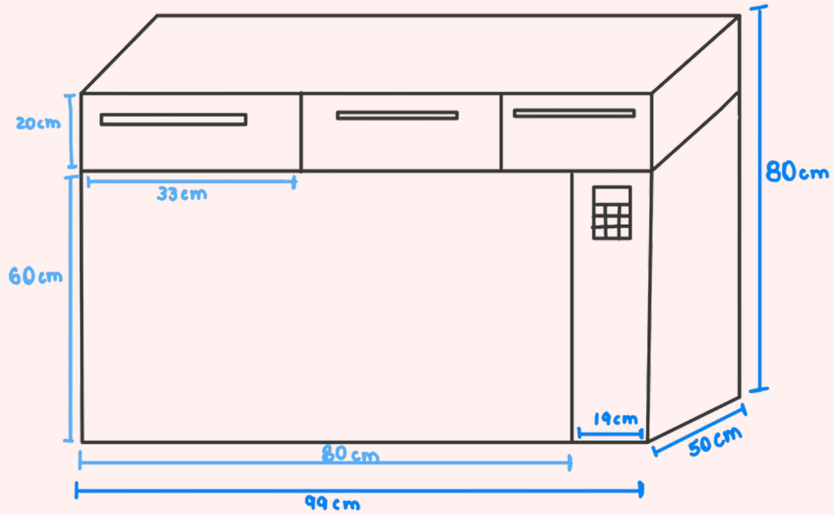


We started the application prototype and we’re hoping to have it finished by April 27th.

Prototype

Our prototype was designed using dimensions tailored to accomodate both letters and packages deliveries.

- Dimensions: 80 cm (height) x 99 cm (width) x 50 cm (depth)
- Structure optimized for 3 post boxes and 1 box for big packages
- Versatile and adaptable to different delivery volumes
- A modern and practical solution for everyday use



If this project becomes a reality, we would have other compartments of different sizes to accommodate all types of packages, depending on user demand, and use a more durable material to ensure longevity.

Challenges faced by the team

Team Dynamics & Knowledge Growth:

Beyond technical obstacles, the team faced external challenges, such as balancing coursework with equivalent credit loads (**6 ECTS**), which created deadline conflicts during critical project phases. Competing academic priorities often forced us to delay prototyping.

We also dealt with technical knowledge gaps. No team member had **prior experience** in mobile app development or Python programming for microcontrollers, requiring accelerated learning during the process.

Material selection added another layer of difficulty. For example, choosing between microcontrollers like the **ESP32** and **Raspberry Pi Pico W** required extensive research to balance cost, power efficiency, and compatibility. Similarly, selecting a **camera** for computer vision and harmonizing **sensors** with conflicting **power/communication** demands proved time-consuming.

Challenges faced by the team

On the technical front, the biggest challenges were:

- Component integration and wiring management: Connecting sensors, microcontrollers, and actuators may require multiple testing cycles to ensure stability.

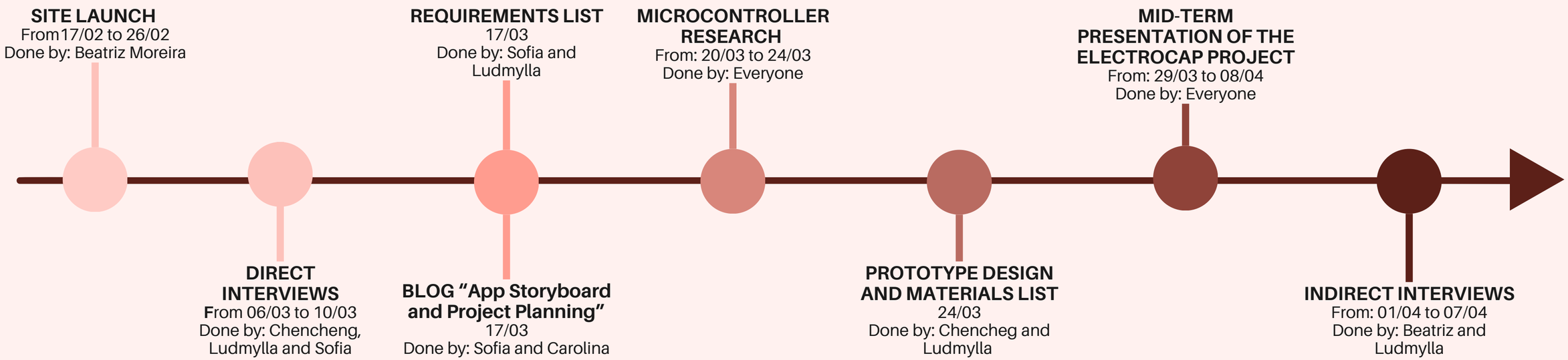
- Connectivity issues: Initially relying on Wi-Fi, we switched to the **GSM SIM800L module** with a **microSIM** card for cellular communication in unstable networks. While this resolved connectivity, configuring protocols and managing data plan costs became new hurdles.

- Continuous power was among research, we found that the energy source could be a problem in our project

Deviations from original schedule

- Difficulty in recognizing what materials would be needed for the project;
- The lack of knowledge needed to carry out the project;
- Communication problems due to members of different courses;
- Problems managing time for the PIC with subjects that need the same attention, since they have the same number of ECTS, and extracurricular activities.

Completed tasks



Contribution of each team member (I)

Ludmylla Wonsoscky

Eletronics Engineer

- Supervision, organization and division of group work
- Research and choice of materials
- Research into prices/stores and choice of microcontroller
- Interviews and Forms
- Prototype design (electronic and physical)

Carolina Lopes

Eletronics Engineer

- Research into a microcontroller with better wifi connectivity
- Blog

Chencheng Liu

Hardware-Software Integration Engineer

- Research into programming languages and choice of microcontroller
- Research and choice of materials
- Interviews

Contribution of each team member (II)

Beatriz Moreira

Front-end Developer

- Website Design and Creation
- Blog Updates
- Research into a microcontroller with better connectivity to the application
- Forms Interviwes

Sofia Nunes

Back-end Developer

- Design of the application storyboard (customer and distributor views)
- Start of the application prototype in Figma
- Requirements List
- Research into a microcontroller with minimum power consumption and logic voltages
- Interviews

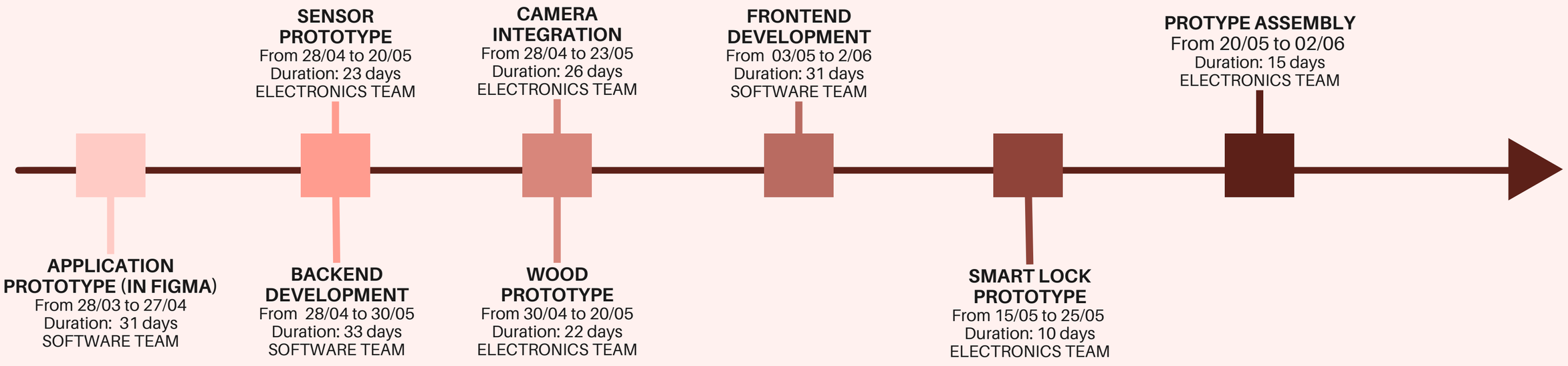
Pedro Yin

Eletronics Engineer

- Study and Research into the best microcontroller

Corrected schedule

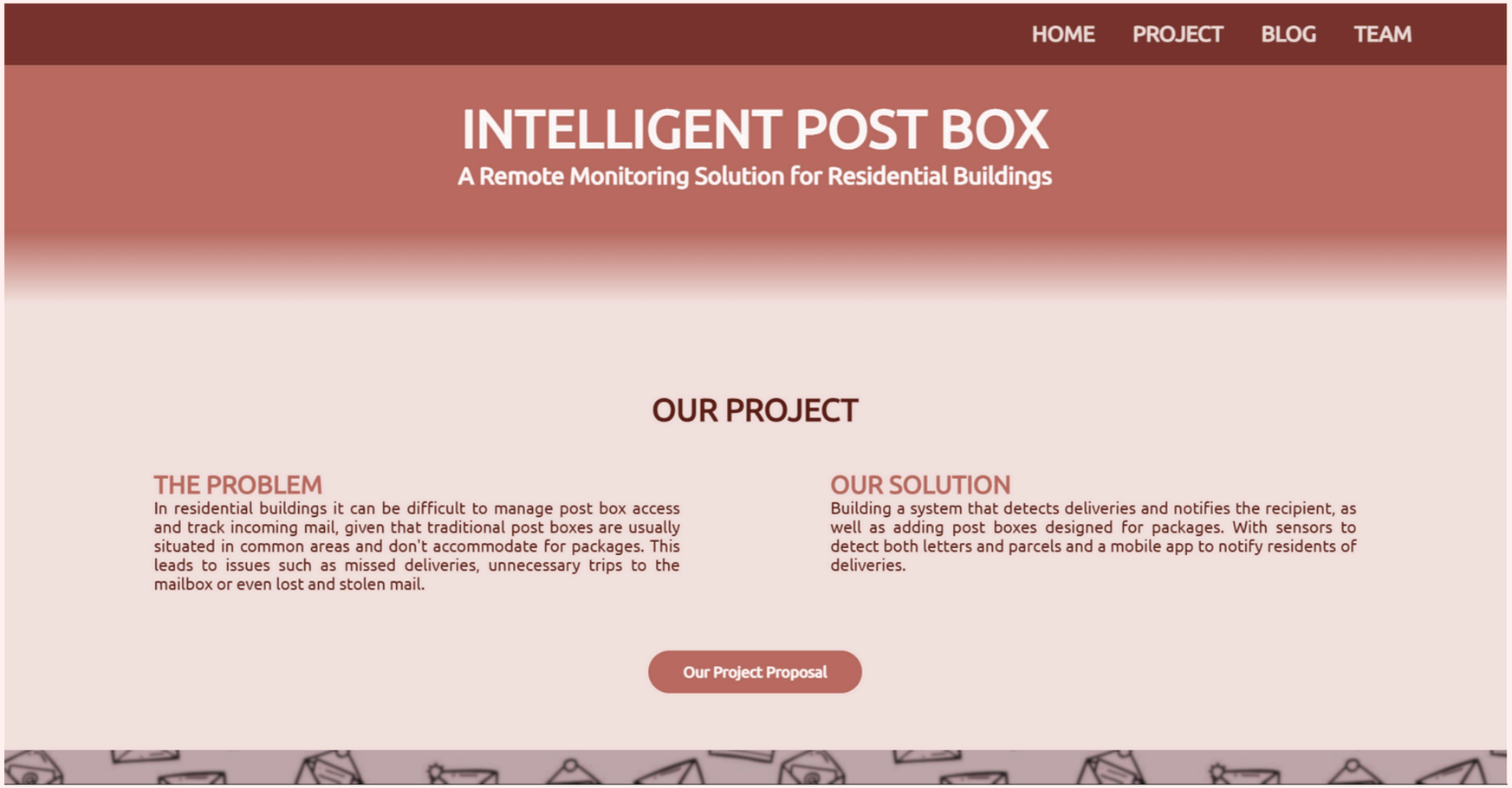
Note: This schedule has been prepared based on the assumption that all materials will be received by **April 28, 2025**. Any delays in delivery may result in adjustments to the timeline.



SOFTWARE TEAM
SOFIA NUNES
BEATRIZ MOREIRA
CHENCHENG LIU

ELECTRONICS TEAM
LUDMYLLA WONSOSCKY
CAROLINA LOPES
PEDRO YIN

Our Website



We have developed a website to promote our project, containing a description of the project and our proposal, our team and a blog with weekly updates on our progress.