Report

Title Partcitypate

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Acknowledgement

Glossary

Abbreviation	Description
EPS	European Project Semester
ISEP	Instituto Superior de Engenharia do Porto
ICT	Information and communication technology
QR	Quick Response
AR	Augmented reality
API	Application Programming Interface

1. Introduction

1.1 Presentation and Motivation

The European Project Semester **[European Project Semester, 2022]** offers students with engineering or other backgrounds the opportunity to carry out a project in a multidisciplinary team at a partner university under scientific supervision within one semester. The following project was realized at the "Instituto Superior de Engenharia do Porto" **[Instituto Superior de Engenharia do Porto, 2022]** by the students Carla Gomes Cardani, Carmen Couzyn, Eliott Degouilles, Julia Aleksandra Engst, and Jan Michael Benner.

Each student has their motivations for participating in the project semester:

- **Carla Gomes Cardani:***"When I was presented with EPS, I knew that I should live this experience. The possibility to meet people from different cultures and study areas is fascinating and could lead to remarkable experiences. I am very excited to explore each member's features and learn from them as a group."*
- **Carmen Couzyn:***"What made me choose the EPS was the opportunity to collaborate with students from other areas of engineering and from different cultural backgrounds."*
- **Eliott Degouilles:***"For me, this EPS is a unique opportunity to work on a multicultural and multidisciplinary team. After studying mechanical engineering for 4 years, I hope to be able to provide my knowledge to this team."*
- **Julia Aleksandra Engst:***"I see the EPS program as an ideal opportunity to get out of my fixed education schedule. Furthermore, I enjoy being pulled out of my comfort zone and being put in an environment where I am obligated to be independent and self-sufficient and at the same time get the chance to learn from others."*
- **Jan Michael Benner:***"By working in a multidisciplinary, multicultural, and multilingual project team in an unfamiliar subject area, I hope to broaden my horizon. The recognition and use of different backgrounds and talents is an interesting challenge."*

To enable productive work in the team, it makes sense to assign responsibilities to team members (see table 1). In this way, one member at a time maintains an overview of the respective area of responsibility and serves as a contact person. However, this does not mean that individual tasks in the subareas can not be taken over by each group member.

Table 1: Team members and their responsibilities

Group member	Origin	Background	Responsibility
Carla Gomes Cardani	Brazil	Design	Graphic Design and Marketing

Group member	Origin	Background	Responsibility
Carmen Couzyn	Austria	Media Technology	Software Development
Eliott Degouilles	France	Mechanical Engineering	Structure - Materials
Julia Aleksandra Engst	Germany	Management (Building Real Estate Infrastructure)	Project Management
Jan Michael Benner	Germany	Energy Engineering	Quality Manager and Reporting

The elaborated project is briefly explained in the following video:

vecteezy_ukrainian-pigeon-flag-with-text-pray-that-you-exceed-your_6671449_370.mp4
[vecteezy, 2022]

1.2 Choosing the topic

After receiving the topic “Our City Experiences” (Smart Cities) it was essential to gather some first impressions, because of this it makes sense to first start with a trip around the city of Porto and analyze what could be improved and what comes to the mind (see Figure 1).

Figure 1: Walk around the city of porto

While brainstorming about the impressions in Porto and the experiences with our hometowns five ideas were developed. Based on basic research on each idea, it was possible to select a topic with which the group can best identify itself with and market opportunities exist.

- **City Guide**: Due to negative experiences with some city guides and individual needs for bundled information on one website, the idea of developing a modern website with information for tourists and citizens regarding all offer in the city was born. The inclusion of information regarding people with disabilities would be an add-on. Often information has to be gathered from different sources and the governmental information sources are frequently overloaded and outdated. Additionally, gamification of a city guide could make people perceive the city differently. Due to fears that a website with all the information about the city could quickly

become overloaded and due to large competitors with high market shares (**[TripAdvisor LLC, 2022]**, Google Maps **[Google LLC, 2022]**, digital city guides **[CITY GAME PORTUGAL, 2019][Secret City Trails, 2021][Team3, 2022]**, etc.), this idea was not pursued further.

- **Sharing Food**: This idea relates to the "buy one give one" principle of some existing initiatives to support populations living in poverty (e.g. "Light the world with love" **[Intellectual Reserve Inc., 2021]**). In this way, when a citizen buys a product at a vending machine its funds go directly to each participating charitable organization, making a difference for those in need. This is a very important and interesting topic, but for this project, it seemed to be difficult to differentiate from existing products and to create innovation, therefore it was decided to continue with a different idea.
- **Recycling and Sustainability**: Recycling is one of the most important challenges to achieving a circular economy. In addition to the recycling of electronic devices, clothes, and buildings, the recycling of household waste also plays an essential role. In many regions, the separation of household waste is uncommon or carried out improperly. Making it easier to separate waste and bring it together with minimum effort to a collection point could encourage people to dispose of it correctly. Due to the desire to deal with a topic in the digital environment, this topic will not be investigated further.
- **Redesign Traffic**: Redesigning crosswalks, traffic lights, stairs, and other traffic objects could give a city a unique look. This could strengthen the recognition value, familiarity, and identification of citizens with the city. Due to the desire for a digital theme, this idea is also not pursued further.
- **City for the people**: According to the quote "What is the city but the people" by William Shakespeare **[William Shakespeare, 1608]**, the citizens of a city are the most important building block. Digitalization and the progress towards smart cities offer the possibility to efficiently involve citizens in urban planning. This topic offers challenges in many different areas such as marketing, human-computer interaction, hardware-/software development, and many more. This forms the basis for a stimulating problem for all team members. For this reason, it was decided that the project would be continued on the topic of citizen participation in urban planning.

> ***"What is the city but the people?"***
>
> – William Shakespeare (Coriolanus, Act 3, Scene 1) **[William Shakespeare, 1608]**

1.3 Problem

Involving people in urban planning offers many benefits, but current methods are failing to get a large number of citizens to participate. People have a high participation barrier when it comes to public participation in urban planning, as it requires a lot of time and initiative only a small non-diverse group of citizens take part in local initiatives. This fact prevents the productivity of citizen participation and can lead to dissatisfaction among the population. Even the use of modern methods in a smart city has not yet succeeded in finding a comprehensive solution.

A more detailed explanation of the issue with a scientific background can be found in chapter 2.

1.4 Objective

This project is intended to contribute to the solution of the aforementioned problem. A combination of a public screen with a visual experience and an active interaction through a website (on a smartphone) will make it easier for citizens to participate. A public screen is placed at the location of a future construction project and is intended to arouse the curiosity of passers-by. The screen will display 3D models of the construction project to provide visualization at the future location, in addition the screen will display information about the project, comments and feedback of citizens. The interaction of the population with the screen should be done via a smartphone with the help of a web application. Using a QR code, it is possible to access the website without having to make any prior arrangements (downloading an app). Several citizens can simultaneously call up further information on the construction project and record their opinion in the form of comments or likes. Active interaction with the public screen is only allowed to one person at a time. This citizen gets the possibility to project different models of the building project on the screen and to move them three dimensionally, for this a limited time window is provided so that a long occupation by a citizen can be excluded. Experience from previous studies should be taken into account to ensure the success of the project. The overall aim of this system is to reduce the barriers to participation and to inspire citizens to engage in urban planning in a fun way.

1.5 Requirements

The requirements for the project can be divided into legal, social, frame conditions set by the project supervisors, and functional requirements.

The following EU directives are to be mentioned as legal requirements:

1. Electromagnetic Compatibility Directive (EMCD);
2. Low Voltage Directive (LVD);
3. Machinery Directive (MD);
4. Radio Equipment Directive (RED);
5. Restriction of Hazardous Substances in Electrical and Electronic Equipment Directive (ROHS)

Social requirements include:

1. As environmentally friendly as possible over the product life cycle
2. The inclusion of as large a population group as possible (as far as possible)

The framework:

1. Budget of 100€ for the prototype
2. Use open-source software and technologies when possible
3. Adoption and use of the International System of Units (The NIST International Guide for the use of the International System of Units)

Functional Requirements:

1. Defying environmental influences when installed outdoors
2. Easy installation and maintenance
3. Residents must be made aware of the opportunity to participate

4. Ease of use of the application

1.6 Functional Tests

With the help of Solid works, a physical stress simulation was carried out, taking into account vandalism and wind effects. As can be seen in section 7.4.4, the durability of the product was verified.

On the software side, both a performance test of the website and a user interaction test were performed. The results can be found in section 7.7.

1.7 Project Planning

In order to keep the goal of the project in scope and to take advantage of the strengths of each team member, it was decided to apply the agile project management method scrum. In section 3, all the techniques used are explained in detail. This includes task, time, cost, quality, people, communication, risk, procurement and stakeholder management as well as spints.

1.8 Report Structure

Table 2 provides an overview of the contents of this report and the respective chapters.

Table 2: Overview of the content

	Chapter	**Summary**
1	Introduction	Introduction of the project environment and the team members as well as a summary of the problem and the solution approach
2	State of the Art	Investigation of the theory underlying the project from the literature as well as a comparison with existing solution approaches
3	Project Management	Overview of the applied project management methods within the team
4	Marketing	Insight into the marketing strategy with identification of target groups, stakeholders, and marketing opportunities
5	Eco-efficiency Measures for Sustainability	Measures and possibilities to integrate the product into a society that is as environmentally friendly as possible
6	Ethical and Deontological Concerns	Analysis of existing Code of Ethics and specific benefits and concerns regarding the project
7	Project Development	Overview of the project process up to the completion of a prototype and test procedures
8	Conclusion	Project results, discussion and outlook for further research

2. State of the Art

2.1 Introduction

In this chapter, the terms “Smart City”, “Public Display” and “Citizen Participation” are first explained and then existing concepts and solutions of citizen participation in urban planning are explained and commented on. Based on these fundamentals, the concept for the project can then be created and developed.

2.2 Smart city

A smart city is a term that is becoming increasingly popular in scientific and political discussions, at the latest after the addition of large companies such as IBM **[Council on Foreign Relations, 2008]**. But what exactly is a smart city?

Initially, the definition was limited to information and communication technologies, such as sensors, for the efficient management of urban infrastructure and services. Today, however, it is used to refer to almost any form of technological innovation to improve the efficiency in urban management **[Sarbeswar Praharaj, Hoon Han, 2019]**.

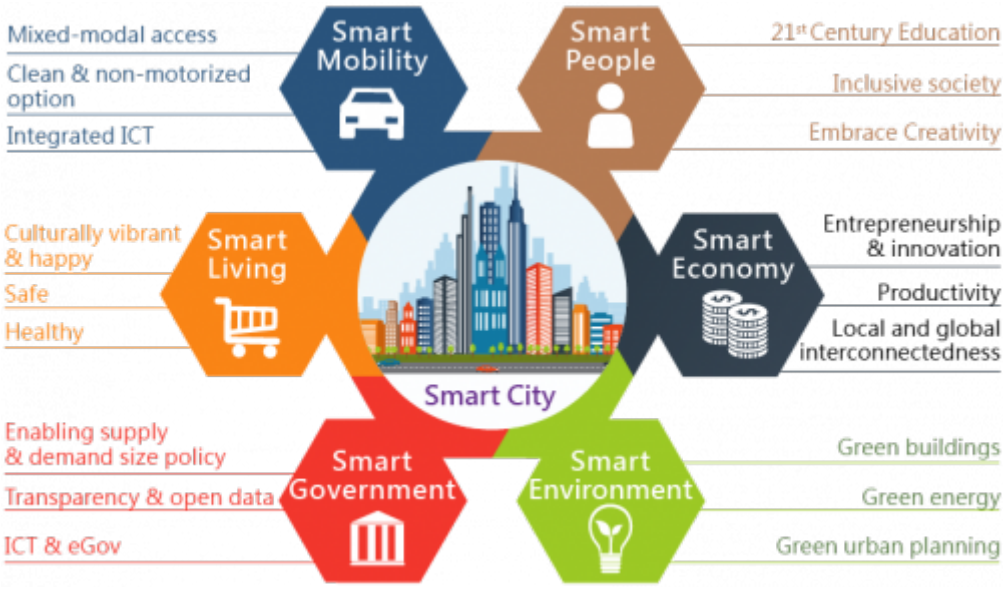


Figure 2: Characteristics of a smart city **[Dr. Winnie Tang, 2017]**

Technology has found its way into all areas of life, including buildings and urban areas. A new domain of the smart technology ecosystem has evolved as a conceptual extension of smart space, from the personal context to the broader community and the entire city **[Gregory S Yovanof, George N. Hazapis, 2009]**. Based on this, the term smart city can be extended to the areas of entrepreneurship and creative industries, Community development and social capital Learning and knowledge-based development and Sustainable development **[Sarbeswar Praharaj, Hoon Han, 2019]** (see figure 2).

2.3 Public Display

Public screens should be familiar to all of us and are present everywhere in our lives. For example, you can find them in shopping malls and streets as advertising platforms or at train stations as

information displays. They are also used to display worldwide sporting events. Artists can use public screens to exhibit new creative art (see figure 3).

Figure 3: Public Screen as a Display for sporting events **["AJJ Press", 2011]**

In summary, mankind has become accustomed to the value and use of public screens but public displays still lack an adequate definition to describe all their features and capabilities **[Guiying Du, 2018]**. The English Dictionary **["Lexico.com", 2022]** describes a pervasive public display as electronic devices for visual presentation that spread widely throughout an area or a group of people. For this project a more detailed understanding of public displays is needed. Moving forward, a public display is defined as a subsegment of public electronic signage that is “centrally managed and individually addressable for display of text, animated or video messages for advertising, information, entertainment, and merchandising to targeted audiences” **[J. Schaeffler, 2012]**.

2.4 Citizen participation

Public Participation is “the involvement of citizens in governmental decision-making processes” it ranges from “being given notice of public hearings to being actively included in decisions that affect communities” **["Oxford Univercity Press", 2022]**. According to Schoßböck et al. **[Maria Leitner, 2018]**, there are four different levels of citizen participation. The intensity of codetermination builds on each level and the degree to which they are binding increases in every stage (see figure 4).

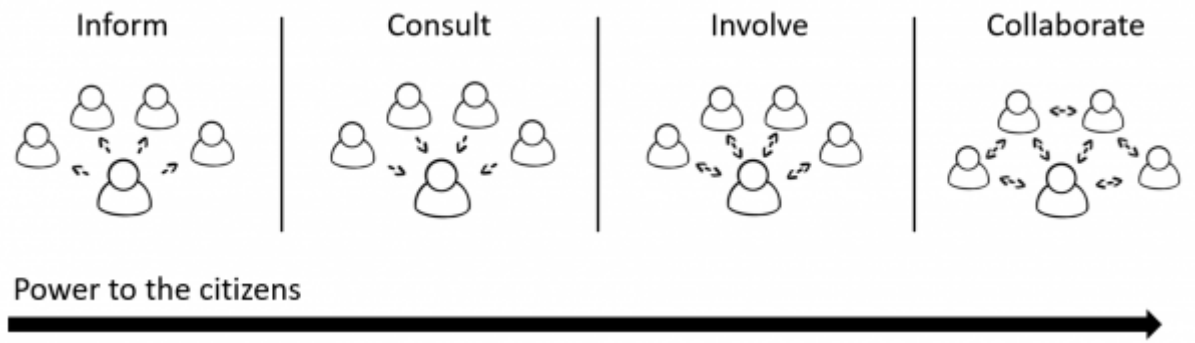


Figure 4: Levels of Citizen participation (cf. **[Maria Leitner, 2018]**)

The purpose of the information is to inform the participants about plans or decisions. Communication at this level runs in only one direction. Information reaches citizens through, for example, newsletters, databases, or meeting broadcasts.

Consultation and involvement enable two-way communication. In addition to receiving information, participants can express their opinion on a particular topic or design. The influence granted to the participants can be of varying degrees. In any case, communication in this framework is from the decision-making unit to the participants and from the participants to the decision-making unit. Feedback may also be provided to the participants. Consultation can also occur at regular intervals over a longer period. The involvement of citizens at this level is traditionally achieved, among other things, through citizen panels, chats, complaint management, and discussion forums. The difference between consultation and involvement is the inclusion of citizens in the brainstorming process and the direct feedback on the citizens' opinion.

Cooperative public participation allows stakeholders to have a “chance on decision-making” in the process. This is done, for example, through online mediation, citizen journalism, or interactive planning. Intensive communication between participants and decision-makers can turn into collaboration, which is the most intense form of participation. Citizens can actively participate in decisions via e-voting or online surveys.

In an effort to involve citizens in decision-making, more and more governments at various levels of power are implementing citizen participation initiatives. This tendency is due to a various number of reasons and implies different sources of potential problems.

“While planners bring technical skills and knowledge, citizens provide community history, local knowledge, and an understanding of cultural values.”

– Innes 1998 **[Judith Innes, 1998]**

To begin with, greater participation of the citizen in urban planning would allow being closer to actual people's needs and are therefore better accepted. All voices used not to be listened to by city planners, and some voices weighted more than others. Moreover, smaller places like playgrounds for example tend to be overlooked during the design of cities which are made on a bigger scale. Thus, the involvement of citizens can fix this problem and go even further by proposing the implementation of more detailed elements (wheelchair ramps, trash cans, guidelines, etc.). In this way, cities will be able to evolve closer to users' needs and develop better its inclusiveness. Furthermore, citizen participation aims to reconnect citizens with their governments, because citizens' trust in governments has reached a particularly low level in recent years **[Antoine Clarinval, 2021]**.

Unfortunately traditional and other existing methods of citizen participation come with drawbacks, warnings, and limitations which will be discussed in the following section.

2.5 Review of participation methods

As shown, the participation of citizens in planning processes leads to an improvement of the overall quality and can contribute to a strengthening of a sustainable local democracy. Getting citizens to participate efficiently and in a useful way is not easy. That was the case before “smart cities” and is still a challenge **[Antoine Clarinval, 2021]**. Involvement can take place through a variety of

methods, a consideration of traditional methods and modern concepts can provide the basis for finding a solution.

Vindasius classified traditional mechanisms for citizen participation in 1974 (see table 3). Various parameters, such as specificity or workload of the methods were evaluated on a scale of 1-3, while 1 is a low score and 3 is the highest.

Table 3: Participation methods and their caracteristics (cf. **[Hend Magdy Mohamed Sameh, 2011]**)

Type of public involvement mechanism	**Focus in scope**	**Focus in specificity**	**Degree of two-way communications**	**Level of public activity required**	**Agency staff time requirements**
Informal local contacts	1	3	3	2	2
Mass media (newspapers, radio, TV)	3	1	1	1	1
Publications	3	2	1	1	2
Workshops	1	3	3	3	3
Advisory committees	1	3	3	2	3
Public hearings	2	1	1	3	2
Public meetings	2	1	2	2	2
Public inquiry	3	1	1	2	2
Special task forces	1	3	3	3	3

These methods have been used for a long time and have proven some advantages and efficiency over a long period of time. Nevertheless, they are accompanied by a list of disadvantages and difficulties (cf. **[Hend Magdy Mohamed Sameh, 2011]**,**[Ole Smørdal, Kristina Wensaas, Susana Lopez-Aparicio, Ida Pettersen, Kristian Hoelscher, 2016]**, **[Antoine Clarinval, 2021]**):

- Often traditional methods provide a confrontational atmosphere (this can lead to a small vocal minority, with often extreme views, dominating the discussion and a quieter majority being discouraged from participating).
- The restricted time period of public hearings/meetings and the physical location can limit broad participation (often in the morning hours when many citizens are working)
- People have to work and family and often have little time to participate further
- One-day events can provide a wealth of information and ideas that can easily be lost if not captured digitally
- People can participate much more effectively when information is presented simply and visually than in words. When the complexity is too high, people may find it difficult to understand the project or discourage people from learning about the subject matter.
- By the time information reaches the citizens and is up for discussion, important decisions have usually already been made by the authorities.
- Many people do not even learn about participation opportunities because they do not live in the immediate vicinity of the project but can still be affected by it.
- Due to the high effort, mostly only simple participation methods are used by the authorities

The use of digital media and tools to enable the participation of inhabitants in urban planning processes on a massive scale is a promising, but currently not comprehensively analyzed approach **[Sander Münster, Christopher Georgi, Katrina Heijne, Kevin Klamert, Jörg Noennig, Matthias Pump, Benjamin Stelzle, Han Meer, 2017]**. An overview of all traditional and modern communication channels can be found in the figure 5.

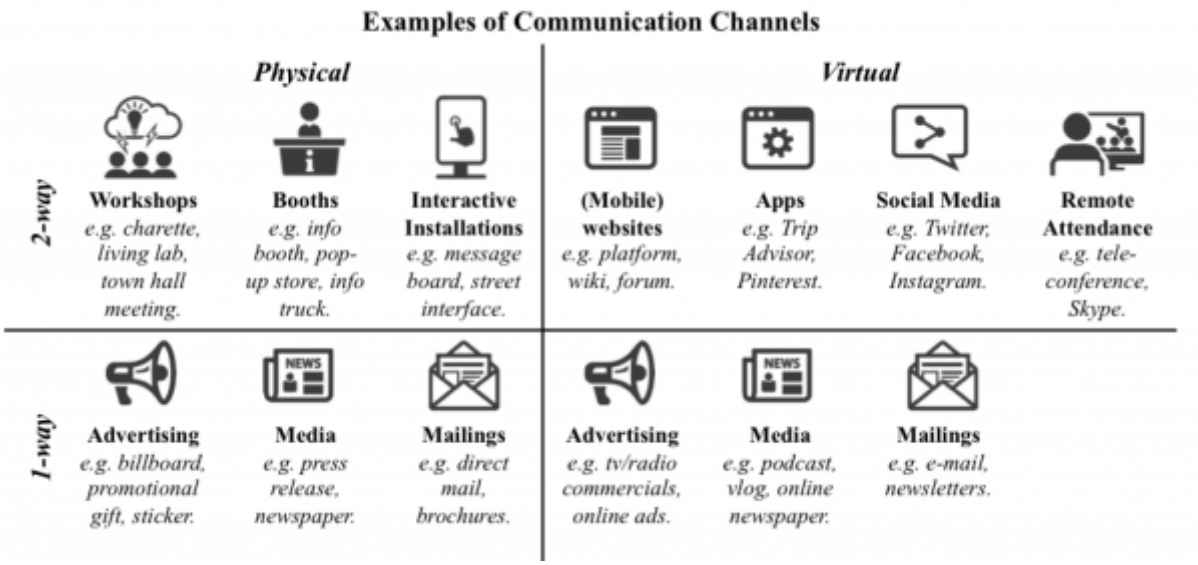


Figure 5: Overview of communication channels: physical, virtual, 1-way and 2-way **[Sander Münster, Christopher Georgi, Katrina Heijne, Kevin Klamert, Jörg Noennig, Matthias Pump, Benjamin Stelzle, Han Meer, 2017]**

The use of ICT makes it possible to reach a large number of citizens with little effort. In addition, people can participate online and anonymously at any time. Citizens can use e-planning to get involved in the planning process at an early stage and generate a new wealth of ideas. As shown some of the problems of traditional methods can be solved through the use of modern ICT resources, but modern methods of citizen participation also have their challenges, which are sometimes similar to traditional methods **[Sander Münster, Christopher Georgi, Katrina Heijne, Kevin Klamert, Jörg Noennig, Matthias Pump, Benjamin Stelzle, Han Meer, 2017]**:

- User group is too small (lack of information on participation opportunities, lack of knowledge of the software, high level of initiative is necessary)
- People who participate are rarely representative of the entire citizenry
- Information is presented in a too complex way (motivation to participate decreases)
- Participation is not possible at the location of the project
- Transparency, inclusion, and fairness (if this is not properly addressed, it can lead to a worse outcome than without any opportunity for participation).

Due to this, according to Schuler **[Douglas Schuler, 1996]**, efficient participation measures should have the following characteristics:

- As many as possible citizens in a city should be reached/involved
- The flow of information should be reciprocal
- It must be easy to reach and as inexpensive as possible for the citizen
- The participation should be with as few restrictions as possible
- Adaptation to changing legal framework conditions and evolving software should be possible
- Transparency, inclusion, and fairness

In addition, interactivity can lead to higher participation from the public. These measures are one of the bases for the development of this project.

In the following section, digital systems already designed to encourage more people to participate in urban planning are presented.

2.6 Similar Projects

Market analysis offers the possibility to examine the strengths and weaknesses of existing solutions and consider them in product development. Recent scientific publications reveal that there are only a few commercial competitors in the field of smart screens for citizen participation, but a lot of studies on that topic. First, Claes et al. **[Sandy Claes, Jorgos Coenen, Andrew Vande Moere, 2018]** developed a device to display environmental measurements, such as pollution data, in the vicinity of the measuring location. This public visualization is paired with a polling system, allowing citizens to respond to the data by pressing one of three buttons showing happy, sad, and neutral smileys. Each of their visualization sets consists of six wirelessly connected displays powered by batteries. Figure 6 shows the structural graph of the installation. The individual displays show different visualization types and representations of the data, such as textual quotes, infographics, or graphs. The authors propose to increase trust and introduce perceived personal ownership by having the devices hosted directly by community residents, who seek to raise awareness on a local issue.

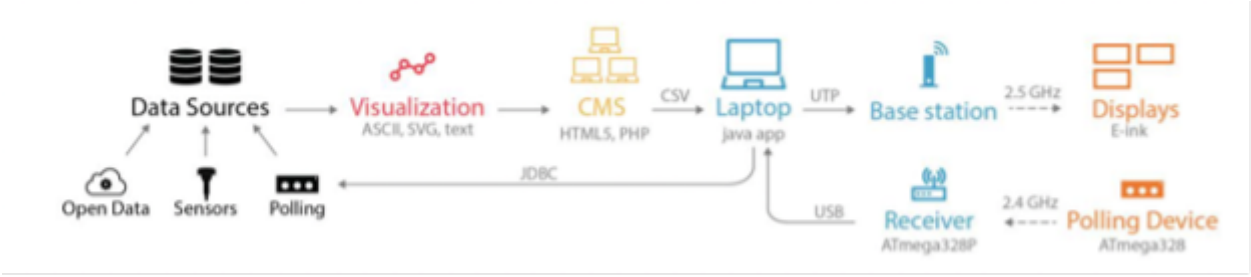


Figure 6: Claes et al. structual graph of the installation **[Sandy Claes, Jorgos Coenen, Andrew Vande Moere, 2018]**

The second competitor, 'Vote with your Feet' **[Fabius Steinberger, Marcus Foth, Florian Alt, 2014]** is a polling system that interactively allows citizen participation in polls through buttons on the ground. The system aims to increase participation by lowering the interaction barrier and drawing attention through a tangible user interface. Figure 7 shows the concept sketch of the installation. In a field study and subsequent interviews, the authors confirmed that the buttons drew considerably more attention from passers-by than the screen alone. Moreover, they proved that the participation barrier was lowered, as participants perceived their installations as inviting and easy to use and a welcome way to pass time while waiting for public transport. However, they also found that kids were eager to play with the buttons to trigger the visual and audible feedback, thus distorting the validity of the polling results.

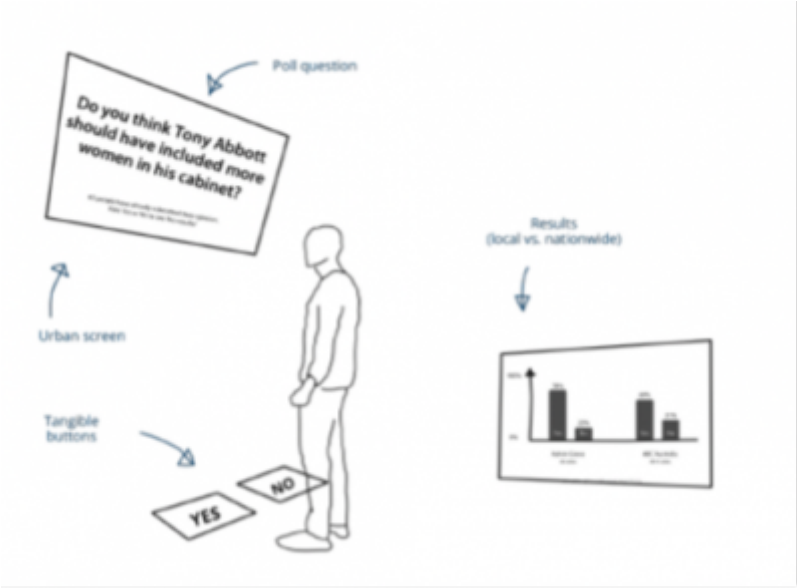


Figure 7: Vote with your feet **[Fabius Steinberger, Marcus Foth, Florian Alt, 2014]**

Ubinion **[Simo Hosio, Vassilis Kostakos, Hannu Kukka, Marko Jurmu, Jukka Riekki, Timo Ojala, 2012]** specifically targets young adults and uses social media integration to establish trust and support content creation, storing, and delivery. The installation aims to increase participation through a playful and fun interaction experience as well as by engaging the users' creativity. Through an integrated web camera, citizens can participate by taking a snapshot, which can then be edited by adding speech bubbles and protest signs with a custom text input. Afterward, the images are shared on Ubionion's Facebook page and the comments are replicated on a Twitter feed. Figure 8 shows the screen flow of the display. Similar to 'Vote with your Feet', the developers of Ubinion found that the display was often perceived and used as a playful attraction instead of a serious feedback device. Moreover, users were frequently distracted by the possibility to take and share a photo. Hence, providing feedback was not the primary purpose of their interaction.

Figure 8: Ubinion **[Simo Hosio, Vassilis Kostakos, Hannu Kukka, Marko Jurmu, Jukka Riekki, Timo Ojala, 2012]**

Furthermore, a research project named Game.Up from the Technical University of Munich **[Sarah L. Muehlhaus, Chloe Eghtebas, Nils Seifert, Gerhard Schubert, Frank Petzold, Gudrun Klinker, 2022]** developed a prototype of gamified public participation application in urban planning. People would use a tablet or a smartphone in the area of interest and within a user interface, game elements were incorporated in the interactions with and between application screens. The structure of the system is shown in figure 9. In the first layer, people can choose their avatar and edit their profile, also achievements during the participation can be shown. The second layer includes the map interface, which displays the avatar at the user's location and project icons at the location of the project. Moreover, information about the project can be accessed. With the third layer user input, Quests, and augmented reality enable participation. Thru the use of avatars, a 3D Modell of the

environment and AR users could feel embodied. This enabled users to find and determine the personal relevance of the project very fast. In addition to the gathering of information about the project, users can participate through quests or surveys, developed by authorities. But the question remains unanswered as to how people are to be encouraged to use the application.

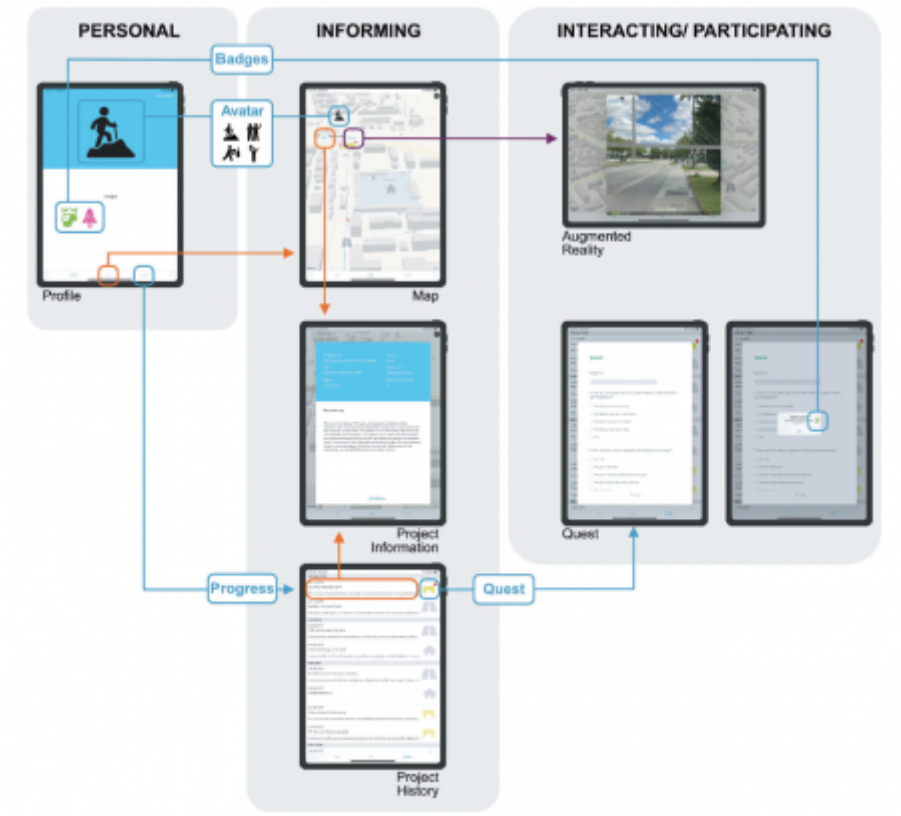


Figure 9: Application user interface layout with gemification elements **[Sarah L. Muehlhaus, Chloe Eghtebas, Nils Seifert, Gerhard Schubert, Frank Petzold, Gudrun Klinker, 2022]**

ChangeExplorer **[Alexander Wilson, Mark Tewdwr-Jones, Rob Comber, 2019]** was a smartwatch application to support citizen feedback on projects. When entering an area where a change is proposed, the smartwatch would notify the user of potential development changes in the area and allow them to give quick responses to prompt questions. They had to reflect on who they would like to improve the area for, and what improvements they would like to make. They could then also add further comments either on their app or on their phone. A summary of the process is shown in figure 10. The notes and interactions were simple and straightforward, allowing the selection of categories for quicker responses, with the option to add additional comments if the user wished to do so. Also, the user did not need to understand the structure of their local council or learn how to use a GIS system. To avoid the problem of comments being too general, ChangeExplorer used categories to guide the user to planning-related comments; this also allowed for easier sorting of comments after they were made. Finally, the user could think about a project while standing physically in the environment. Nevertheless, there were some criticisms of this principle, so it didn't allow for further information on thought or opinions like sketches. Also, there wasn't a feeling of direct feedback on an idea and the lack of further information on the exact changes that were proposed. A lot of people saw the app as a way of evidence gathering around issues and requested a possibility to submit photographs to document these problems. So the device was not able to capture the richer discussions that took place around the vote but let participants submit the first thing that was obvious.

Figure 10: Operating principle of ChangeExplorer **[Alexander Wilson, Mark Tewdwr-Jones, Rob Comber, 2019]**

Finally, in a study by the University of Münster **[Guiying Du, Christian Kray, Auriol Degbelo, 2020]**, an interactive and immersive public display as a conduit for increased involvement in urban planning was developed. It involves a three-sided immersive video environment, showing panoramic videos of the place where an urban development project is to be realized (shown in figure 11). The videos are overlayed with planning content, like static overlays of 3D drawings as well as voting and comment panes. An additionally mobile app offers the possibility for commenting and voting on the topic. The system was easy to use and overall provided easy access to participation through the use of the smartphone. Negative aspects are the physical distance to the real construction project due to the installation in buildings far away from the project and the lack of direct feedback and interaction. In addition, it was necessary to install the application on the smartphone to use it.

Figure 11: Prototyp implementation of an interactive and immersive public display **[Guiying Du, Christian Kray, Auriol Degbelo, 2020]**

A comparison and differentiation between the different comparable solutions for citizen participation are shown in the following table.

Table 4: Comparison of different aproaches

Project	Depth of Participation	Used Devices	Strengths	Weaknesses
Public visualization of pollution data with polling system **[Sandy Claes, Jorgos Coenen, Andrew Vande Moere, 2018]**	Information and feedback in form of three different smileys	Public screen, Environmental measurements, Buttons	Makes people aware of problems in public places	Limited feedback (No possibility to propose solutions), No further interaction or information
Polling system that allows citizen participation in polls through buttons on the ground **[Fabius Steinberger, Marcus Foth, Florian Alt, 2014]**	Information and voting	Public Screen, Buttons	Buttons draw attention	Limited feedback (No possibility to propose solutions), No further interaction or information, used as a playground
Ubinion (Public Screen with integrated camera) **[Simo Hosio, Vassilis Kostakos, Hannu Kukka, Marko Jurmu, Jukka Riekki, Timo Ojala, 2012]**	Commenting	Public Screen, Camera, Touchscreen	Camera draws attention, Possibility to comment in an online environment	No further Information on the project, Playful attraction instead of a serious feedback device
Game.Up (Gamified public participation applications) **[Sarah L. Muehlhaus, Chloe Eghtebas, Nils Seifert, Gerhard Schubert, Frank Petzold, Gudrun Klinker, 2022]**	3D-Feedback, Comments	Application for smartphone/tablet	People could feel embodied through AR, A lot of information and feedback is possible	Hurdle to make people aware of the application, High need for adaptation to different projects
ChangeExplorer (Smartwatch application) **[Alexander Wilson, Mark Tewdwr-Jones, Rob Comber, 2019]**	Comments and further feedback	Application for smartwatch/smartphone	Easy and fast feedback, Notifications	No further information on the project, Hurdle to make people aware of the application, Limited Feedback
Interactive and immersive public display **[Guiying Du, Christian Kray, Auriol Degbelo, 2020]**	Comments and voting	Public Screen, Smartphone	Easy and fast feedback, Information	Need to install an application, Physical distance to the real construction project

2.7 Conclusion

As described in section 2.4, citizen participation in urban design can have many positive effects. The combination of a public screen with a visual experience and an active interaction through a website

(on a smartphone) to make it easier for citizens to participate in urban planning can be used for all 4 levels of citizens' participation. They can use the display to find out about current projects and to understand them better with all the advantages and disadvantages. But a smart display can also encourage citizens to cooperate or even collaborate **[Maria Leitner, 2018]**. In the further course of the project, however, the findings from section 2.5 regarding the problems of existing participation opportunities and the conclusions from section 2.6 must provide the basis.

For this reason, the following ten goals should be achieved:

1. As many as possible citizens in a city should be reached/involved
2. The flow of information should be reciprocal
3. It must be easy to reach and as inexpensive as possible for the citizen (inviting and easy to use)
4. The participation should be with as few restrictions as possible
5. Transparency, inclusion, and fairness
6. Interactivity should be possible
7. Participation should be possible at the location of the project
8. Anonymous participation
9. Be taken seriously as a participation opportunity (not as a toy)
10. Possibility of participation of several persons at the same time

3. Project Management

In the context of our project, our team chose the agile project management method SCRUM because of its iterative and incremental process. With this method, small components of our product can be delivered. Special features are that one the one hand there are no hierarchies, i.e. our team is self-organised and, on the other hand, there is no need for detailed pre-planning. This means that the goal of our product does not have to be defined in detail from the beginning, but develops in small intervals and it is possible to obtain feedback and reacted to.

3.1 Scope

The project scope includes the key deliverables that will help us to successfully complete the project. The key deliverables are broken down into smaller, manageable components or tasks so that they can be specifically assigned to a team member.

In order to get a detailed overview of all necessary tasks, we decided to illustrate this with the help of the WBS. The WBS is a tool that can be used to monitor the progress of the tasks required to complete the project. Furthermore, it can be used to estimate an initial timetable for the duration of each task. In order to have a clear overview of all tasks, we have decided on a process-oriented WBS (see Project WBS) on the one hand and a product-oriented WBS on the other (see Product WBS).

The **project scope** represents all the requirements that are demanded of us with regard to our project. For efficient documentation control, an alphanumeric coding "EPXXXX" was chosen, where "EP" stands for "European Project". The project is divided into six sub-projects "Initial", "Design", "Interim", "Executive", "Testing" and "Final".

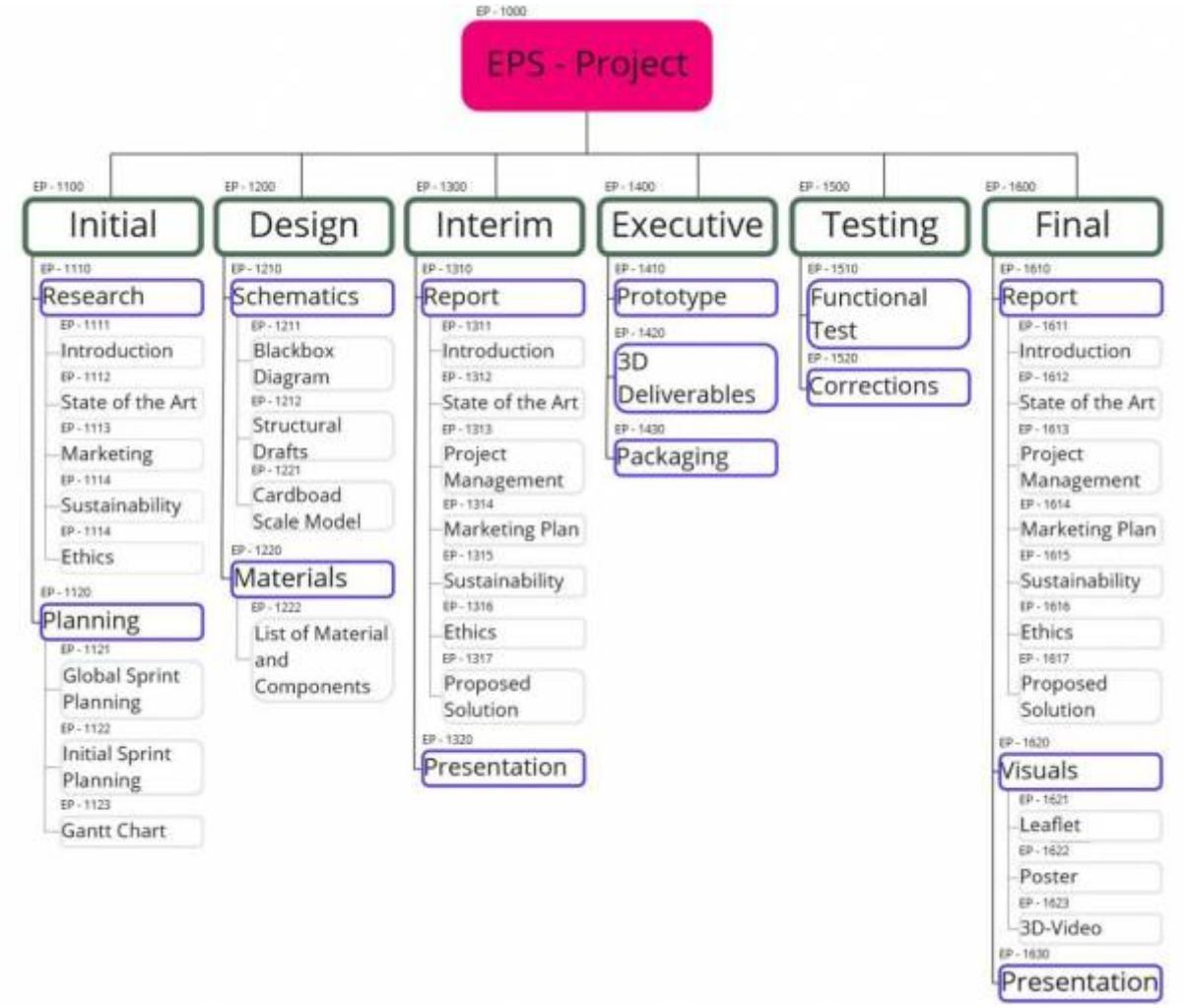


Figure 12: WBS - Project

The **product scope** represents all requirements regarding our product. For efficient documentation control, an alphanumeric coding “SDXXXX” was chosen, where “SD” stands for “Smart Display”. The project is divided into three sub-products “Software”, “Hardware” and “Design”.

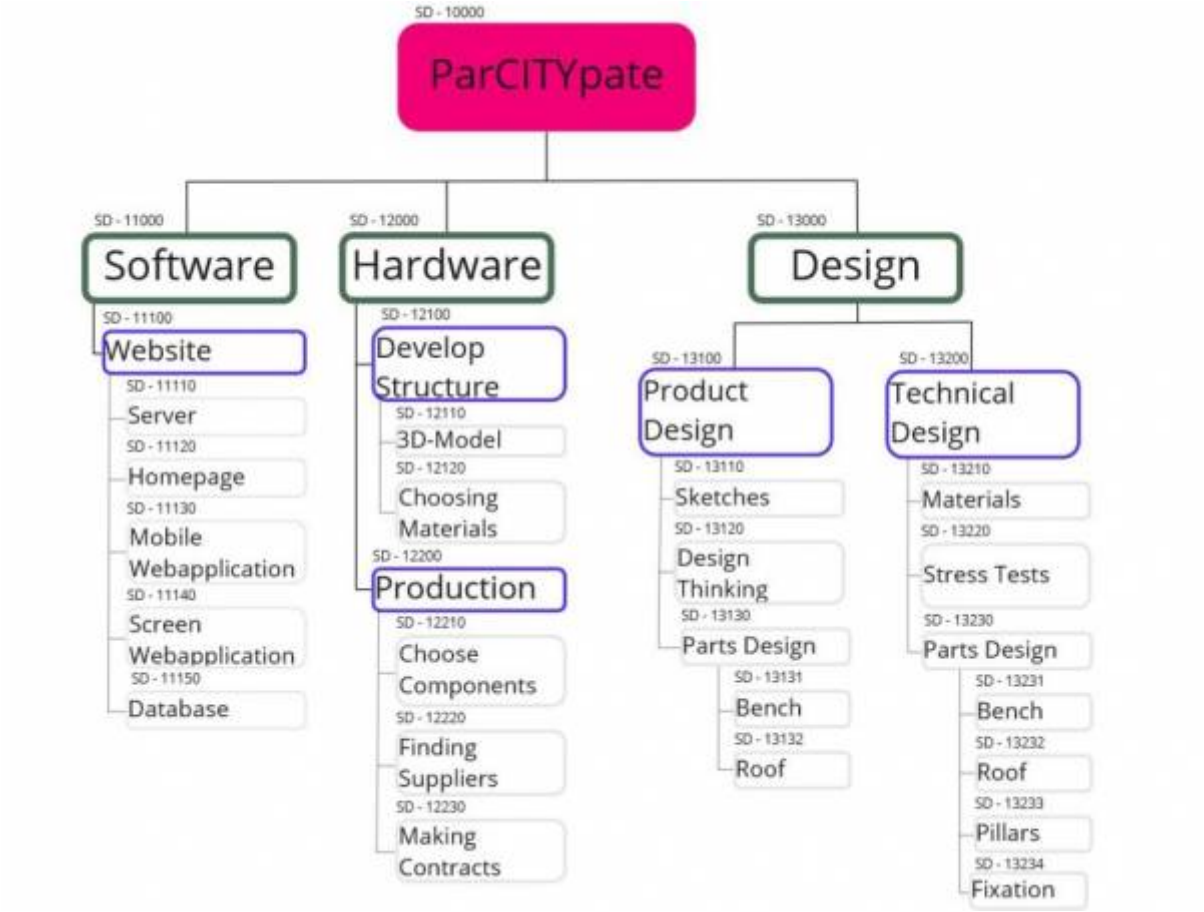


Figure 13: WBS - Product

3.2 Time

Scheduling is an important management tool for project control. It is broken down into individual activities that are coordinated in terms of time and define the individual project milestones. It also serves as an instrument for efficient project monitoring in accordance with the work breakdown structure.

In order to obtain a detailed schedule overview, we have used the Gantt chart (see figure 14)).

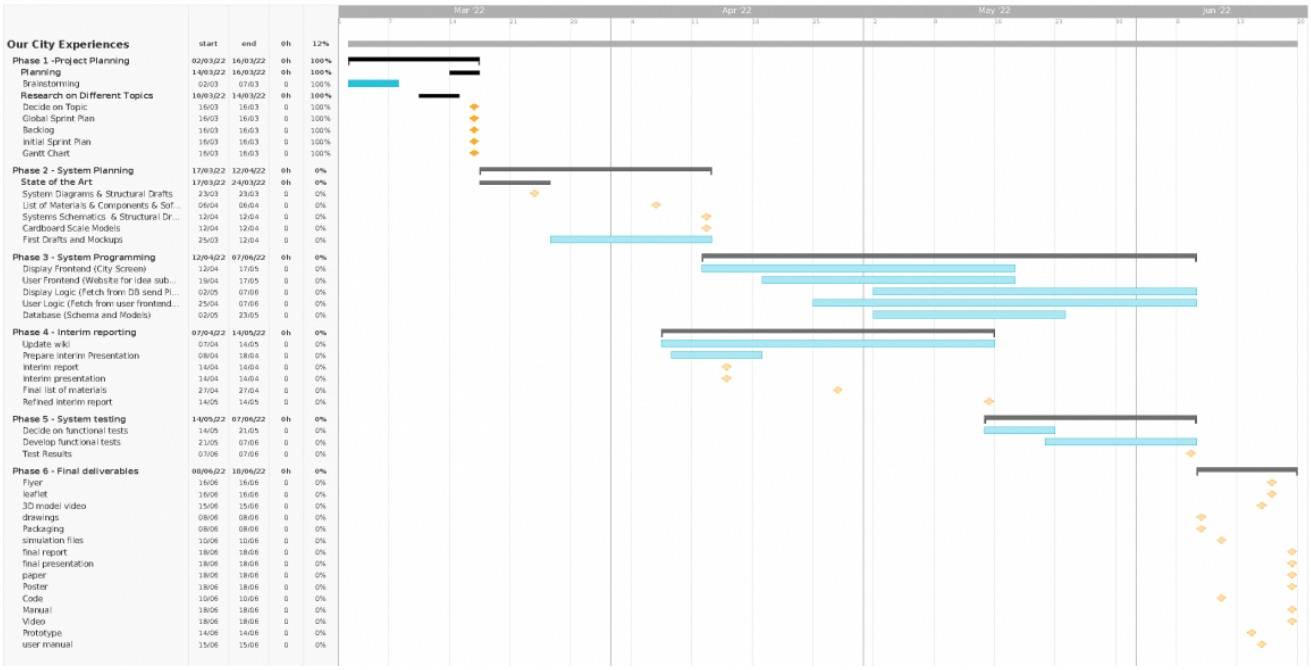


Figure 14: Gantt Chart

3.3 Cost

In order to keep the project costs within reasonable limits, it is important to prepare an accurate and detailed cost estimate. The aim is to calculate the costs as accurately as possible, which can be achieved through good research, empirical values and estimates. It is also possible to forecast whether our budget will be sufficient, whether certain parts of the product will have to be omitted for cost reasons or whether a loan will have to be taken out. At the end of the project, the planned costs are compared with the actual costs incurred.

Budget - In total we have a fixed amount of 100€ for the realization of our project. This budget will definitely be exceeded for our real product, so this budget will only be used to cover the costs of our prototype. Since our team does not have any financial resources for the final product, the costs are calculated for taking out a loan.

Internal Labor Costs - Under internal labor costs, we count staff costs. As a Start-Up, we decided to forgo our salary at the beginning and invest all our financial resources in our project.

External Labor Costs - We have already set up the costs for the prototype in chapter 7.4.1. In theory, a total of 142 € will be incurred. The sum exceeds our budget, but we were able to borrow most of the components, such as the Raspberry Pi from our supervisors and provide the screen from our own funds, so no costs were incurred. The cost of our final product is estimated to be around 15 000 EUR.

The costs for marketing were broken down in chapter 4.7. In total, the costs amount to 1 450 €. The high costs are due to the fact that there are marketing costs for the buyer, on the one hand, and for the users on the other.

3.4 Quality

Quality is one of the most important aspects to consider, as a lack of quality can have a long-term impact on our product and image. This is because quality management is not only about checking the quality of the product, but also involves ensuring that all processes that occur during the project life cycle, are carried out efficiently. In addition, it should be ensured that the stakeholders' requirements for the project result are met satisfactorily. Outstanding quality thus helps our project to achieve maximum success and generates a clear competitive advantage. With the help of systematic quality management, we can generate positive effects on the customer on the one hand and reduce quality costs preventive on the other - although the prevention costs are higher, the risk of high costs arising from errors is minimized.

Overall, according to the PMBOK, quality management is divided into three phases: **Quality Planning, Quality Assurance and Quality Control.**

Quality planning - This phase is about planning and developing the quality requirements to be achieved in terms of the project outcome and the required processes. Following the project objectives from chapter 4.4, we have highlighted the most important metrics related to our product and the project and set up a quality roadmap.

Table 5: Quality Metrics and Measurement Approaches

	Metrics	**Thresholds**	**Measurement**
product	Deliver finalized prototype	22.06.2022	Deadline
	High public participation	1 500 user connection + within two months	Number of connections with our device + deadline
	Final product is weatherproof	No damage by using device outside	No complains about the product
	Software reliability	Zero failure	Stress simulation without any failure
process	Limited budget	100 EUR	budget
	Request for our materials in time	28.04.2022	Sprint planning
	Weekly meetings on Thursdays to update our project progress	Weekly	Reports

Quality Assurance - In this phase, quality assurance checks are carried out using our predefined metrics (target-performance comparison). The focus here is particularly on project quality and customer satisfaction.

Quality control - Quality control serves as a guarantee of the quality standard. Unlike quality assurance, this phase is reactive and takes place only after a problem has been identified. Problem identification is followed by problem analysis and problem solving.

3.5 People

In the context of a project, a large number of interests from different groups of people, also called stakeholders, are represented. The success or failure of a project depends largely on the stakeholders, as they may have a direct or indirect influence in the project. The information needs of each stakeholder depend on the degree to which they are affected.

In order to get a clear overview and initial identification of the stakeholders in the context of this project, we have divided the stakeholders into internal and external stakeholders.

The **internal stakeholders** include the project team, the supervisors and the professors at ISEP. The project team, consisting of Eliott, Carla, Carmen, Jan and Julia, is a hierarchy-free, self-organizing team that acts as a multidisciplinary group. The team is responsible for creating and achieving the defined project goal. The supervisors accompany the team throughout the project and contribute to the project development with the help of feedback and support. The professors provide the basis for the successful completion of the project by teaching the basics of technology, project management, marketing, sustainability, ethics, communication and Portuguese language and culture.

Under **external stakeholders** fall the customers and suppliers. The special feature of this project is that two customer groups are addressed, the buyers and the user group. The product is to be sold to governments, so this group is the investor group. The users are the public. The suppliers finish our product components for the final product.

3.6 Communications

Communication is also one of the most important tools to complete a project successfully. This chapter will focus on the communication structure and information dissemination within the team during this project semester. A good communication culture only takes place when it is possible to provide the right information to the right person at the right time in the right intervals in the right quality and scope with the help of the right medium. To establish this culture, it is necessary to plan and define a project information system even before the project begins.

The main objective is to provide and distribute all project-relevant information to all members of the team in order to create a basis for the distribution of project tasks. Furthermore, information should be provided promptly and in the shortest possible way. Two types of information dissemination are distinguished. One is via **oral** communication and the other is via **written** communication.

Oral communication is considered the most effective and intensive form of cooperation. Meetings belong to the formal communication channel. The team has agreed on weekly meetings within the team and additionally with the supervisors. In the team meeting, the work results of the previous week are presented, feedback from the supervisors is discussed and the next sprint plan is drawn up. In the jour fixe with the supervisors, the current project developement are presented and discussed.

In addition to the meetings, unplanned conversations take place in the team. These take place either between lessons or via the communication tool Whats App. With the help of this informal form of communication, difficulties can be solved more quickly and flexibly, and possible developments can be discussed much earlier.

In **written communication**, information is provided in writing so that each team member has access to the documents of other participants. In addition, each member has the possibility to retrieve certain information independently. Information is provided on the cloud-based storage “OneDrive” of ISEP University, as this tool enables collaborative work. Protocols, documentation and task logs are kept in this folder, making all steps relating to the project traceable. Our reporting is done on the Wikipedia page.

3.7 Risk

Risks in general are understood as the danger that the realized result deviates from the planned result. This happens mainly due to unknowable events. The main goal of a well-developed risk management is therefore to systematically identify risks at an early stage in order to then minimize them to increase the probability that the project goals will be achieved. A lack of a well thought-out risk management system can lead to partial or, in the worst case, total failure of the project. Also, early and effective minimization of the risk potential leads to avoidance of rework costs.

There are four phases in the risk management process: Risk identification, risk assessment, risk treatment, risk controlling.

Risk identification - Collection of potential risks in various fields of observation that arise in the course of the project.

Risk assessment - Evaluation of risks, depends on the risk preference of the decision maker. As a risk-neutral company, our decisions are based primarily on expected values.

Risk management - Development of strategies to manage risk. The measures can be preventive or corrective. The following risk strategies are distinguished: risk avoidance, risk reduction, risk transfer, risk assumption.

Risk monitoring - Review of the planned measures and their effect as well as the further development of risks. The individual processes do not represent completed procedures, but must be monitored regularly and re-evaluated when new information about a risk is available. The following tables are identified risks regarding to the project and product.

Table 6: Risks on the project level

Risk Event	Probability	Impact Rating	Risk Handling
Deadlines are not kept	possible	significant	creating sprint plant to keep all members updated with the current tasks, finding out the origin of the delay, weekly meetings
Lack of appropriate prior knowledge to gather expertise promptly	very likely	significant	assign different expert roles to each person, who informs their group members about their research and transfers learned skills
Coordination problems between the team members	possible	moderate	weekly meetings incl. writing minutes that are published in the shared cloud

Table 7: Risks in the product level

Risk Event	Probability	Impact Rating	Risk Handling
technical issues (failure of parts)	unlikely	severe	creating stress simulation
delivery delay	possible	significant	guaranteed delivery on time
too costly	possible	moderate	make or buy decision, finding a cheaper alternative, finding sponsors
public has hurdles to participate	unlikely	severe	strong study of the state of the art

The biggest challenge of a project is that due to existing risks a project’s success can be achieved completely, partially or not at all. With a well-developed risk management, the chance of achieving

the project goal is increased and risks can be minimised through early and effective identification. Furthermore, minimizing the risk potential also means avoiding post-processing costs. The tasks of a risk manager include: risk identification, risk evaluation, risk handling, risk controlling.

3.8 Procurement

The first decision that had to be made was about the screen as the main feature of our product. It was obvious that the team wouldn't be able to manufacture a screen by itself so we started to look at what exist in the market. During our research, we realised that screens which meet our criteria (resist hot, cold, rain, chocs, ...) are actually final products. Those often contains every thing needed, including brightness sensors, controler, etc. and ends up behing ecenomicaly advantageous.
Since we found our screen, we have to design the structure to go with. And because we are designing it, most part will have to be made especially for our product. It is not realistic to think it will be possibleto manufacture them ourself. Therefore it is needed to adress local subcontractors which would be able to manufacture them. Obviously,standard parts are favored whenever possible as for the hardware (screws and brackets).
The only part that could be profitable to be build by the company is the bench. If it's made out of HDPE (cf material selesction in section 7.4) and design the way it is, then it could be made by rotomolding. This would allow to make this part by ourself at lower costs.
To be added. Document your procurement management strategy including make vs buy decisions, materials/services to be acquired, sources, costs, timings, etc.

3.9 Stakeholders Management

Stakeholders management is about how will internal stakeholder (such as our group members) handle external stakeholders. In the case of Parcitypate, there are three main external stakeholders that can be indentified : Users, clients and suppliers.
Users are the most important ones, especialy for our project where our first goal is to get them invested as much as possible. However, interaction with users will only be done though the use of parcitypate. Therefore, the product is completely designed to improve the participation rate and user experience. This is archieved through everything possible like the website but also via the design of the structure.
Clients are another very important stakeholder for any project. For parcitypate, clients are mostly going to be town halls. To have them engaged, and for the longest time, it was necessary to identify their needs as well as strengh and weekness of the project. The chapter 4 about marketing explains and details these choices that were made.
The last external stakeholders identified are the suppliers. Their importance is great because the manufacturing of the product relie almost them. From the raw materials, to the shaping of parts, but also the transportation, all these cannot be fully carried out as explained in the previous section 3.8 procurement. Therefore, it would be detrimental to not maintain good relationship with them. But on the other hand, since we are so dependant on them, it is necessary to monitor them closely. Thus, contrats must clarify precisely needs and expectation as well as what should happen if not respected (delays, etc).

3.10 Sprint Outcomes

The following tables show the weekly sprints, indicating the task, the completion status and the person in charge. In addition, the planned working hours are compared with the actual workload.

Table 8: Sprint 1 - week 9

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		74	74	all	done
PROJE	Choosing our Topic	2.5	2.5	all	done
PRMTW	Preparation of a Team Building Game	2.5	2.5	all	done

Table 9: Sprint 2 - week 10

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		80	80	all	done
PROJE	City Walk	20	20	all	done
	Research of our Preferences	30	30	all	done
	Project Backlog	2	2	Carmen	done
	First Global Sprint Plan	3	3	Carmen	done
	Gantt Chart	4	4	Julia	done
	Report + Agenda	2	2	Carmen	done
ETHDO	Code of Conduct (Engineering)	10	10	all	done

Table 10: Sprint 3 - week 11

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		98	98	all	done
PROJE	State of the Art	20	32	all	doing
	Blackbox	3	4	Carmen	done
	Structual Drafts	5	5	Carla	done
	Report + Agenda	2	2	Jan	done
ESUSD	Research about Energy (Flow and Reserves)	2	?	Eliott, Jan	done
MACOM	Our Group Target	5	7	Carla, Carmen, Julia	done

Table 11: Sprint 4 - week 12

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		118	118	all	done
PROJE	State of the Art	4	9	Jan	doing
	Blackbox	3	2	Carmen	done
	Report + Agenda	2	2	Julia	done
MACOM	Finding our Team-ID	14	16	all, Carla	done
MACOM	Leaflet	8	8	all, Carla	doing
PRMTW	WBS	6	6	Julia	done

Table 12: Sprint 5 - week 13

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		129	129	all	doing
PROJE	State of the Art	5	8	Jan	doing
	Continuing with Team ID	20	20	all	doing
	Report + Agenda	2	2	Carla	done

Table 13: Sprint 6 - week 14

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		56	42	all	done
PROJE	Leaflet	5	5	Carla	done
	List of Materials	8	9	Eliott	done
	Sprintplan and Backlog	6	8	Julia	doing
	Report + Agenda	2	2	Eliott	done

Table 14: Sprint 7 - week 15

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		33	33	all	done
PROJE	Upload Intirim Report	40	50	all	doing
	Cardboard scale model	10	10	all	done
	Report + Agenda	2	2	Carla	doing

Table 15: Sprint 8 - week 16

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		110	110	all	done
PROJE	List of Materials	8	8	Jan	done
	3D-Model	15	18	Eliott + Carla	done
	Report	20	20	Carmen + Julia	doing

Table 16: Sprint 9 - week 17

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		50	50	all	done
PROJE	New Product Design	50	50	all	done
	Schematic	8	8	Jan + Carmen	done
	Report + Agenda	8	8	Julia	doing

Table 17: Sprint 10 - week 18

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		70	70	all	done
PROJE	New 3D-Model	24	24	Eliott + Carla	done
	Marketing	20	20	Julia	done
	Sustainability	10	10	Eliott	done
	Website	20	20	Carmen	doing

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
	Report + Agenda	6	6	Jan	doing

Table 18: Sprint 11 - week 19

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		65	65	all	done
PROJE	Website	20	20	Carmen	doing
	Physical Stresstest	10	10	Eliott	done
	Marketing	10	10	Julia	doing
	Paper	6	6	Jan	doing
	Packaging	10	10	Carla	doing

Table 19: Sprint 12 - week 20

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		112	112	all	done
PROJE	Renderings	20	20	Carla + Jan	doing
	Schematic Prototype	8	8	Jan	done
	Marketing	20	20	Julia	done
	Ethics	10	10	Eliott	done
	Website	20	20	Carmen	done

Table 20: Sprint 13 - week 21

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		50	50	all	done
PROJE	Prototyp	30	30	Jan + Carmen	doing
	Paper	30	30	all	doing
	Project Management	10	10	Julia	doing

Table 21: Sprint 14 - week 22

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		20	20	all	done
PROJE	Leaflet	5	5	Carla	done
	Poster	5	5	Carla	done
	Rendering	10	10	Carla + Jan	done
	Functional Tests	10	10	Carmen	done
	Prototype	10	10	Jan	doing
	Project Management	12	12	Julia	doing
	Paper	8	8	Eliott	doing

Table 22: Sprint 15 - week 23

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		30	30	all	done

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
PROJE	Product Video	20	20	Carla + Jan + Eliott	done
	Cardboard scale model	8	8	Carla + Julia	done
	Report + Agenda	2	2	Carla	doing

Table 23: Sprint 16 - week 24

Subject	Task	Estimated Duration (h)	Real Duration (h)	Members Involved	Status
Weekly Classes		25	25	all	done
PROJE	Final Report	50	50	all	done
	Paper	20	20	all	done
	Video	15	15	all	done
	Manuel	6	6	Carmen	done

3.11 Sprint Evaluations

Due to the high workload caused by the lectures in the middle third of the project semester and illnesses of some team members, the team fell behind somewhat towards the end of the project period. Nevertheless, a strict distribution of tasks and a lot of teamwork made it possible to lead the project to a successful result. The division of larger tasks into sprints made it possible to better estimate the time required and to keep motivation as high as possible. There is potential for improvement above all in a more balanced distribution of workload over the entire course of the project. The joint focus on finding a solution in the event of time bottlenecks should be emphasized positively.

3.12 Conclusion

Well-structured project management serves as a key element to ensure a high-quality project that is completed on time and within budget. It is important to live project management throughout the entire project phase, i.e. from project planning to project closure. With the help of the SCRUM method, the work schedules and tasks were organized and successfully completed. The detailed management plan regarding quality, people, risk, procurement and stakeholders helped the project team to successfully complete the project.

In the following chapter, a complete marketing plan is created. Through a comprehensive marketing analysis, the strengths and weaknesses of the company and the opportunities and threats related to our product are addressed and the marketing strategy and its control are outlined.

4. Marketing

4.1 Introduction

The marketing decision-making on a company shouldn’t be made without planning. Part of a company’s success come from a marketing plan, specifying its objectives and strategies to help achieve the main goal - it’s more than promoting a product. This plan should be elaborated to help identify, anticipate and integrate the purpose of the product and its brand.

A Marketing Plan is a document that clarifies our marketing objectives, strategies, budget and action plan to accomplish the target. It is a tool that can be considered a manual to be used and updated every year.

It allows the improvement of the company by the relation with the client, internal organization, and in your relation with the market. It allows to gather information about our target group , decide how to behave based on real data, market analysis, helps define and reach the goal, besides controlling investment and anticipating crisis (know how to deal with it). In that way, it makes the company prepared to act and respond to whatever adversities there is.

Throughout this chapter, it is going to be shown the analysis of the different marketing areas that are necessary to create a marketing strategy and what is the best way to include our product in the city.

4.2 Market Analysis

A Market Analysis is essential to understand and direct resources to aim the desired target. Our goal is to use the results of the marketing analysis to evaluate the market and to work out the opportunities and risks for our product. Furthermore, we want to identify and understand trends and changes in the market in order to adapt our product to the needs of our customers.

Our analysis is divided into three analytic parts: environment, market and company.

The goal of the **environment analysis** is to understand trends and changes in the market , which are indispensable for the alignment of the marketing strategy. This also includes the identification of opportunities and risks regarding to our product. The environment analysis belongs to the external analysis.

At the **market analysis**, customers, competitors and suppliers are filtered out and analyzed. Also this analysis has an external focus.

The **company analysis** comprises the company itself. It filters the strengths and weaknesses of our team.

4.2.1 Environment Analysis

To cover most of the external factors, we decided to use the PESTEL analysis. The acronym PESTEL stands for political, economic, social, technological, environmental and legal. This method also helps us to define our first opportunities and threats regarding to our product.

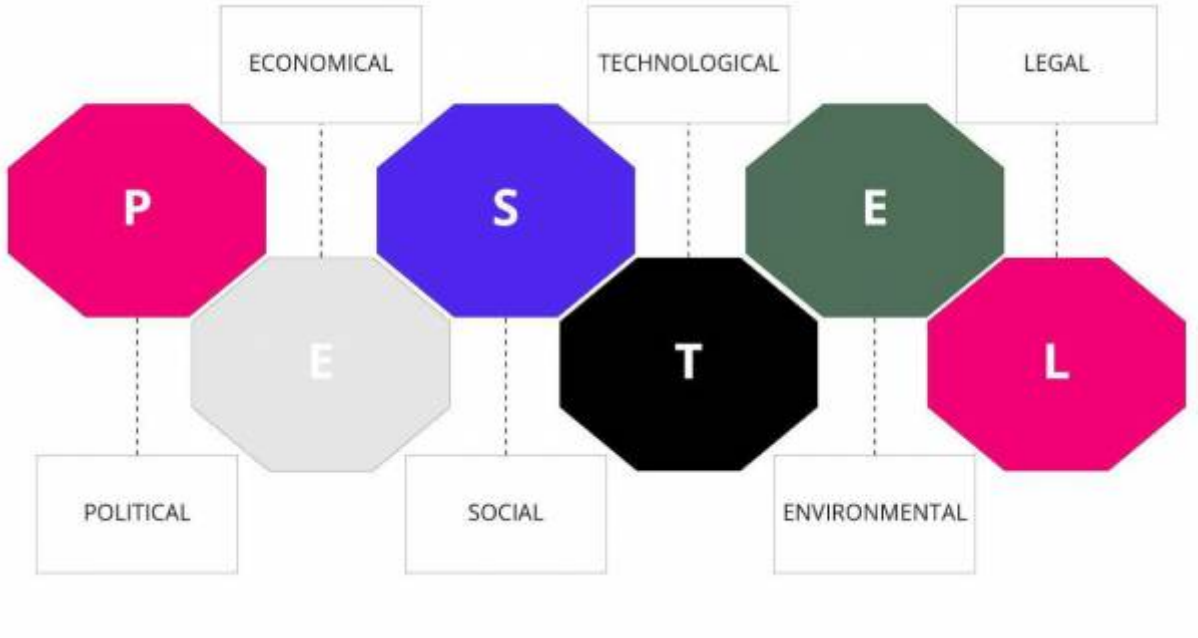


Figure 15: PESTEL-Analysis

Political - Portugal is a parliamentary democracy since 1975 **[Expatica, 2021]**. The central Portuguese government has executive power and is responsible for policies in education amongst other things. For a long time, there were no subjects in public schools that taught students the basic civic values of democracy. This leads to difficulties because they are not taught what democratic participation means. The current government has finally decided to include a subject like social studies in the curriculum. **[Tilo Wagner, 2019]**

Economical - Besides the real state taxes that citizens pay, there is a touristic tax that charges all tourists during their accommodation in Porto – which was increased during 2020. In that way, the government feels more pressure to maintain all urban infrastructure excellent for everyone **[Jorge Duarte Estevão, 2020]**.

Social - The study “The Political Participation of Youth in Portugal” found that more young people in Portugal are interested and engaged in politics. While participation is not reflected in “conventional” modalities such as elections or party meetings, online political participation increased in e.g., political discussions in social networks as well as in civic participation through demonstrations, signing petitions, fundraising, or boycotting “certain products for political reasons” or against climate change **[TPN/Lusa, 2022]**.

Technological - Around 98 % of the Portuguese population is using the internet on a smart phone. Around 84.9 % of people are operating with a laptop or computer. These numbers are based on the population aged between 16 and 64 **[Simon Kemp, 2021]**.

Environmental - In 2021, 79.5% of Portugal's electricity was generated from renewable sources. Wind power plants produce 28% of the electricity on the mainland and thus offer more than all fossil fuel technologies combined. Furthermore, Porto has committed to becoming a climate-neutral city by 2030. This includes a growing share of renewable energies. With this in mind, we assume that the energy supply of our screen will be powered exclusively by green electricity and that the implementation of solar panels could have a bigger environmentally damaging **[Lucas Morais, 2021]**.

Legal - For the public installation of our product, it needs to follow the rules about its regulations, such as flat shapes, without sharp edges, pointed or cutting elements, impact-resistant, non-oxidizing,

combustible or corrosive materials and, where applicable, a watertight lighting system inaccessible to the public, and many others **[Porto - Câmara Municipal, XXX]**.

4.2.2 Market Analysis

Suppliers

In order to guarantee the high quality of our product, the selection of suppliers is particularly important. In addition to quality, reliable delivery (i.e. no defective goods + in time delivery) and sustainably produced goods are important criteria that influence our choice of suppliers. Our product should be robust, durable and weather-resistant, as our product will probably be placed mainly outdoors. As we have limited our first location to Porto, we want to source local suppliers first, as this can prevent a delay in delivery due to a pandemic, for example.

Potential Customer Market

The main demand for our product will come from governments who want to increase citizen participation in their city/country. This is not only about increasing voter turnout, but mainly about giving young people an alternative to conventional participation opportunities. The preceding analysis has shown that more young people are interested in politics and also get more involved. Another interested party could be the Civic Participation Initiative, which is researching exactly how to better involve young people in decision-making. It is important to mention that our customer is the government, but the users are the inhabitants of the respective city/country.

Distribution

Our Smart Display is brought to the place where, for example, a new construction project is pending, a new park is to be created or in the market place. It will be erected specifically in the place where the right inhabitants will be reached. We want to start in Porto - the second-largest city in Portugal. In the long term, we want to expand our offer throughout Europe.

Competitors

As seen in chapter 2, section 2.6, there are no similar products established on the market. There are only projects that are not in circulation, so it is difficult to draw a comparison with our product. It should be noted that these projects have not been launched on the market because the interest of the inhabitants has strongly decreased after a short time. On the other hand, e.g. with the participation with the feet were only used for fun, so that no meaningful results could be achieved. In addition, all the prototypes presented can only be used in public. In order to obtain as many opinions as possible, including critical ones, the voting is done privately on the mobile phone.

4.2.3 Company Analysis

To analyze our strengths and weaknesses, we looked at the Business Model Canvas. The model is an innovative method for describing, analyzing and designing business plans. The model also covers the areas of customers, supply, finance and infrastructure and how we position ourselves as a start-up in these areas.

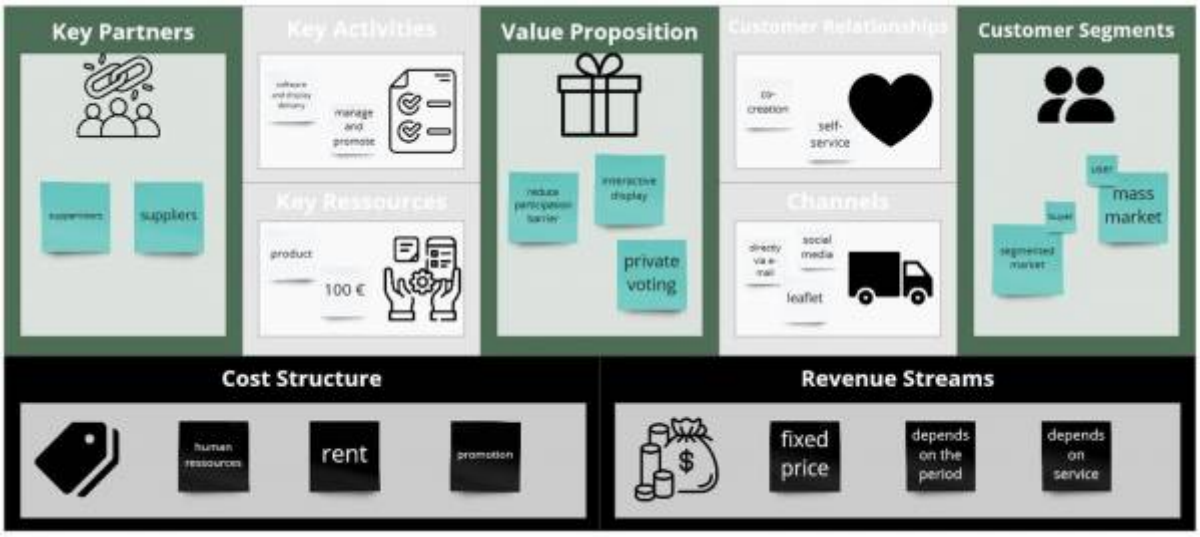


Figure 16: The Business Model Canvas

Customer Segments - We advocate for the segmented market because our product is for governments that want to have more citizen participation. However, there can be slightly different needs from the government about the voting options, so we can customise the voting options. The special feature of our product is that the buyers are the government, but the users are all citizens of a city/region, etc., thus the user group belongs to the mass market, as we want to reach especially many citizens

Value Proposition - People have a high participation barrier when it comes to public participation, as they do not want to share their views and opinions on community issues publicly. It is important to push participation with new innovative ideas, because the interest of young people is there, but you cannot reach this group with traditional services. So our target group is governments that want more citizen participation in urban planning. We at ParCITYpate provide an intelligent display that encourages citizens to contribute their opinions and ideas on urban decisions through an interactive screen. Unlike our competitors, we provide both an engaging interactive screen and a private platform for submission and voting.

Channels - We want to draw the attention of our buyers via brochures. In addition, the government is to be contacted directly via e-mail. We want to make our users aware via posters. Another way to reach our users can be through social media. In addition, customers will already be aware of our display through our set-up of our product at the respective location. Fix Me! no brochure - online maybe directly to https://www.anmp.pt/en/

Customer Relationships - It is very important to us to respond to the needs of our customers. We will provide our product (the display and the system). Project descriptions, 3D models, etc. are provided by our customer so that we can incorporate them into our product. To address these specific needs, we generate a close collaboration (co-creation). We do not build a special relationship with our users. They can use our offer (self-service).

Revenue Streams - Our customers are offered our product at a rental price. This price depends on how long the product is needed and extra services such as promoting and managing the data. For users, however, the product is provided free of charge.

Key Resources - Our product consists of a bench, 4 struts, a display. The materials and manufacturing are done externally (physical) Our budget is currently limited to 100€ to finance our prototype. If our project becomes a reality, we will look at our cash resources and possibly take out a loan. Furthermore, we can also consider that our product will only be manufactured once interest has

been declared on the part of the clientele (financial).

Key Activities - We offer our customers the provision of our display construct as well as our software. In addition, the promotion of the use of the product can also be booked.

Key Partners - In the context of this project, our supervisors are the key partners who will provide us with the necessary materials for our project and support us in the development of our product. Furthermore, we will establish a close supplier relationship to ensure a secure supply. The supplier should preferably be from Portugal.

Cost Structure - Costs include personnel costs, rent to house our products and advertising costs. The costs are further detailed in chapter 4.7.

4.3 SWOT Analysis

SWOT is a method for a realistic assessment of the initial situation in order to develop measures and strategies for the implementation of goals. With the help of this method, we want to identify our competencies and service to use them as our advantage on the market.

The acronym SWOT stands for Strengths, Weaknesses, Opportunities and Threats. The strengths and weaknesses are derived from the company analysis. The opportunities and threats, on the other hand, result from the analysis of the environment and market.

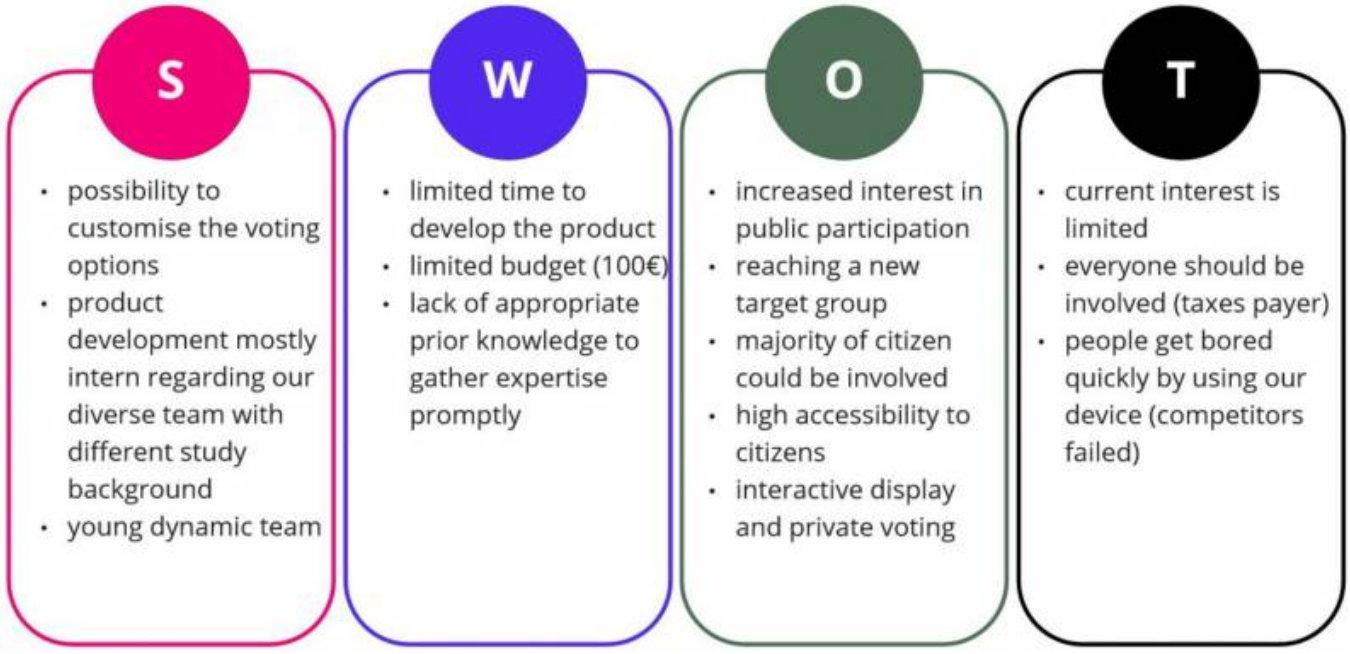


Figure 17: Parcitypate SWOT analysis

4.4 Strategic Objectives

In marketing, the definition of goals makes a fundamental contribution to achieving the economic success of a company. They allow us to understand our strategic objectives and decide if our plan is successful and well executed. In order to establish basic requirements towards our goal, we have followed SMART method. This method assumes that the characteristics of our goal must be specific,

measurable, achievable, realistic and timely.

Moreover, our main goal can be classified into result goals and procedure goals. Result goals are based on our task. Procedure goals refer to the entire process, i.e., the boundary conditions that must be observed to achieve our result goal.

Result goals

- finalized prototype by 22.06.2022
- at least 2 of the 18 city councils are committed to our product by 31.12.2022
- conquering the market by 30.06.2023
- 1 500 user connections within two months
- at least 500 votes on the website within two months
- final product should be weatherproof
- our software shouldn't fail once during a project

Procedure goals

- budget constraint: 100 EUR for the prototype
- request for our materials in time (latest on 28.04.2022)
- completion on time and planned hours (see chapter 3.7)
- weekly meetings on Thursdays to update our project progress

4.5 Strategy / Targeting / Positioning / Brand

The marketing strategy allows the company to recognize skills and resources available to accomplish the success of its product.

For city Governments who want citizen participation in urban planning, the Parcitypate is a smart display that encourages citizens to submit their opinion and ideas on city decisions through an interactive screen, unlike Claes, “vote with your feet”, or ubinion. Our solutions allow private participation through a connection with a website.

To understand Parcitypate marketing strategy, it was also divided into three pillars of the model of the brand triangle: identity, object, and response pillars (see Figure 18)

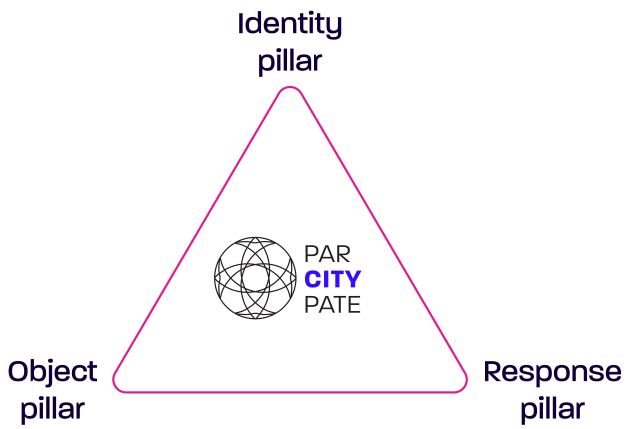


Figure 18: The Brand Triangle

Identity pillar

Parcitypate is the junction of City and Participate, and it was created to represent the idea of interaction of the citizens in the city planning. For the product logo design, its symbol was created to represent the city. Considering that this project is being started in Porto, it was analyzed what could originate from geometric forms seen in Porto sketches and that could be embraced in our design – creating a connection with the city. Also, a strong and modern typography was adopted to be attached to the representative geometric symbol to show the power and importance of the city.

Object pillar

Parcitypate consists of two products: the screen environment and the web/app design. In order to accomplish both successfully, it is needed to the robust and connected with the visual identity of the brand. The product itself was designed to draw attention of citizens to participate in the city decision-making.

Response pillar

A consolidated human resource is needed to make be in contact with distributors and suppliers and make sure the product is functional and not harmful to its consumers.

The brand concept is shown and explained in chapter 7, section 7.3 Ideation.

4.6 Adapted Marketing-Mix

A consolidated human resource is needed to make be in contact with distributors and suppliers and make sure the product is functional and not harmful to its consumers.

To analyze the market mix of Parcitypate, it is going to be separated into the 4p's: **Product, Price, Place and Promotion**, as well as the service and experiences.

Product

Parcitypate a public display with a smart screen and motion sensors that interact with citizens through a website provided by a QR code.

Price The price of our product is around 15.000 € - which involves the structure, screen, and website

Place

Parcitypate would be placed in cities - the first try of the product was designed to be tested at Porto, Portugal.

Promotion

People would be attracted by the structure of our product. In addition, there are going to be posters, leaflets, and flyers around the city enunciating Parcitypate.

Therefore, the product overcomes the problem of the participation barrier by offering a private platform for submitting and voting in combination with an attractive and engaging structure with an interactive screen.

4.7 Budget

The marketing budget throughout media advertising is necessary to **increase consumer exposure, market positioning and create product awareness**. Since Parcitypate is a product with a different approach around the city, a promotion is needed to build the product's recognition. To achieve this, Parcitypate will utilize printed and online advertisements to approach the citizens and the city authorities.

In contemplation of **printed materials**, they will be divided into leaflets and posters. Both methods will embrace the Parcitypate's logo and contacts, along with appealing product information.

For **social media** exposure, it will be broadcast through Instagram, Facebook, Twitter, and LinkedIn. In that way, it will not only promote for citizens and city authorities, but also allows them to share their perspective of Paricitypate.

The specified budget for each approach is demonstrated in the tables 14 and 15.

Table 24: Marketing Budget - **Public**

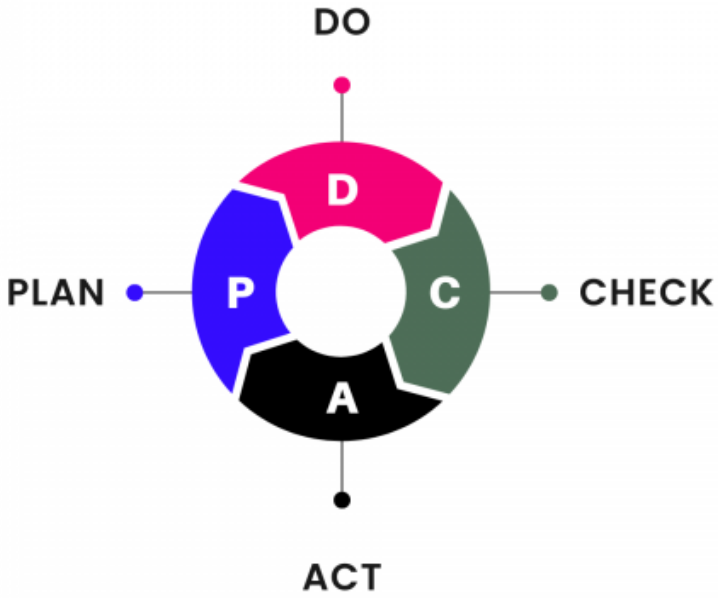
Costs	**Price (€)**
Instagram	450
Twitter	150
Posters	200
Leaflets	200

Table 25: Parcitypate Marketing - **Government**

Costs	**Price (€)**
Facebook	150
LinkedIn	300

4.8 Strategy Control

For the product Strategy Control, it will be followed an approach that has 4 stages to improve and promote Parcitypate. PDCA (Plan Do Check Act) (see Figure 20) cycle is a strategy beneficial to accomplishing constantly development of our product.



y

PLAN

For planning, we understand the market during this moment, and decide how our purpose is going to fulfil this opportunity. In this way, the barrier on voting in urban decisions must be solved by Parcitypate.

DO

At this point, a test is needed to understand if it is working; start measuring the way it works. Identify if people are interested to participate.

CHECK

Analyze the results from the planning. It the problem barrier was solved, and if not, return to **PLAN** step.

ACT

On this step, we implement the best solution emerged from the other steps.

This strategy is not done once. If can be constantly used to keep improving the product.

4.9 Conclusion

Based on this market analysis,the team decided to create Parcitypate - intended to encourage citizens to submit their opinion and ideas on city decisions through an interactive screen because there is a barrier when it comes to citizen participation. Consequently, the team decided to create a product that is attractive to the people. Parcitypate is a public display with a smart screen and motion sensors

that interact with citizens through a website provided by a QR Code. It is easy to access, giving citizens the opportunity to have an impact in the city decision-making.

In addition, for the next chapter, it will be discussed how our product will respect all the three pillars of sustainable development.

5. Eco-efficiency Measures for Sustainability

5.1 Introduction

The concept of sustainable development as we understand it today was born at the end of the 20th century. As originally defined in 1987 at United Nations, it is “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Sustainability can be achieved by taking into consideration these three pillars: environmental, economic and social. The consequences can easily be observed when these principles have not been applied. As an example, it is possible to cite the global warming for the environment, subprime crisis for the economy or child labor for the social.

Smart cities are a direct enforcement of these principles. In this context, our product, ParCITYpate, should respect all of the three pillars from the sustainable development. Therefore, in the following sections, we are going to present its impact on the environment at first, and on the economic aspect. Then we explain the social value of our product before ending with a life-cycle analysis.

5.2 Environmental

ParCITYpate impacts the environment at three diverse levels.

Firstly, manufacturing needs resources for making every component inside. These same components might also be transported which impact the environment as well. As an example, manufacturing a screen (especially if it is a large one) is extremely polluting. But once all these components are coming together, we still need a structure to hold and protect them. This structure needs materials which are probably going to be transported, transformed, and shaped. All these operations will have some impact on the environment either directly or by the usage of energy. We will try to avoid or minimize environmental consequences as much as possible. This is going to be a defining criterion for many of the choices we are making (material used, manufacturing methods, etc.).

In a second time, ParCITYpate will be impacting the environment through all the energy it will consume during its time in service. To save as much energy as possible, we tried to choose components which consume less and implement some functions to adjust the energy consumption depending on the situation (adaptative brightness, sleep mode, etc.).
Low energy consumption is one thing but energy source matters even more. Our two main options to power our system were to connect it to the electricity grid or to power it with a built-in solar panel. We came to the conclusion that the best option was to connect directly to the grid. There are several reasons for that. In addition to the fact that a solar panel would certainly not provide enough power, its inconsistency would force us to add a battery to our system to store energy when the weather is

not good enough. As we know, manufacturing solar panels and batteries aren't the cleanest thing on earth and the benefit would not compensate for their environmental cost. So, we decided to connect our device to the electricity but, depending on the country, this electricity can be very clean or not at all. As an example, producing electricity in Sweden emits almost no CO^2 unlike Poland which emits 60 times more for a similar amount.

Finally, our product will impact the environment after its lifetime. Therefore, we need to design it in a way that would generate no waste. To begin with, it must be possible for our system to completely take it to pieces. This allows unique parts to be changed if they stop working and to be reused after the product lifetime. The structure of the product must be easily 100% recyclable which limits usable materials but also prevent the use of multi-material parts.

5.3 Economical

Economic sustainability can be defined as the ability to support a certain economic level in the long term. Although a lot of companies tend to favor this aspect of sustainability, it should be done without impacting negatively on social and environmental aspects.

Our project is directed towards large cities so we should take care that Parcitypate does not disturb the town hall's economic equilibrium. Fortunately, the price of our product will be low enough to almost look negligible compared to the economy of a municipality of this size.

On the other hand, we must take actions about our own economic sustainability or that of our surroundings. For example, we will try to favor local providers as much as possible. We also want to try to reduce some of our costs (like using a single size of screw to reduce logistic costs) where it is possible without giving up our principles and commitments about social and environmental sustainability.

Finally, we want to be perfectly transparent to our clients and users, this also includes accountability and objectives.

5.4 Social

Social sustainability has been the center of the discussions from the very beginning. Indeed, by trying to get any citizen invested in city planning and urban decisions, our main goal is to solve a social sustainability problem.

Therefore, the question of social sustainability was really at the definition of our project. But while defining it, we encountered a few problematic we had to resolve by placing strict delimitation to what we want to do. We also identified traps which we do not want to fall into (accessibility to anyone, …)

5.5 Life Cycle Analysis

Life cycle analysis is a method to assess the impact of a product along its complete cycle. It helps to

develop new products while taking into account more consideration. We identify six distinct stages that the product will go through in order: Resources, Processing, Manufacturing, Distribution, Use, End of life.

Ressources

In order to reduce the impact of our product on the environment, we tried to use as much as possible materials that are recycled, reusable, non-toxic, and long-lasting. Therefore, we decided to use stainless steel for part with mechanical properties, HDPE (thermoplastic easily recyclable) for the bench, and glass for the transparent roof. Concerning electronic components (such as the screen), there is not much we can do since they are absolutely necessary for our product.

Processing

Reducing the impact of the processing implies to design parts in a different way. The number of operations used to form the parts must be limited as much as possible and techniques used must consume as little energy as possible.

Manufacturing

Key elements to improve the manufacturing impact are : energy efficiency, continuous improvement of production methods, reduction of production steps, and choice of local providers.

Distribution

There are three main aspects of the distribution we can influence to reduce its impact. First we decide to choose local providers. It has the benefit of reducing the distance on which our parts and products must be transported. Second, also try to lower as much as possible the number of distinct places where operations are made. If every part is made and assembled in the same place, then the distribution impact would be minimal. Third, we want to use cleaner means of transportation instead of the more polluting ones (avoid plane, etc.).

Use

The more obvious aspect when it comes to the use is the energy consumption. To reduce it , we try to choose components that comsume less energy. We also included sensors to save energy when the system isn't actively used.
Then comes the question of the energy powering. We had to choose betwin two main options : Solar panels or electricity grid. We decided to go completely with the second one because solar panels had a lot of drawback (too big surface needed, need battery in support, need sunny location, electricity sometimes less clean than the electricity grid du to the solar panel own life cycle).
The last aspect is the maintenance aspect. In order to do maximise the lifetime of our product, we designed it in a way that every part can be disassembled and replaced independently from others. So, if a given part breaks or stop working for whatever reason, it is easily replaceable without

compromising the entire system.

End of Life

At a point, the product will reach the end of its life, either because it stopped working or because it isn't useful anymore. Since this is inevitable, we have to do everything in such a way it can be reused or recycled. First the screen and electrical components can be reused as they are since they weren't designed especially for our project. Then, every other parts built especially for our project are made in such a way they are easily recyclable :

- single material parts (no composite so materials don't have to be separated before recycling)
- Materials used are easily and completely recyclable. The process used to recycle the materials shouldn't use too much energy and have a good yield.

Therefore, every single element of our system will be either recycled or reused as it closes the life-cycle of the product.

5.6 Conclusion

At all step of the devellopement of our project, we took into consideration sustainability concerns. From the main goal of our project that answers a social issue, to the design of the product that minimize the environmental impact, we tried to make Parcitypate in a way to have the best impact possible on its environment (ecological, social, economical,...) This thinking we exposed in the past sections influenced and defined all the decision we made but we also had to consider a lot of ethical questions. In the following chapter, we detail them and explain how it influences our project.

In addition, for the next chapter, it will be discussed how our product will respect all the three pillars of sustainable development.

6. Ethical and Deontological Concerns

6.1 Introduction

The word deontology derives from the Greek words for duty (deon) and science/study of (logos). According to the Stanford Encyclopedia of Philosophy **[Stanford Encyclopedia of Philosophy, 2021]**, deontology is a “normative theory regarding which choices are morally required, forbidden, or permitted”. It does not assess what kind of person you should be nor the consequences of your actions. Instead, it focuses on guiding and assessing our choices of what we ought to do by using a set of rules.

Ethical and deontological concerns are extremely important in a society, firstly by proposing rules which goes even beyond the laws. Companies has a lot to lose from ethical scandals especially companies which rely on their brand image. Indeed, we have seen many companies losing clients,

losing markets, or even collapsing after ethical troubles. This effect could be even more important in recent years with the development of social media in our society.

We are caring about making our project ethically blameless. To do so, we focused on different angles which make the following sections. First of all, the engineering ethic, where we focus on the engineer's duties. Then, sales and marketing ethics, where we try to delimit the frame in which these activities can be done. But also, environmental ethic which is related to the sustainability section and finally liability.

6.2 Engineering Ethics

The deontological rules for engineering can vary from one country to another and some countries do not even have a written code of ethics. We decided to comply to the Portuguese code of ethics **[62]** by the engineer's order. The first section of the document reminds engineer's goals and justify the importance and necessity of having ethic rules. In a second time are listed all ethical rules engineers working in Portugal should comply with. They are divided into 3 main sections: Responsibility, Orientation, Implementation. For each one of these, we identified which one does apply to our project :

- Be responsible for our acts
- Assume solid principles of economic, social and environmental sustainability
- Take into account the implications that result from our performance
- Use caution and take responsibility
- Cover information to customers
- Be aware of the implications of integrating technical systems in the social, economic and environmental context
- Avoid situations that could expose them to external pressures and immediate, abusive and arbitrary constraints
- Don't create unethical product
- Contribute to the development and continuous adaptation of the fundamentals of ethics in engineering
- Update our skills and refrain from carrying works for which we are not competent
- Analize and ponder controversial views

However, in the context of this project, our clients are distinct from the users of our product. This makes some of the previous statements not relevant and others even more important.
Firstly, our personal ethical standards and open discussions among the group take centre stage and stand as the most important thing to look out for. We also identify some specific practice to absolutely avoid. The first of them being to affirm false statements or deform true to our advantage.

6.3 Sales and Marketing Ethics

Because we want our project to be ethically blameless, marketing ethics should not be left aside. In order to achieve this, we followed the Principles of Ethical Marketing :

- All marketing communications share the common standard of truth.

- Marketing professionals abide by the highest standard of personal ethics.
- Advertising is clearly distinguished from news and entertainment content.
- Marketers should be transparent about whom they pay to endorse their products.
- Consumers should be treated fairly based on the nature of the product and the nature of the consumer.
- The privacy of the consumer should never be compromised.
- Marketers must comply with regulations and standards established by governmental and professional organizations.
- Ethics should be discussed openly and honestly during all marketing decisions.

However, in the context of this project, our clients are distinct from the users of our product. This makes some of the previous statements not relevant and others even more important.
Firstly, our personal ethical standards and open discussions among the group take centre stage and stand as the most important thing to look out for. We also identify some specific practice to absolutely avoid. The first of them being to affirm false statements or deform true to our advantage.

6.4 Environmental Ethics

Environmental ethics is the discipline that studies the moral relationship of human beings to, and also the value and moral status of, the environment and its non-human contents. It teaches that humans are forming a society with other living entities (plants and animals). Therefore it is important to take into consideration the effects we can have on them, whether it is direct (deforestation, use of fur or tusks, etc.) or indirect (climate or environment modifications, etc.). Environmental ethics also raise attention on moving from an anthropocentric (human-centred) vision, to a non-anthropocentric vision (nature-centred) thus promoting nature instead of using it as a resource.

Importance and interest in theses questions have grown during the last decades. Although some companies actually stared to act in a more responsible way, a lot of others reduced it at a communication tool. However, labels such as “sustainable”, “green” or “natural” are, many times, wrongly used. This type of action is part of what is called the greenwashing. It basically consists of giving a false impression or providing misleading information about how a company/product/service is more environmentally friendly than they are. It can include the abuse of overused term, association of ideas (green logo = natural and clean), partially true information (products sold as recyclable if it is partly), or the promotion of irrelevant actions.

In this context, it is important to be transparent in our communication on these questions (cf marketing ethic). Instead, we are trying to include truly determining choices in the creation of our product and make decisions which would truly allow reducing our product impact on the environment. All the consideration we made is detailed in the sections 5.2 and 5.5 of the sustainability chapter.

6.5 Liability

We can define liability as “the state of being legally responsible for something”. While developing a product, this legal aspect must be taken into consideration to protect the company from eventual lawsuits regarding accidents that could happen in relation with the product whether it is by the product itself, its usage, or the communication around it.

To do things properly, we decided to comply with the following EU directives:
♦ **Machine Directive** (2006/42/CE 2006-05-1705-05-1717): concerning the danger machines may present to men, such as explosions, vibrations, radiation, finger joints, dangerous substances in flight, force limits for the operation of machines, minimum safety distance.
♦ **Electromagnetic Compatibility (EMC) Directive** (2004/108/EC 2004-12-15): intends to regulate side effects between electronic components that are connected/interface together, like electromagnetic radiation, fields in the vicinity of electronic components, etc.
♦ **Low Voltage Directive (LVD)** (2014/35/EU): concerning health and safety challenges of electrical equipment with defined limits of voltage.
♦ **Radio Equipment Directive (RED)** (2014/32/EU): a regulatory framework for placing radio equipment on the market, ensuring no interference and data security regulation in radio communication with other devices.
♦ **Restriction of Hazardous Substances (ROHS) in Electrical and Electronic Equipment Directive** (2014/32/EU): prohibition of the use of certain substances, to protect the environment and public health.

Liability doesn’t only concern the product itself, but also its name. So, while choosing “Parcitypate”, we took care that no company already is using this trademark by consulting the European Union Intellectual Property Office (EUIPO) database. We also verified that it doesn’t risk hurting anyone by having offensive meaning in other languages, or a different cultural interpretation.

6.6 Conclusion

During this chapter about ethics, we tried to identify the most important points we need to take care of and cautions we have to worry about. Firstly, our personal ethical standards and open discussions among the group take centre stage and stand as the most important thing to look for. We also identify some specific practice to absolutely avoid (false information, greenwashing, etc.). For each of these fields, engineering marketing and environmental, we identified various precautions we should take.

All these ethical constraints and guidelines we identified are driving and influencing the decisions we made about our product. In the next chapter, we describe the technical and design decisions we made and how it evolved over time.

7. Project Development

7.1 Introduction

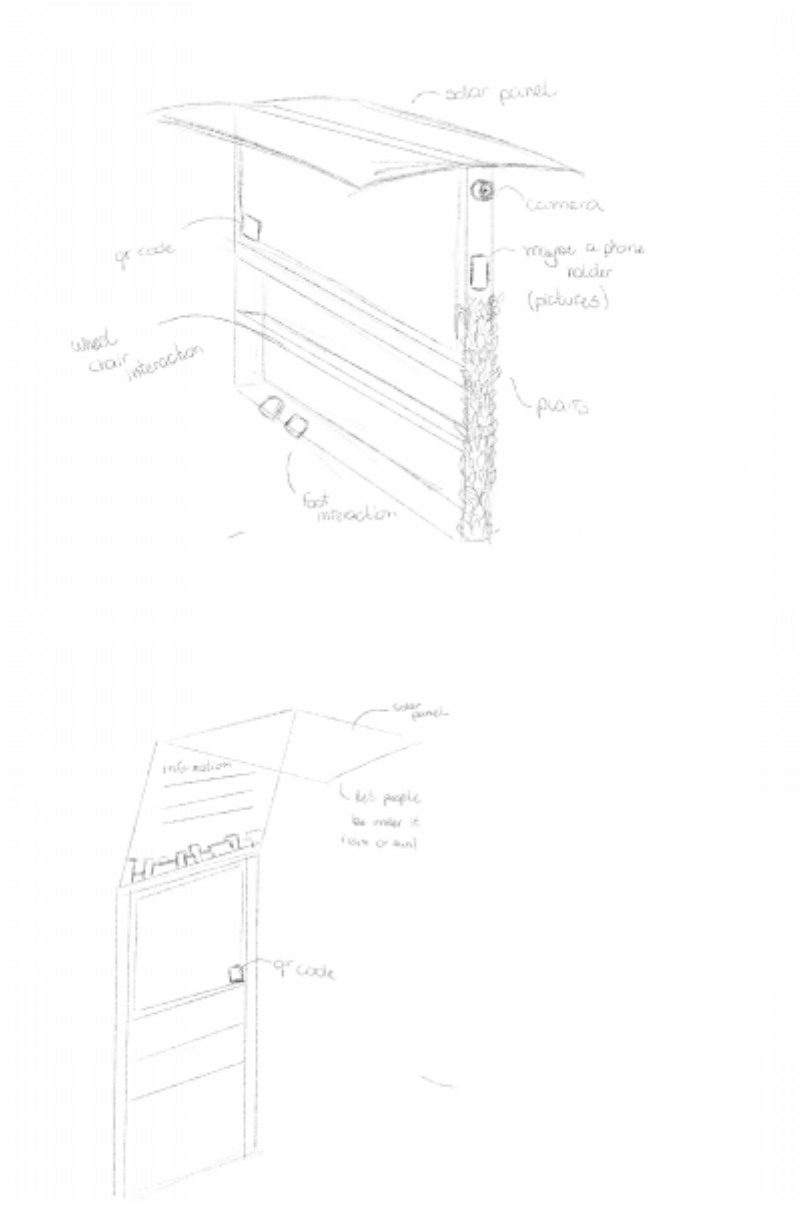
As a starting point for this project, a state-of-the-art analysis was carried out. The findings of this analysis show that all existing projects face one common problem when aiming to increase citizen interaction with public screens, namely, overcoming the participation barrier. If the participation barrier is too low, e.g. allowing interaction simply by stepping on buttons, the installation is used for amusement rather than serious participation. On the other hand, if the barrier is too high, e.g. by having to publicly share your personal opinion or by using very extravagant movements for the interaction, people's motivation to participate will be too low. Consequently, the aim of our project is

to create a method for citizen participation that combines public attention and private interaction.

7.2 Ideation

To address the above outlined problem, an idea was created that combines the advantages of public displays with the privacy of smartphone interaction. More specifically, a combination of a public display for immediate visual feedback and web applications for user input will be developed. The primary aim of the public display is to increase awareness of the participation opportunity. Moreover, citizens are confronted with the urban planning choices in the place that they are relevant for. Further, the immediate visual feedback on the screen reacting to the interaction with the smartphone, creates a sense of novelty, which improves the hedonistic user experience. Finally, it serves as a metaphor for the public influence of small choices made by citizens.

After identifying this solution, the engineering team moved to the ideation phase and created several structural sketches for different screen models. Figure 20 shows the initial structural sketches.



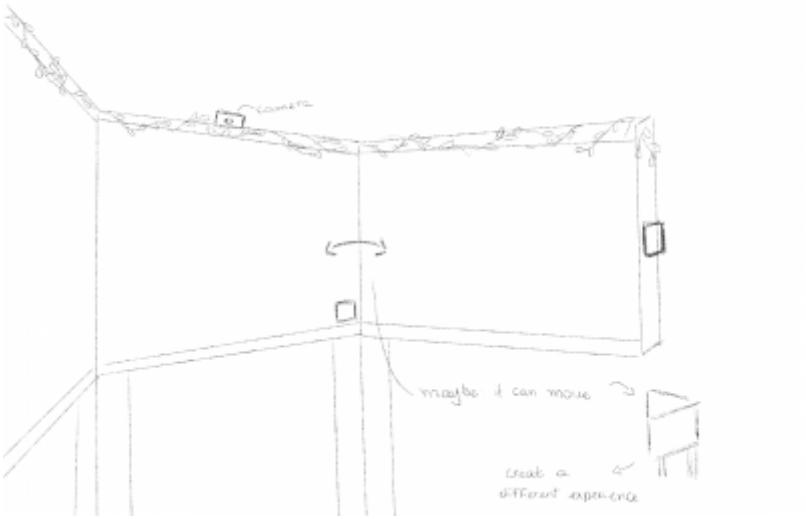


Figure 20: Initial brainstorming sketches

The ideas were thoroughly discussed and the conclusion was drawn, that the participants' focus should be clearly guided to notice the content of the display and understand the purpose of the interaction, instead of using additional gimmicks on the installation for their pure amusement. Therefore, to avoid distracting participants and to keep their focus on the mission of citizen participation in urban planning, the team decided to keep the hardware design of the display simple and minimalistic (cf. Figure 21).

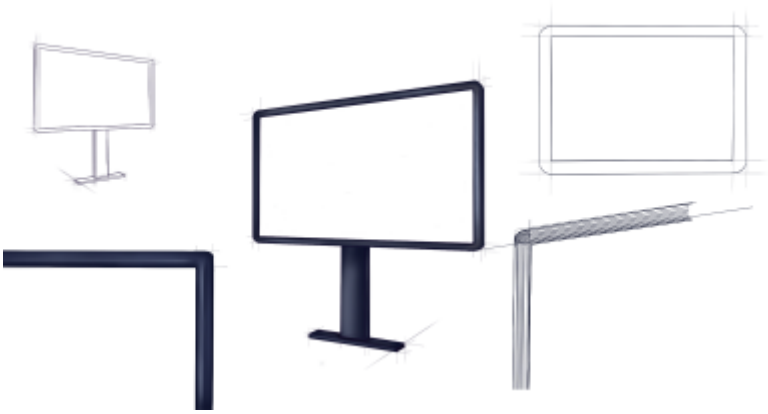


Figure 21: Structural drafts minimal display

To further specify the hardware and software components required to develop the project, a blackbox diagram was created (cf. Figure 22). The blackbox shows that the user interacts with both the smartphone app and the display at the same time. The user provides input on their phone and receives visual feedback on the display. The components required for the display are the screen, a raspberry pi connected to the internet, and a light and movement sensor. Additionally, for the web application, a website frontend must be developed and a shared server and an API must be developed that handle the communication flows and facilitate the application logic. Finally, a database will be created for data persistency.

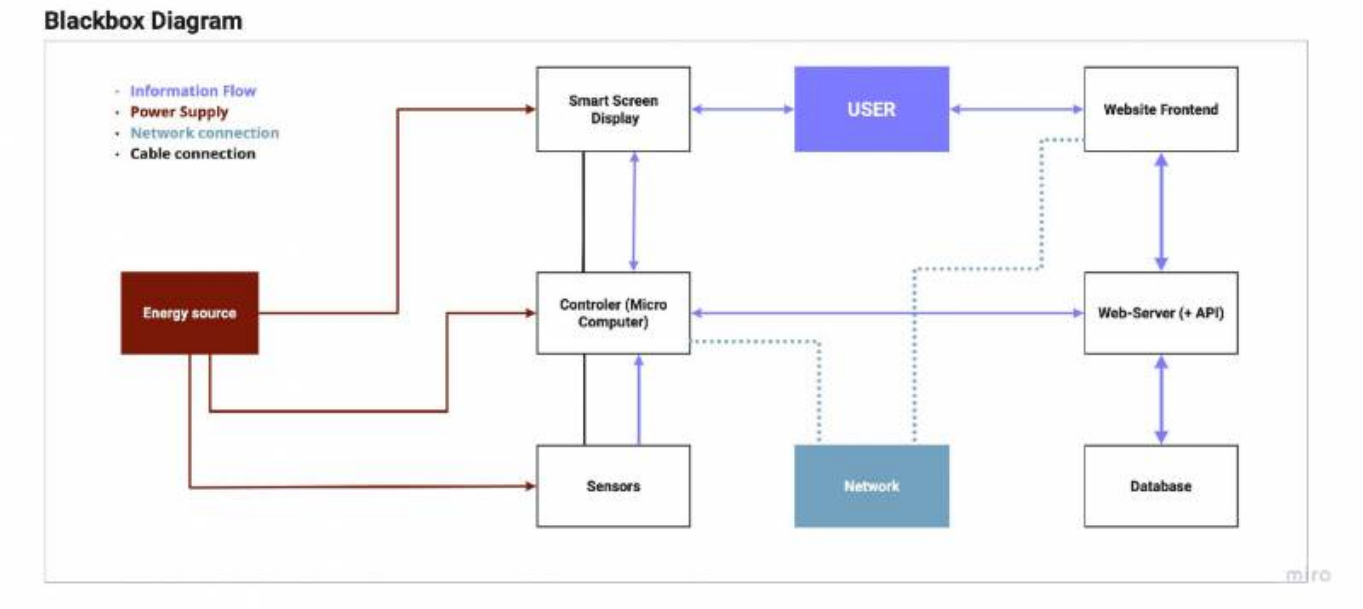


Figure 22: Blackbox diagram

To summarize, two main components must be created and developed as part of this project:

1. The smart public display consisting of
    - a screen
    - a light sensor
    - a motion sensor
    - a computer to control the display
2. The web application with
    - a mobile-first user interface
    - a server that handles the communication with the public display

7.3 Concept

This section includes the logo design and concerns and requirements for the project

7.3.1 Logo and Designlanguage

The Parcitypate logo was based on the city this project is being originated: Porto. It is the combination of geometric forms that can be seen from Porto’s famous buildings (Figure 24).

Figure 23: Inspirations for logo design

Parcitypate is the junction of City and Participate, and it was created to represent the idea of interactiveness of the citizens in the city planning. Adopting a strong and modern typography attached to a representative geometric symbol shows the power and importance of our city (Figure 24).

Figure 24: Logo design

There are two variants of the logo. The horizontal is the main application (Figure 25).

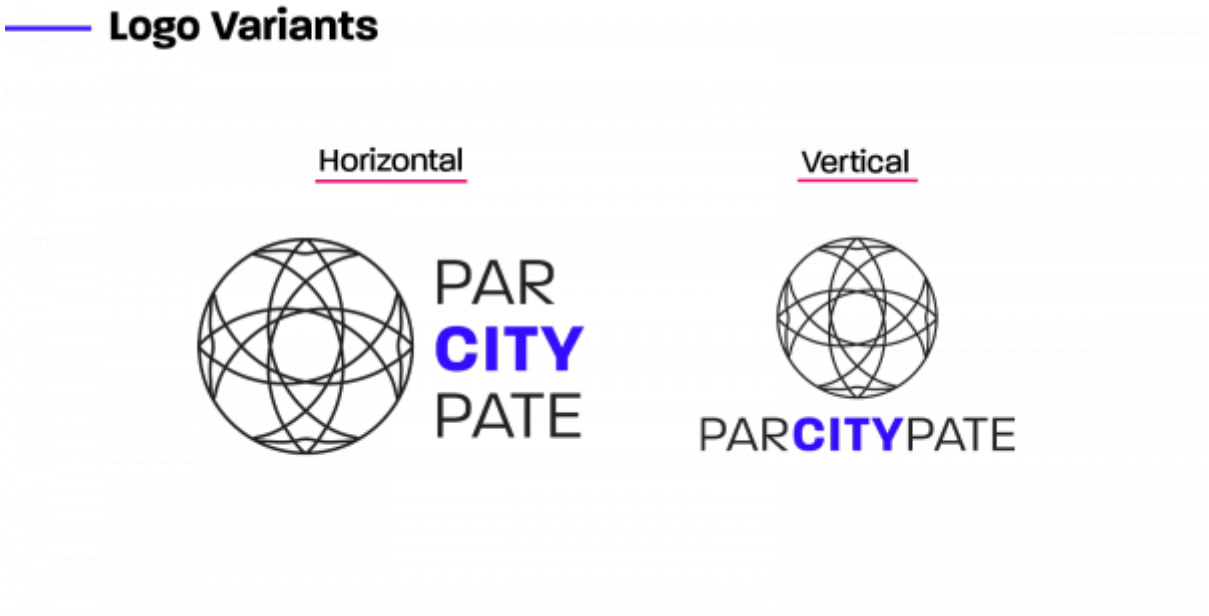


Figure 25: Variants of the logo

The monogram of the logo is the symbol of our project. It can be used as a minor feature to harmonize in the design applications (Figure 26).

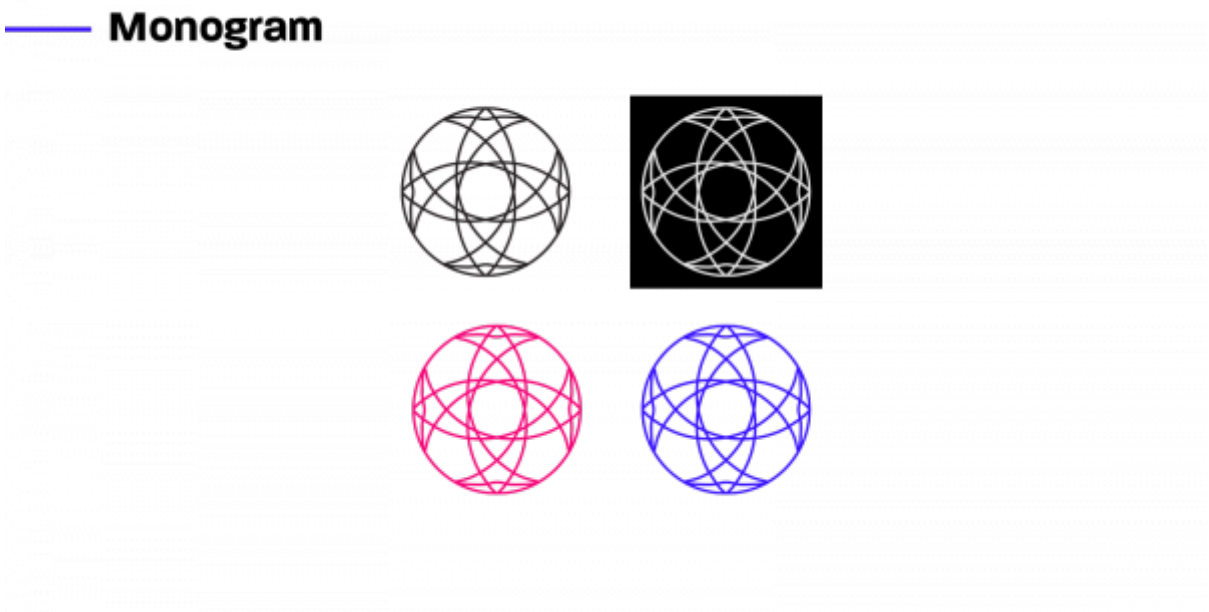


Figure 26: Monogram of the logo

Paralucent and its variants are the choice to embrace the design (Figure 27).

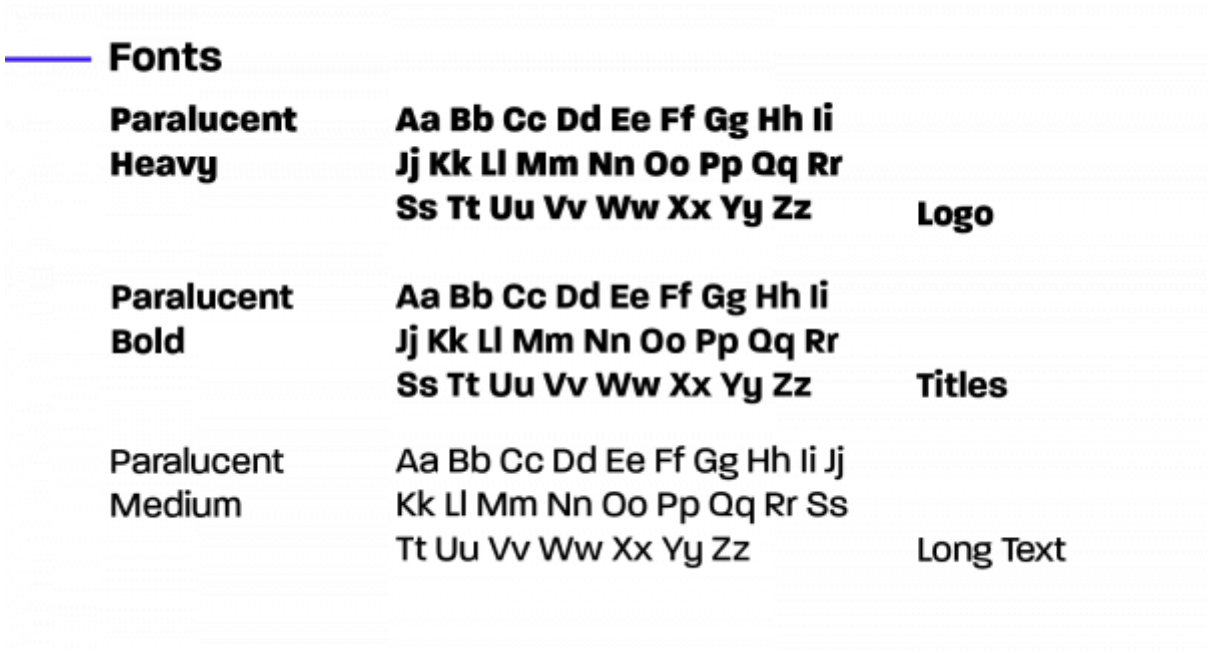


Figure 27: Paralucent font

7.3.2 Requirements and Concerns

As the display will be outside, the key requirement is sturdiness and resistance to environmental influences as well as human influences, such as vandalism and theft. Moreover, the screen must detect if there is no audience available and automatically shut off to save energy. Due to the varying light conditions, the screen must have a high maximum brightness and automatically adjust the brightness level. To facilitate the communication, the raspberry pi must have a fast and reliable internet connection, which should be achieved through a LAN cable connection.

The content displayed on the screen must take into consideration the location of the installation. For instance, if there is street traffic nearby, no flashy images or videos should be shown as to not disturb traffic and comply with legal traffic regulations.

Due to the limited budget, the key requirement concerning the software technologies is that they must be open-source and free to use.

7.4 Structural Design

7.4.1 Choice of components

Parcitypate includes a physical aspect which needs several components to make it work. These must be defined and selected with the precaution to have the best product possible in the end. The main components are the following: a screen, a computer, a light sensor, a motion sensor, a frame, and a power supply unit. The tasks and technical conditions of the necessary components are listed in Table 8.

Table 26: Requirements for the hardware components

Needed Component	Task	Technical Requirements
Screen	Grabbing the attention of passing citizens and creating a visual experience	• Sufficient size • Weather resistance • Resistance against vandalism • Adjustable brightness • Antireflecting and High Brightness • Visual connection to the computer • Recyclability • Energy consumption as low as possible
Computer	Communication between the screen, the sensors, and the server.	• Processing unit • Stable internet connection • Visual connection to the screen
Light Sensor	Detection of environmental signals to adjust the brightness and operation of the screen	• Detect brightness • Passing the signal to the computer
Motion Sensor	Detection of passing passers-by to activate the screen	• Detect movements • Passing the signal to the computer
Power supply unit	Provide the correct electrical current for the devices	• Conversion of the network voltage to the operating level of the respective devices
Frame	Protection and positioning of the screen	• Resistance to environmental and mechanical influences • Protection of the other devices • Harmless for the users • Recyclability

A market research resulted in the products listed in table 9, which could be considered for the production of a prototype as well as their technical characteristics. An assessment regarding the fulfilment of technical and economic requirements from – to ++ was also made.

Table 27: Market research for the prototype

Component	Possible solutions	Technical properties	Fit	Price
Screen	Touchscreen Display 7" 800x480 Raspberry Pi official	• 7" Touch screen Display • Screen Resolution 800 x 480 pixels • Connects through DSI port • Power consumption 8-10W	+	- (70-85€)
	TFT LCD Display Kit 7" 1024 X 600 HD For Raspberry Pi	• 7" Display • Resolution: 1024 x 600 • Connects through DSI port • Power consumption 6-7W	o	- (85€)
Computer	Raspberry Pi 4 Model B 2GB	• Processor: Broadcom BCM2711, Quad-Core Cortex-A72 (ARM v8) 64-bit SoC O 1.5GHz • Memory: 2GB LPDDR4 • Wireless 2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac; LAN, Bluetooth 5.0, BLE; Gigabit Ethernet; 2x USB 3.0 ports; 2x USB 2.0 ports. 2x Micro-HDMI Ports (Supports up to 4Kp60); 2-Lane MIPI DSI Display Port; 2-Lane MIPI CSI Camera Port • Power consumption 15W	++ (50€)	+ (50€)
Light Sensor	Yocto-Light-V4	• Size 20 x 35 mm • Micro-B USB connector • Refresh Rate 10 Hz • Sensor TI OPT3004	++	- (24€)
	UUGEAR Light Sensor Module	• Size: 26mm x 14mm • Analog and digital output • Working voltage: 3.3~5V • With adjustable potentiometer to adjust the sensitivity	+	+ (4€)
	Sensor de Luz Digital de Longo Alcance - Adafruit TSL2591	• Size: 19mm x 16mm • Digital output • Working voltage: 3.3~5V	+	o (11€)
Motion Sensor	PIR Motion Detection Sensor HC-SR501	• Operating Voltage: DC 5V-20V • Level Output: High 3.3V, Low 0V • Measuring distance of 6m • Delay time: Adjustable (0.3 seconds to 10 minutes)	+	++ (4€)
	Arduino-compatible PIR motion sensor - Whadda WPSE314	• Operating Voltage: DC 5V • Level Output: High 3V, Low 0V • Measuring distance of 7m • Delay time: Adjustable (0.3 seconds to 18s minutes)	+	+ (7€)
Power supply unit	USB-C 5V 3A Power Supply with Switch	• Input: 100V ~ 240V, AC, 50/60Hz • Output: 5V 3A, DC • Charging Port: USB type C	++	+ (9€)
Frame	Build out of Cardboard or Wood			

As a result of the mart analysis, the components shown in table x were selected. A reason for the selection decision can also be found in the table.

Table 28: Components for the prototype

Component	Product	Supplier	Picture	Reasoning	Price
Screen	Touchscreen Display 7” 800×480 Raspberry Pi official	Mauser.pt **[Robert Mauser Lda., 2022]**, PtRobotics.com **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	 **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	Easy Connection, Sufficient resolution, Cheapest Price, Known compatibility with other components	75€
Computer	Raspberry Pi 4 Model B 2GB	Mauser.pt **[Robert Mauser Lda., 2022]**, PtRobotics.com **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	 **[raspberrypi.com, 2022]**	The only solution on the market that offers sufficient interfaces and computing power in this price range	50€
Light Sensor	UUGEAR Light Sensor Module	UUgear **[Dun Cat B.V., 2021]**	 **[Dun Cat B.V., 2021]**	Digital output for connection to the Raspberry, inexpensive, sufficient accuracy	4€
Motion Sensor	PIR Motion Detection Sensor HC-SR501	PtRobotics.com **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	 **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	Measuring distance 6m, inexpensive, compatible with raspberry pi	4€

Component	Product	Supplier	Picture	Reasoning	Price
Power supply unit	USB-C 5V 3A Power Supply with Switch	Mauser.pt **[Robert Mauser Lda., 2022]**, PtRobotics.com **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	 **[PTRobotics - Especialista em Componentes Electrónicos, 2022]**	Compatible with raspberry pi, Inexpensive	9€
Frame	Build out of Cardboard or Wood			The frame is intended for demonstration purposes only and does not claim to be a finished product. Special mechanical loads as with the final product are not to be expected	-
Sum					142€

Due to the higher technical requirements and thus also the necessarily increasing budget for the final product, different components are needed. Here, too, a selection was made on the basis of the evaluation system already introduced.

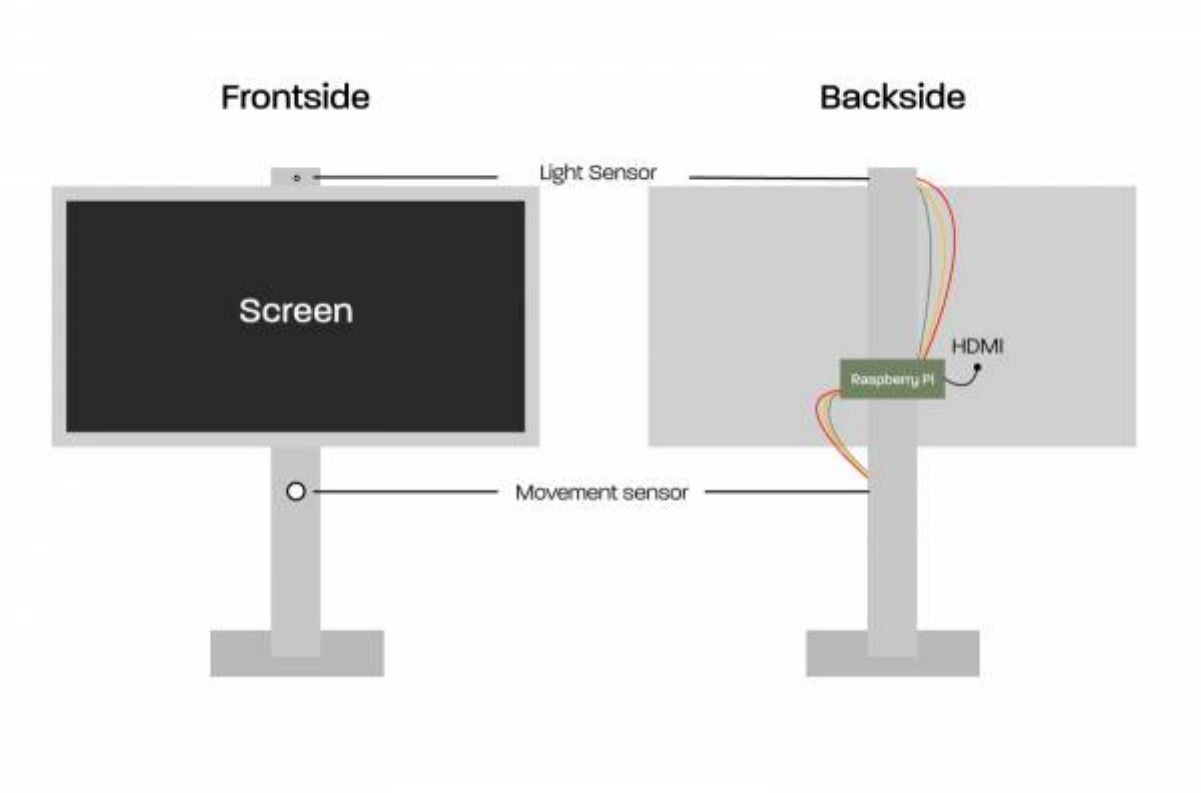


Figure 28: Structural drafts

7.4.2 Detailed drawings

The design of our product evolved a lot as the project was going. You can see on figure 30 the final version. Unlike previous versions, it features in addition to the screen a roof to protect users and a bench where they could seat.

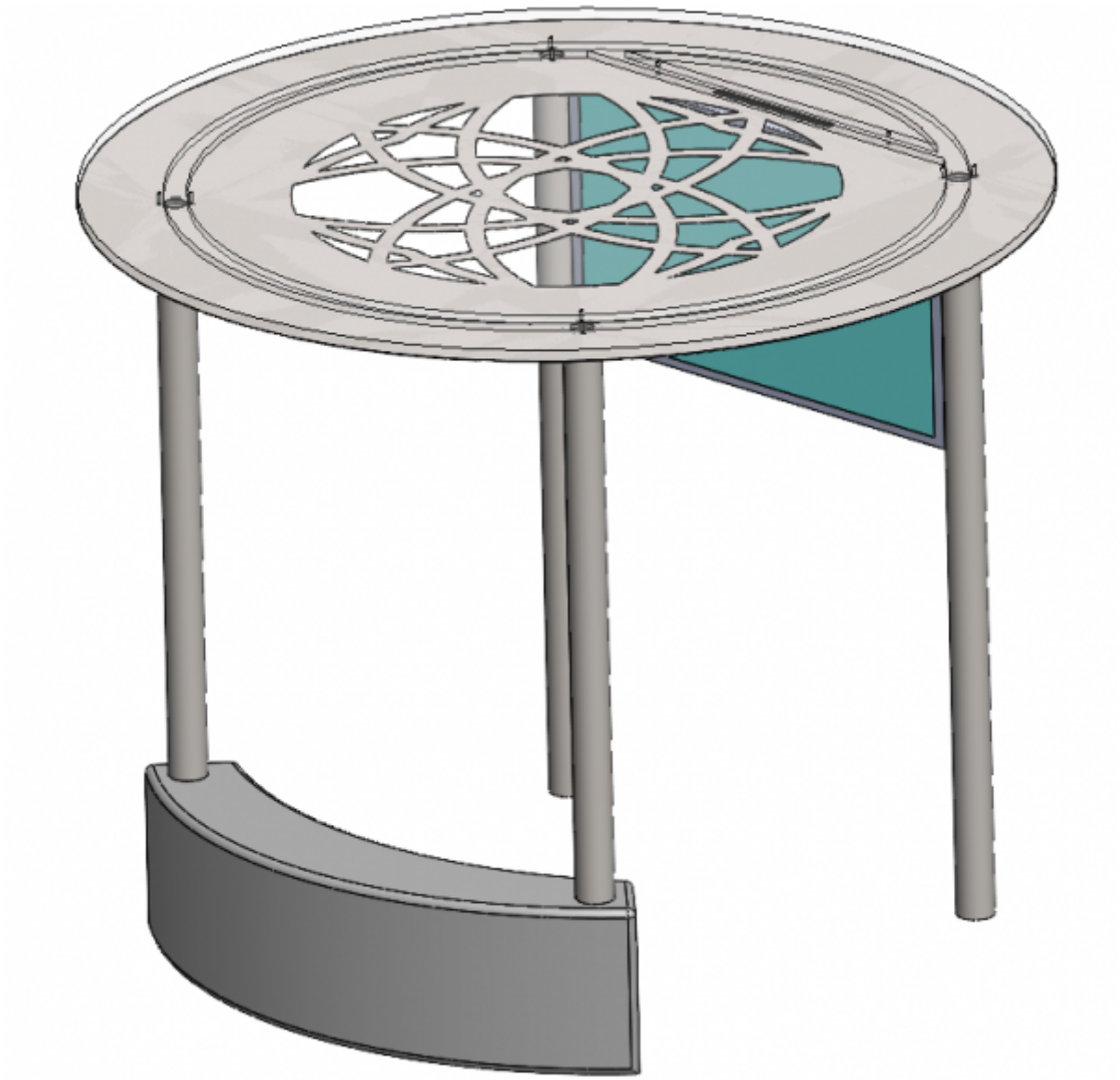


Figure 29: final design

The roof is made of 2 distinct parts : a thin sheet of metal cut according to our logo and a transparent plate on top of it. They are 2,50 m large and have several functions. It protects the user and the screen from rain and sunlight and it allows wires to pass through the roof and hide them. Attached under the roof, a support is holding the screen and protecting it's back and connections. All these parts are carried by 4 pillars in steel. They are empty inside to allow wires to pass through and reduce the overall weight. They are open on the bottom to let wires out and they can be attached to the ground with brackets. They are 2 m high, for 3 mm thickness, and a diameter of 10 cm.

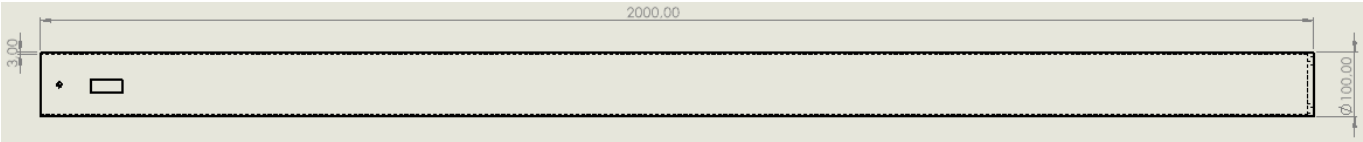


Figure 30: pillar detailed drawing

The bench is placed around the too pillars in front of the screen. Users on it will stand a little less than 2 m away from the screen. For packaging purposes, the radius of curvature is the same than from the roof.

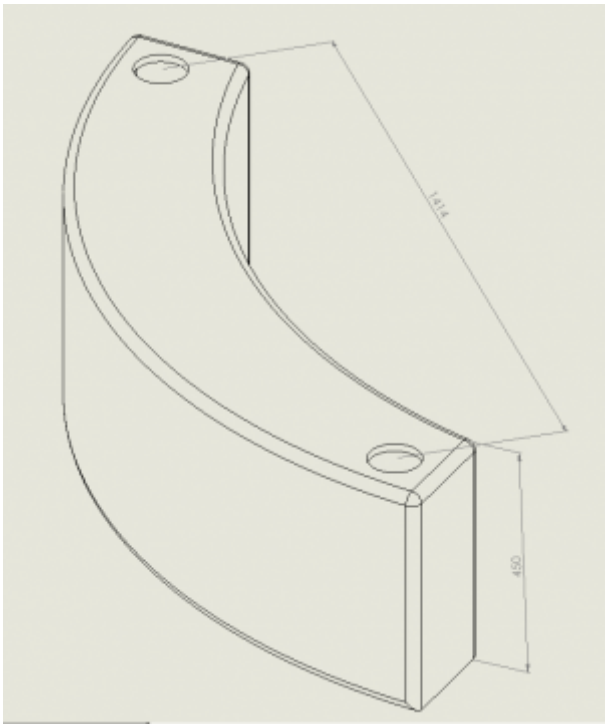


Figure 31: Bench detailed drawing

In order to be able to transport the product to the later installation site, a packaging system was designed (see figure 32). The concept produces as little waste as possible, so the product itself is used as a transport package and fixed with Vime. A bench, which is also used as packaging, can provide additional value.

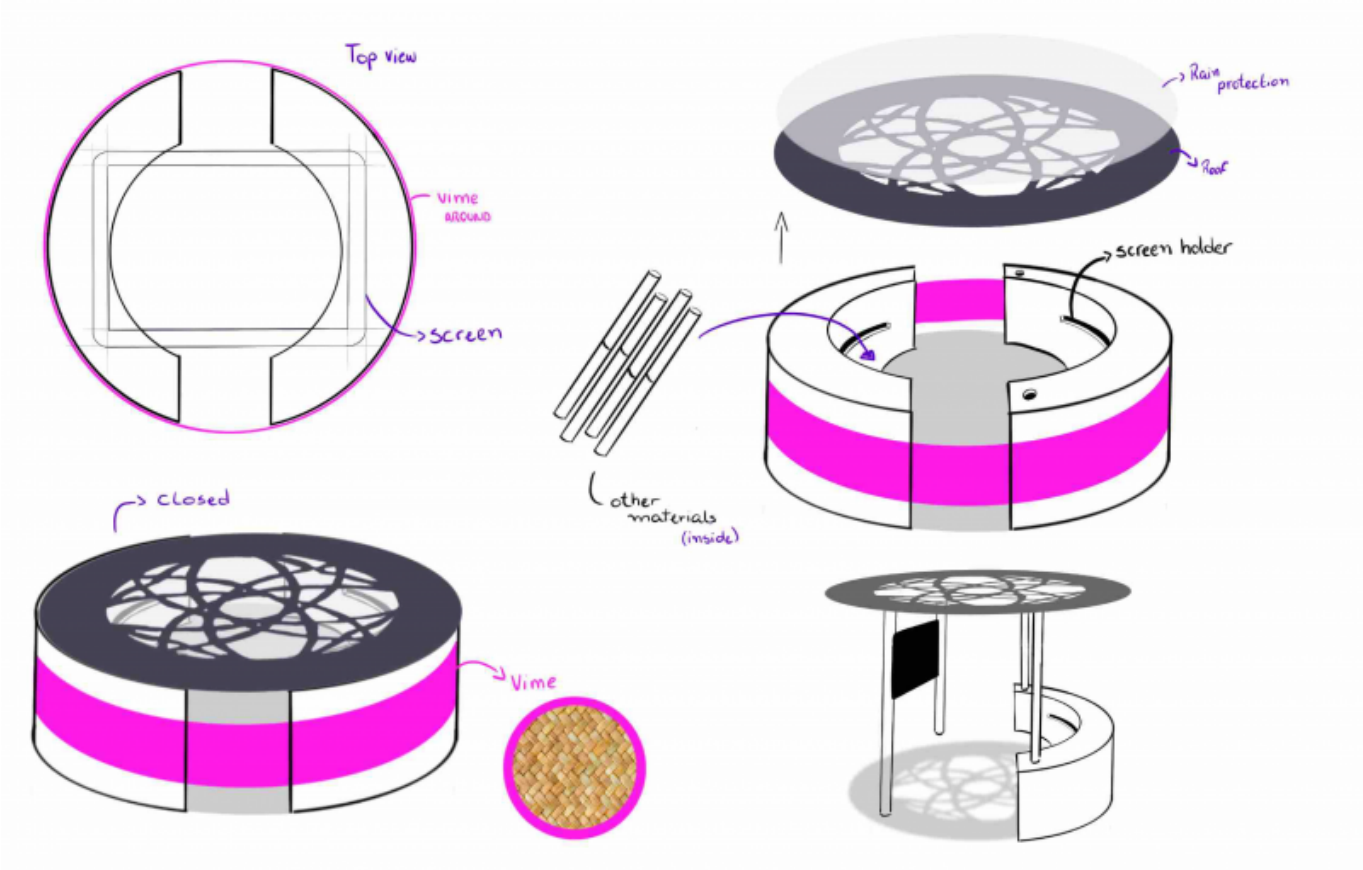


Figure 32: Packaging

7.4.3 Selection of materials

While designing the structure, we also had to decide which materials we want to use for each part. As explained in the sustainability chapter, we applied ourself several constraints about the materials selection : single material parts, material 100 % recyclable only, etc. Some other constraints come from the context and the use of the product : resist UV, rain, temperature, etc. Most parts have to resist some load and chocs, so we decided to use mostly a basic stainless steel since it provides great mechanical properties, great durability in outdoor usage, and comply with our sustainability constraint. Therefore, the pillars, the logo in the roof, and brackets are made of AISI 304 (XCrNi18-10). Then we decided to make the bench out of HDPE (high-density polyethylene) which is a thermoplastic with nice mechanical properties and good durability. But its thermic conductivity is lower than those of metal. This allows users to touch and seat safely even if the bench was warmed up by radiation from the sun. We needed a roof to protect the screen and users from the rain but we need it to be transparent to let sunlight go through. So we decided to build the roof out of glass because it is more sustainable than other transparent materials such as PMMA or PET.

7.4.4 Load and Stress Simulation

In order to make sure our system is strong enough, we conducted some stress simulations. In this simulation, we considered part's weight (g = 9,81 m/s²), users seating on the bench (4500 N), wind pressure (150 km/h), and even people eventually climbing/jumping on the roof (20 000 N).The following figure 33 shows the results of the simulation.

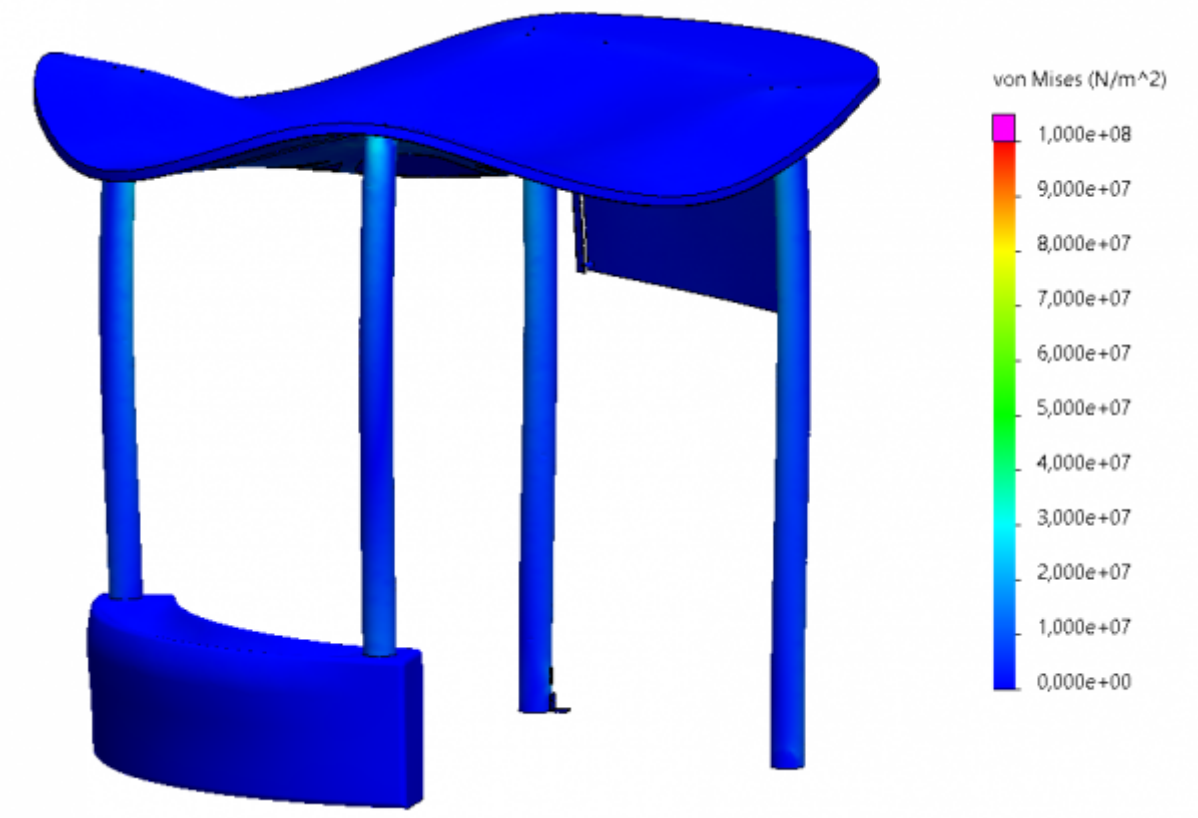


Figure 33: global stress test

According to this simulation, the highest Von Mises criterion calculated approach 10^7 N/m² on the top of pillars the yield strength of AISI 304 is about 200 MPa or 2.10^8 N/m². This shows quite a good

margin before risking a break in the structure. Please note that deformations are exaggerated on the picture so we can see them, in reality.

7.5 System Design

Detailed Schematics

The software aspect of the project consists of four components, a server, a client for the display, a client for the mobile web application and a database (cf. Figure 34). The server is connected to both clients through WebSockets. When a user interacts with the website on their smartphone, the information is sent to the server. The server then forwards the interaction to the client controlling the public screen. Finally, when a user likes or comments on a model, the information is stored in a database.

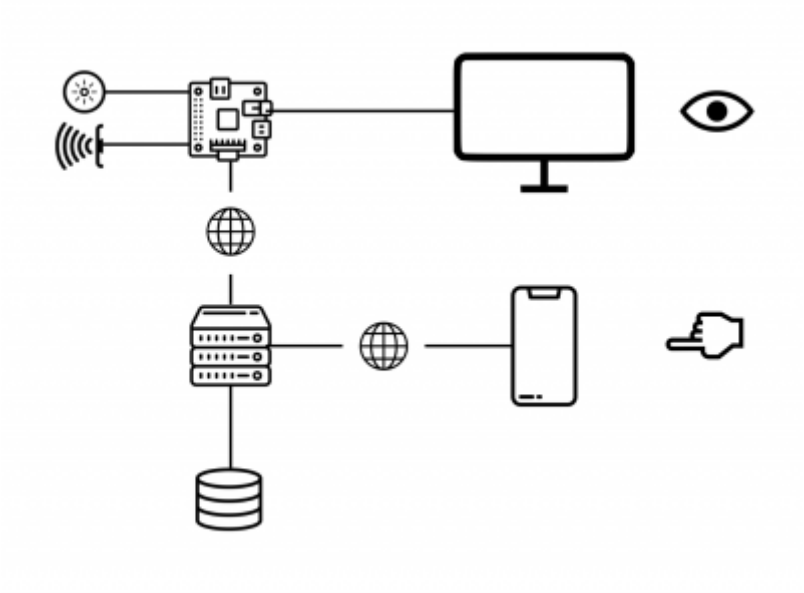


Figure 34: Interaction schematic

Choice of components

In order to minimise the budget required for developing the software aspect of the project, the following open-source technologies were selected:

- Server: Node.js - Javascript runtime
- Web-application Frontend: Vue.js - JavaScript Framework
- Screen Frontend: Vue.js - JavaScript Framework
- Database: MongoDB - noSQL database program

Mockups and simulations

After the system requirements were defined and the technologies for the components were selected, the user interface design was created. In order to identify the required views and pages, the possible user interaction flows were analysed. The following diagram shows the user interaction flows and outlines the communication between the components (cf. Figure 35).

Interaction flows

	Start state	User input	Smartphone frontend communication with server	Backend logic and communication with city screen	End state
Starting connection					
Case 1: no other device currently connected	*City screen shows standby view*	User scans QR code with their phone	Mobile application connects to server	Server has no other active connection and connects to city screen	*City screen shows connection feedback to user (welcome view)*
Case 2: other device currently connected	*City screen shows current other interaction view*	User scans QR code with their phone	Mobile application connects to server	Server detects other active connection, sends rejection response to mobile application	*Mobile application provides feedback to the user, user can look at models on their phone*
Model interaction					
Case 1: opening 3D model	*City screen shows welcome view*	User opens 3D model	Mobile application sends model information to server	Server sends model information to city screen	*City screen opens 3D model*
Case 2: navigating around 3D model	*City screen shows model view*	User rotates 3D model on their phone	Mobile application sends coordinates to server	Server sends coordinates to city screen	*City screen rotates 3D model*
Case 3: liking/ commenting model	*City screen shows model view*	User likes/ comments model on their phone	Mobile application sends information to server	Server sends information to city screen and saves it in the database	*City screen shows feedback to the user*
Closing connection					
	City screen shows current interaction view	No user input for 60 seconds	Mobile application closes connection to the server	Server sends information to city screen	*City screen shows standby view*

Figure 35: User interaction flows and component communication

Finally, mockups were created for all interface views on the display and the mobile web application (cf. Figure 36 and 37). A simulation of the interaction flow can be found here.

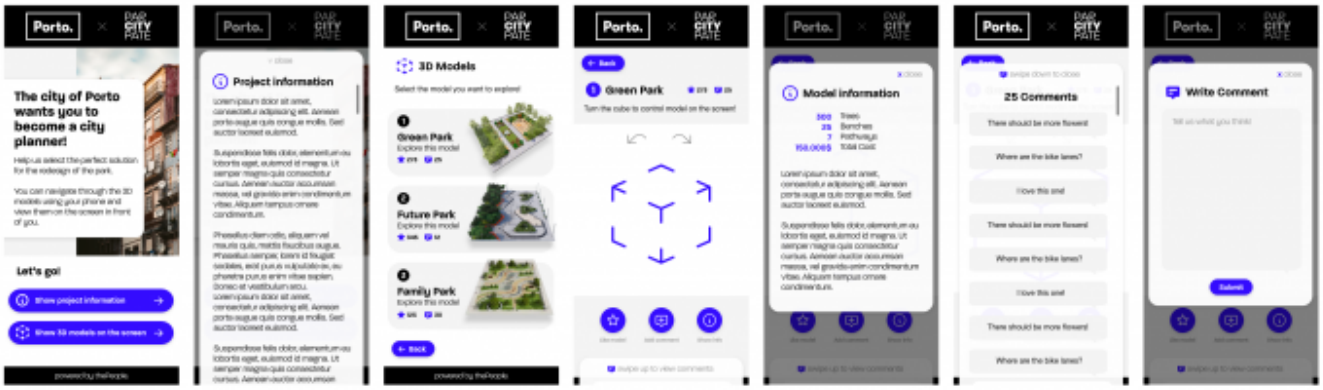


Figure 36: Mobile user interfaces

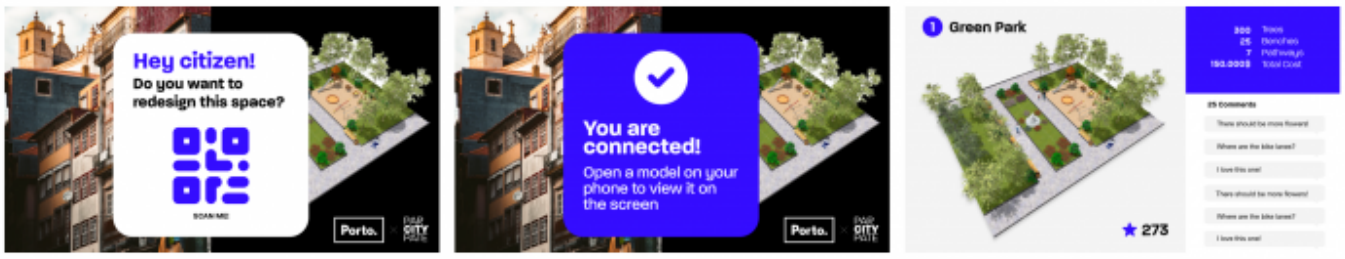


Figure 37: Public display user interfaces

Cardboard model

To be able to imagine the physical appearance of the screen, a model was made from cardboard (see figure 38). In this way, the proportions and physical properties can be easily illustrated. The model was built out of cardboard and wood.

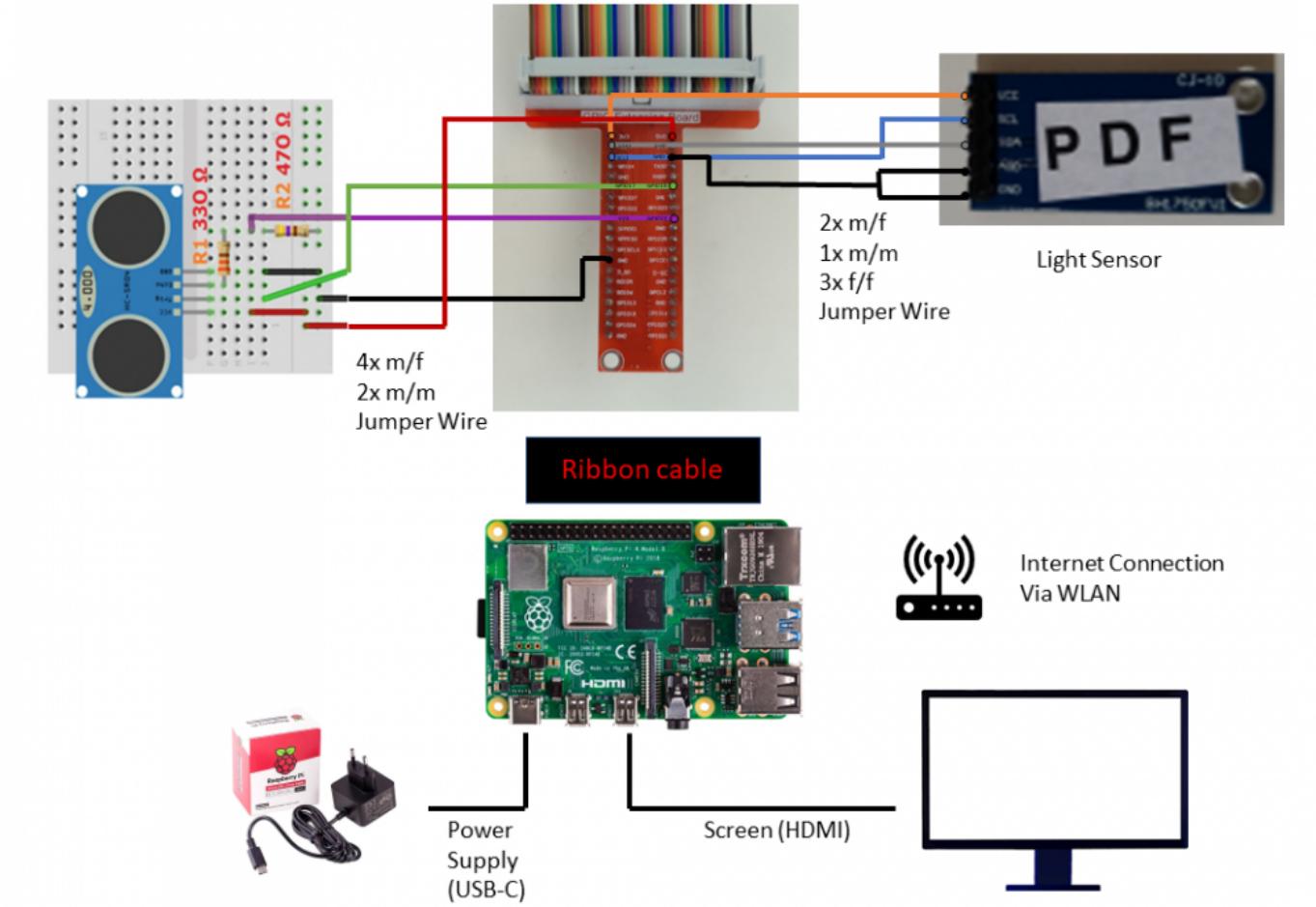
Figure 38: Cardboard model

7.6 Prototype

To explain the product, it is helpful to illustrate the functions using a prototype. It is essential to include the most important features of the product. For this product, this means displaying and communicating with the website and energy-saving measures of the screen. The final used physical components are:

- Raspberry Pi 4 (2GB of RAM)
- GPOI extension boards
- Resistors
- Distance Sensor HC-SR04
- Light Sensor BH1750FVI
- HDMI Monitor
- Smartphone to connect to the website

The schematic of the prototype can be taken from figure 39).



schematic.pdf
Figure 39: Schematic of the Prototype

As described in the previous chapter, the software components of the website are open source products. Free software solutions were also used to operate the rest of the prototype. Ubuntu 22.04 **[Canonical Ltd., 2022]** is used as the operating system for the minicomputer. This system is based on Debian **[Inc. Software in the Public Interest, 2022]** and uses GNOME **[The GNOME Project., 2022]** as desktop environment. Furthermore, the used chip architecture “arm” is supported. For getting readings from the sensor, a Python **[Python Software Foundation, 2022]** script is used.

Since the screen is connected via HDMI, it is not possible to adjust the screen brightness. Depending on the ambient brightness, the prototype switches between a “dark” and “light” mode of the operating system for the demonstration. Through the distance sensor, it was realized that the screen turns on and off depending on whether a person has been in front of the screen in the last few minutes.

7.7 Tests and Results

After developing and deploying the components of the parcitypate software, two tests were carried out to assess the user interface as well as the technical performance of the applications.

User interaction test

The interaction flow was tested with the quality assurance platform Rainforest, which allows for automated interface testing based on pixel and text recognition algorithms. To test the web

application in a mobile setting, the test was carried out in a virtual machine simulating an iPhone 11 Pro Max and Safari version 14.

To test all functionalities of the mobile application, a comprehensive user flow was defined (see figure 40). This flow included an automatic connection with the screen when the page is first loaded, navigating through all pages of the application and interacting with the models by adding comments as well as liking and voting for models. Finally, the interaction included an idle time of 61 seconds to test the automatic disconnection.

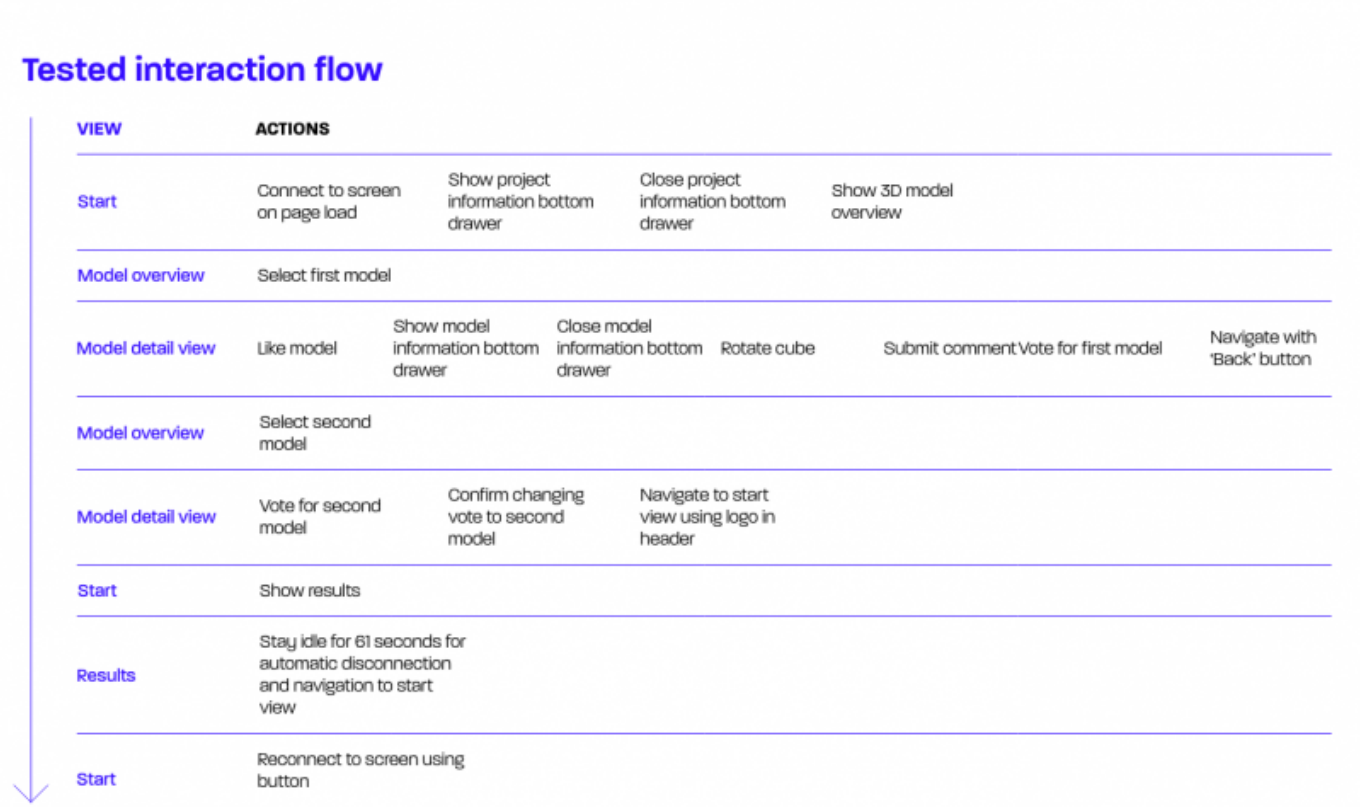


Figure 40: User flow for interaction test

The results of the test show that all views and functionalities are visible and accessible on a mobile device and lead to the correct interaction outcome. The http logs as well as a video of the simulation can be found on the Deliverables page of this wiki.

Performance test

The technological performance of software was assessed using the Google Developers service Page Speed Insights, which sends a request to the page and measures response and load times. The performance scores of the mobile and screen applications were both high with 90 and 92 percent respectively (see figures 41 and 42). The small reduction in performance scores is due to the large data size of the 3D plugin.

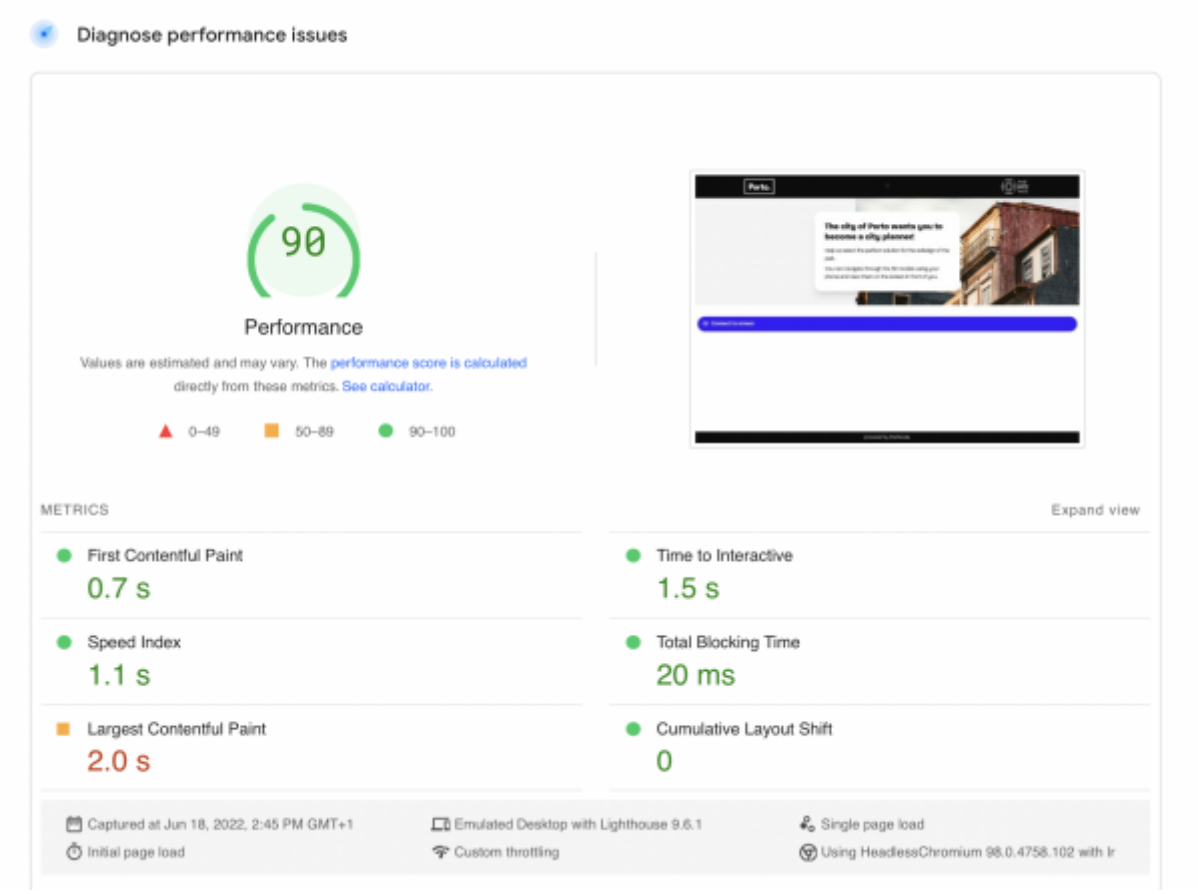


Figure 41: Performance result mobile application

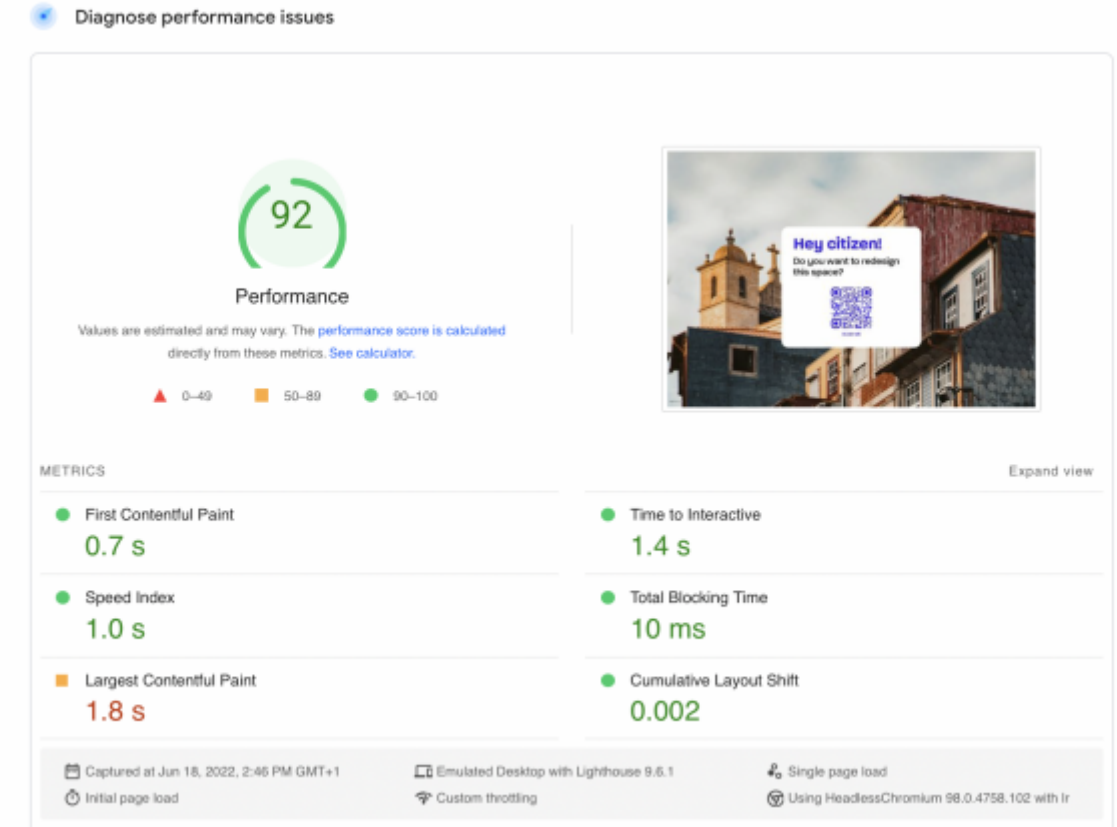


Figure 42: Performance result screen application

7.8 Conclusion

The prototype was able to represent essential elements of the final product at low cost by using open source products and already existing hardware. Both user interaction with the website and energy-saving measures could be demonstrated. The user interaction and performance tests of the website can attest to its functionality. In the following chapter, the conclusions from the project are summarized.

8. Conclusions

8.1 Discussion

After analyzing traditional concepts of citizen participation and considering modern approaches, it was possible to identify existing problems and solve them with the resulting product. All the objectives of the product listed in chapter 2.7 were met.

Working in a multinational and multidisciplinary team proved to be a challenge. Due to different cultural and academic backgrounds, the ways of working and the way of thinking about the project were very different. Ultimately, this has led to the need for human and professional development in order to adopt different perspectives and learn from other team members. These experiences can be seen as extremely positive and may prove useful in the future.

8.2 Future Development

As the complete physical construction of the project would have exceeded the scope of the EPS, only a prototype of the project was developed to demonstrate the idea and general functionality. Therefore, the next step in potentially further development of the project would be to construct a life-sized prototype. With this prototype, more realistic user tests could be conducted and the feasibility of the construction and packaging solutions could be examined in more detail.

As far as the software is concerned, a potential further addition would be a front-end application for city governments, where 3D models and the corresponding information could be uploaded. Moreover, it could include a functionality to collect and export user data and interaction statistics to provide further information on participation demographics.

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