Report

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Acknowledgement

Glossary

Abbreviation	Description
EPS	European Project Semester
ISEP	Instituto Superior de Engenharia do Porto
USB	Universal Serial Bus
LCA	Life Cycle Analysis
SDI	Sustainable Development Indicators
PMBOK	Project Management Body of Knowledge
AI	Artificial Intelligence
RPG	Role-playing Game
4Ps	Product, Price, Place, Promotion
SMART	Specific, Measurable, Achievable, Realistic, Time-bound
SWOT	Strengths, Weaknesses, Opportunities and Threats
PDCA	Plan, Do, Check, Act
BPI	Product Backlog Items
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
EU	European Union
UN	United Nations
BCM	Business Model Canvas
CPM	Unit Cost per Mille

Abbreviation	Description
KPI's	Key Performance Indicator
CEE	Energy Saving Certificates
TGAP	General Tax on Polluting Activities
ISO	International Organization for Standardization
GDPR	General Data Protection Regulation
NSPE	National Society of Professional Engineers

1. Introduction

1.1 Presentation

We are six people from different countries and our goal is to develop a project together at ISEP. Each team member has their own strengths and also, a different field of study. This is what makes us strong as a team. As the “Garbage Gladiators”, we are dealing with the topic recycling and waste management. More details about our study background and home country can be seen in Table 1 below.

Table 1: Members of the team

Name	Country	Study programme
Nina Bohon	Slovakia	Creative computing
Lukas Jasny	Germany	Logistics
Charlotte Emmelot	The Netherlands	Industrial engineering and management
Olivier Durand	France	Mechanical engineering
Kathrin Reisinger	Austria	Media technology
Koen Hellemans	Belgium	Applied computer science

Meet our team in Figure 1:

Figure 1: The “Garbage Gladiators”

1.2 Motivation

Our personal motivation for EPS

- Nina Bohon: “I chose to participate in The European Project Semester because I believe in the importance of working in international teams of people from various backgrounds. In the following months, I hope to improve my communication skills, learn about project planning, project management and make friends along the way!”
- Lukas Jasny: “I choose the EPS because I think it is a unique experience to work in an international team with members of different profession. Personally, I have the feeling that through interactive learning methods, like working on a project, I get the most benefits of. The biggest challenge will be the team coordination so that all team members can contribute their knowledge into our project’s topic. I am excited how this will work in the next months.”
- Charlotte Emmelot: “EPS appeals to me because it is a combination of project-based learning and allows me to evolve skills that I cannot receive from a book. I have the ambition to develop my international experience in a multidisciplinary and multicultural environment even more because I believe it is of great importance with the increasing globalization.”
- Olivier Durand: “EPS motivates me because I'm always excited to carry out projects and cooperate with new people.”
- Kathrin Reisinger: “I see the EPS program as a great opportunity to gain experience in an international team. The chance to meet people from different cultures and backgrounds is exciting and can lead to interesting results. I look forward to learning from each other and growing as a team.”
- Koen Hellemans: “The reason why I choose EPS is because I wanted to have international experience. Meeting people from all over Europe with different backgrounds is very excited, I know I will learn a lot of them. Getting out of my comfort zone is always a task and it helps you

later on in your life. I also want to improve my English and learn about the culture.”

Why we choose our topic

In the beginning we all had a similar top three of subjects, with “Our city experience” ranking far above the others. We chose our project “Bin it”, because we want to help raise awareness of waste management and recycling among people in the city. The cleaner the city, the more attractive and livable it is. With our combined knowledge, we believe we can develop a concept and propose a solution to address this problem.

1.3 Problem

Waste disposal is a problem in many cities. Mostly because many people do not care or do not have the adequate knowledge about proper waste disposal. In this project, the problems of waste management in Europe will be addressed. One of the main problems is the lack of uniform rules for waste separation in Europe, which leads to confusion among people. Another problem is the lack of responsibility of some people when it comes to proper waste disposal. Very often, public places in cities are polluted, which makes inhabitants feel uncomfortable. Only a clean city is a livable city.

This project aims to counter these problems. The goals are to reach young adults and strengthen a sense of responsibility in the community. To do this, there will be an app developed that will address these problems and help people deal with waste disposal.

1.4 Objectives

The goal of the project is to simplify waste disposal and educate young adults about different waste disposal and recycling options. For this, an app will be developed that contains a city map and an educational platform. The app allows users to easily find the nearest garbage bin in their area. This makes it easier to properly dispose of waste, as most of the time the nearest garbage bin is very close or on the way.

In addition, “Bin It.” wants to create a sense of community by offering users the opportunity to earn points and badges for their actions. The app will show a rankingscore for marking and validating bins and proper waste disposal. In addition users can earn badges when a certain amount of points are achieved. The vision is that the campaign will encourage more and more people to join and that a community will be created. One main goal for the future is to create a new social norm where responsible waste management is evident and develop trends that make waste disposal more attractive. Therefore, the main target group is young adults.

1.5 Requirements

During the project process, the requirements and limitations listed below will be followed:

Initial requirements

1. Comply with the following EU Directives:
    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);
2. Mandatory adoption and use of the International System of Units (The NIST International Guide for the use of the International System of Units).

Budget requirements

1. Maximum 100 €

App requirements

1. Use of open source software and technologies;
2. User-centered design;
3. Ease of use;
4. Error prevention;
5. High compatibility with devices;
6. Aspect of security to protect user data.

Substainable requirements

1. Use of sustainable materials;
2. Reduce waste and use recycling material whenever possible;
3. Use energy-saving technologies during the production process;
4. Keep the carbon footprint as minimal as possible.

1.6 Functional Tests

App:

- When a bin is uploaded, the user gets points added to their score;
- When a user confirms/declines a bin, points are added to their score;
- When a user registers, the account is saved in the database;
- When a user changes their password, it is changed in the database;
- When a certain amount of points is reached, the user gets a badge.

Physical Bin:

- When the user press the pedal, the bin opens;
- When the user release the pressure, the bin close.

Performance Tests

- If I register five accounts it will consume 1060 B and it will take 191 ms;

- If I add five posts it will consume 1060 B and it will take 198 ms;
- If I add five bins it will consume 1270 B and it will take 217 ms;
- If I want to get all the posts five times it consume 3500 B and it will take 35 ms, this depends on the length of the list.

1.7 Project Planning

To manage the project the PMBOK approach together with the SCRUM method are being used. To form the project constraints a project scope is needed, together with time and costs, in order to define the extent of the project and the work needed to produce it. This includes a work breakdown structure. The backlog forms an overview of all the needed tasks. The backlog is elaborated and planned in the sprint plans. The global sprint plan gives a distribution of the available times per week. The sprint plans are weekly where the backlog items are prioritized and divided per week. Finally, there is a sprint plan evaluation where the tasks will be reviewed.

1.8 Report Structure

The report is divided in eight chapters as can be seen in Table 2 below.

Table 2: Report Structure

Task	**Description**
Introduction	Team introduction, definition of the problem and the requirements of the project.
State of Art	Research and analysis of the focussed topic.
Project Management	Includes all documents/graphics/descriptions showing the planning process of the project.
Marketing Plan	Description of the market analysis, the SWOT analysis and the marketing strategy.
Eco-efficiency Measures for Sustainability	Sustainability analysis of the product based on environmental, social and economical factors.
Ethical and Deontological Concerns	Analysis of ethical challenges and limitation with the product.
Project Development	Shows the design and prototype of the product, including the final tests and results.
Conclusions	Final summary and analysis of the project with possible improvements for the future.
Bibliography	List of all sources used in the report.

2. State of the Art

2.1 Introduction

At the beginning of the project, the time during the design thinking workshop was used to come up

with proposed solutions for the waste problem in cities. Those ideas included to think about innovative trash cans, innovative recycling systems and waste management concepts in cities and campaigns for cleaner cities. To achieve a better overview a research needed to be done for the state of art to know what already exists. That is necessary to create an innovative solution for the waste problem in cities. With the help of the ISEP team the idea to focus on education of the society was obtained. Furthermore, this suggestion was used to expand the research on that topic as well.

2.2 Smart Bins

In the current state there are already existing designs of different smart garbage bins with various focus-points. There are smart bins, for example, the self-sorting Bin-e, the self-pressing Mr. Fill or the deep waste Molok bin.

- Bin-e bins are an good example of a smart bin were a variety of components come together. The bins sorts and compresses the waste automatically, controls the fill level and processes data for convenient waste management **[BinE, 2023]**. In this way recycling will be simplified. Bin-e is further elaborated in Table 3.

Table 3: Pro/con Bin-e

Pro	**Con**
Everything is coming together	States nothing about using green energy
High waste sorting accuracy (92 %)	Fill-levels can be controlled, but nothing is stated about picking-up options/routes
Lower costs of waste management and disposal	
Incentives for proper waste disposal	
Digitization of waste management services	

- Mr. Fill offers self-pressing solar-powered bins, underground pressing modules and smart sensors to calculate the filling level and adjust the pick-up routes accordingly **[MrFill, 2020]**. In this way litter, CO_2 emissions and costs will be reduced. The bins include a sensor, therefore pick-up trucks can detect if the bins are full. This way the route can be specified to filled bins only, instead of going by every bin **[Conure, 2021]**. Mr. Fill is further elaborated in Table 4.

Table 4: Pro/con Mr. Fill

Pro	**Con**
Solar-powered energy	States nothing about recycling options
Closed stainless steel insert valve and inaccessible to pests	
The compression with the press results in a possible compaction of at least 1:5	
Smart sensors → Route can be mapped out, resulting in 75 % cost savings on waste collection costs	
Smart city management	

- Molok presents deep waste collection bins, were 60 % of the waste is underground to save space **[Molok, 2023]**. Moreover, the coolness of the ground minimizes odours and gravity compacts the waste by its own weigh. Molok is further elaborated in Table 5.

Table 5: Pro/con Molok

Pro	Con
Deep waste collection saves space	Most beneficial for mixed waste and not for recycling waste
Gravity/coolness is being used as power	Missing of fill-level sensor or some sort
Fewer emptying pick-ups and reduced fuel consumption	Missing waste/smart city management
	States nothing about picking-up options/routes

2.3 Recycling in Public Spaces

Recycling in outdoor public spaces such as parks or downtown areas is challenging. Yet, communities invest again and again into these campaigns. Communities that have implemented waste management strategies, which tackle common issues such as appropriate bin placement, effective design, and clear communication on the disposal of different types of waste, typically have more effective waste management systems **[Alec Cooley, 2022]**.

Campaigns focused on recycling in domestic settings tend to be more successful. Information about recycling at home tends to stick with people, as the process of recycling at home rarely changes. Getting information about recycling in public spaces out there is more difficult. Every space is different, location of bins is not a given and differs from place to place **[Waste360, 2018]**.

Communicating the complexities of recycling of certain materials poses a challenge. Paper is a good example for such a material — it is a low volume waste with many sub-types. Paper cups or cardboard packaging is often lined with plastic and can therefore not be recycled. Same goes for receipts, gift wrapping or sticky papers such as post-its or labels. Sanitary products such as used napkins or wet wipes can not be recycled either **[Recyclenow, 2023]**.

Functionality should go before aesthetics. Often, the decision of bin types and location is based on aesthetics rather than functionality. Placing bins too close to each other can lead to little to no usage by by-passers. Being intentional about placements can improve both the aesthetic of the public space and increase the volume of collected waste. Clear signalling is also important — colour coding and symbols communicate the type of bin faster than words **[Waste360, 2018]**. Using verbal description only can create a barrier for tourists, immigrants who do not speak the local language **[C. Alexander, C. Smaje, R. Timlett, I. Williams, 2009]**, illiterates and kids. Using only colour coding poses difficulties for the colour blind. Furthermore, colour coding of recycling bins differs in different cities, areas and countries. Different locations have different rules for recycling in place. This can pose another barrier for non-locals.

In “Will they recycle? Design and implementation of eco-feedback technology to promote on-the-go recycling in a university environment (2016)”, authors describe how they significantly increased participation in recycling at a campus by using interactive bins. Mozo-Reyes et al state *“Interactivity was demonstrated to be one of the key elements that make the WeRecycle bin a more effective approach towards recycling, but HCI characteristics such as immediate feedback and subtlety of colour and pictorial realism (performing a “green” activity) were also factors that may have made it a successful strategy.”* Furthermore, the WeRecycle bin not only increased participation in recycling at the university campus but also reduced contamination of the recycle stream in the bins **[Eliana Mozo-Reyes, Jenna R. Jambeck, Patricia Reeves, Kyle Johnsen, 2016]**.

2.4 Campaigns

Since littering is a worldwide problem, many different cities tried to find solutions. One aspect were campaigns to draw attention to the problem of littering and try to reduce pollution through that. In general, a difference is made between supra-regional campaigns and regional campaigns.

Let's clean up Europe creates a European community for clean-up events **[Letscleanupeurope, 2022]**. They organize for example special weeks in which they call their community to start cleaning up their local environment. The "European Week of Waste Avoidance" includes a photo competition. The six best photos get 300 €. The promoters developed information flyers about how to clean the environment to not disturb the eco systems as well. Effects: More than 1.200 clean-up and plogging actions all around Europe in 2022.

Zero waste Europe is an European initiative which created a platform for an international exchange about pollution in different cities worldwide **[Zero Waste Europe, 2018]**. In these meetings European and Non-European cities talk about their regional problems and solutions they tried to implement. The initiative has involved:

- 450+ Cities and municipalities in the Zero Waste Cities programme
- 170+ Local groups represented through our 35 members
- 35 members in 28 countries
- 1425 press mentions in 2021
- 2-3 years: Average period for implementation of a zero waste plan by a city or municipality

In terms of measures adopted by different cities, there are general examples:

- Expansion of the number and volume of waste containers
- Increase the emptying intervals
- Change the design of the containers
- Work on awareness and education

as well as specific examples:

- Coupon system to get free beer
- Supersized trash cans
- Refurbished recycled ads
- Personification of trash cans
- Recycling Lotteries
- Bins as art
- Trash Food Chain ads for problem attention
- Plays and workshops for children to educate them about pollution **[Laura McQuarrie, 2014]**.

Through the many different worldwide campaigns, some insights can be derived which can make a campaign more successful:

- The effects of short-term campaigns are hardly measurable
- Prevention campaigns are more effective than clean-up campaigns otherwise litterers get used to other people collecting their trash.
- Campaigns should raise the inhibition threshold for littering but at the same time create incentives for correct disposal
- Littering campaigns generate a lot of media attention but they also lose their interest after the implementation.

- Individuals should be addressed directly; this brings awareness to the individuals actions.
- Messages should be formulated clearly and concisely as well as in a polite and requesting language
- Campaigns should focus on identity and social norms
- Ambassadors as role models help people to sympathise with the topic
- Humorous campaigns have greater impact than serious ones
- Campaigns with a commanding tone reinforce littering as people feel threatened in their freedom
- Conspicuous trash cans are used more often than normal ones
- Artistic garbage cans should be resistant, otherwise they will be damaged by vandalism and lead to the neglect of the environment (Broken-Window-Theory)
- Measures should raise the inhibition threshold for littering but at the same time create incentives for correct disposal **[Carina Seeburg, 2021][Till Berger, Annick Staub, Johannes Heeb, 2008]**.

Psychological aspects for our solution:

In the context of our project, it is important to know how to change people's behaviour in a sustainable way. That is why we searched for psychological aspects we need to focus on for our solution.

- Benefits work better then solutions based on punishment
- Identification with the city helps – Anonymity is a reason for pollution
- Cities as a role model so when the public administration doesn't care about pollution the people won't do that as well: "Broken-Window-Theory"
- If a person does not act in an environmentally protective manner, although the personal ecological norm speaks in favour of environmental protection behaviour, an unpleasant state of tension arises. Psychologists call this cognitive dissonance.
- Smaller behavioural changes can be the trigger for further larger behavioural changes in that field, e.g. a sticker against nuclear energy could lead to go to a demonstration about it: "Spillover-Effect"
- Rewards with positive emotions help establishing environmentally friendly behaviour
- Another goal is breaking habits. Once you broke them you are more likely to continue with your new behaviour
- Social norms and support lead to a bigger acceptance
- Story telling: Positive stories of environmental protection can trigger joy and motivation in us. The most empathy arises when it is about a single character and that character resembles us **[Till Berger, Annick Staub, Johannes Heeb, 2008][Claudia Thea, Schmitt, Eva Bamberg, 2018]**.

Although monetary incentives attract the attention of people who have had a little previous contact with the issue of pollution but non-monetary incentives are more sustainable in the long term.

2.5 Gamification

Gamification is a strategy in which mechanics similar to games are used in order to motivate people to engage in non-game related activities, services or products.

Gamification models

There are several gamification models. Selecting a gamification model that appeals to core audience can increase user interaction or make a marketing campaign more successful.

Some gamification models are:

- **Action:** In the Action model, things need to be quick. Developing such campaigns is fast and the costs are low. Usually, a pre-existing white-labelled game is used as a starting point. Mechanics of the game need to be intuitive, easy to understand and the environment should be highly competitive. Users should be able to earn rewards. The bounce rates are high — creating leader boards to create a competitive environment can help to keep users interested.
- **Simulation:** Developing a simulation is time and cost intense. These types of application require good story telling to on-board players. Overall quality of the game, rewards and objectives are important to keep the audience engaged.
- **Interactive storytelling:** Interactive storytelling provides people with a unique experience which typically leaves a lasting impression on the audiences. However, the cost of development is high and it can take months to develop such campaign.
- **Adventure:** Adventure games require users to invest a lot of their time into the game. They are costly to develop but can be very rewarding if executed correctly.
- **Puzzles:** Campaigns that require some kind of problem-solving skill are puzzles. It can be anything from the logic, pattern recognition or sequence solving. To ensure that users come back, it is good to give them an unrealistic time to solve the puzzle. Otherwise they finish it in one setting and are unlikely to return.
- **Skill based:** The outcome of skill based games is determined by the audience's reactions, mental abilities, strategic thinking or trivia knowledge. There isn't necessarily a right or wrong answer to this kind of game. To avoid campaign being labelled as "gambling", users should not be asked to pay to play. Skill-based games give the player the opportunity to increase their chances of winning by improving their skills.
- **Multi-player:** In multi-player games, user play either against each other or against a computer. By letting users to partner up with each other, a social communication element can be created.
- **Educational:** Educational games educate audiences while they are playing — these kind of campaigns can be very successful if there is some aspect of a product or a service which is often misunderstood and used incorrectly. It can be an entertaining way to learn something valuable about a product or a service.
- **Role playing:** RPG campaigns provide players with a fully immersive branded world which is full of elements centred around the campaign's objectives.

Determining the Best Game Model for Your Audience

Following Table 6 gives an overview of how to determine the best game model for audiences:

Table 6: Game Model

Game Model	Cost	Development Time	Brand Exposure	Audience Interest Retention
Action	Low	1-2 weeks	2/5	1 week
Simulation	High	3 months	3/5	1 - 2 months
Interactive storytelling	Very High	4-6 months	4/5	3 months
Adventure	Medium	2-3 months	5/5	1 month
Puzzles	Low	2-3 weeks	3/5	1 week
Skill based	Medium	1 month	3/5	2 weeks
Multi-player	High	2-3 months	3/5	2-3 weeks
Educational	High	2-3 months	3/5	2-3 months
Role playing	High	2-3 months	4/5	2-3 months

Common gamification elements

There are many mechanics and concepts that are used for gamification. The five most common elements are Purpose, Progress, Pressure, Position and Play:

“Purpose: Purpose is all about instilling the sense that you are specially chosen for an epic quest and are contributing to something larger than yourself. This often is communicated through narrative. Progress: Progress refers to an indication that you are overcoming obstacles and getting closer to your goal. This often takes the form of points, levels, boss battles and progress bars. Pressure: Pressure is created by promoting urgency to take action, the fear of losing or the feeling that you can’t turn back now. Countdown timers, streaks and scarce collectibles are all examples of pressure in action. Position: Position in gamification means there is a way to showcase your accomplishments and compete with — or compare yourself to — other peers or players. It shows up in activities by way of trophy shelves, badges and leader boards. Play: Play refers to the sensation of fun, pleasure and surprise. Typical examples of play include Easter eggs, branching choices, exploration and customization” **[Hal Koss, 2022]**.

Gamification techniques for learning

To gamify learning, four types of gamification techniques can be used.

- Gamification as a cosmetic: game elements and visuals are used to enhance a programme. A good example are roadmaps which can be followed as users progress through the programme.
- Gamification as an accessory: Points, badges and leader boards are typical examples of gamification as an accessory. Progress is marked and rewards certain behaviours or activities.
- Integrated gamification: In this mechanic, there is no difference separation between the game mechanics and learning progress — the elements and dynamics are integrated into the programme.
- Raison d’être is when the entire programme is a game and learning is a by-product of the game. Players are aware that they are playing a game but often do not realise they are also learning on the way **[Jonathan Peters, 2018]**.

Gamification in marketing campaigns

In marketing campaigns, gamification can be incorporated in several ways. Using a real game in a marketing strategy can be a successful way of gaining more traction. Loyalty reward programmes can also be perceived as a gamification technique. By collecting points and rewards, customers show their loyalty and are rewarded with e.g. discounts. Rewarding customers who interact with a platform encourages the likelihood of future interaction with the platform. Contests are a way of integrating gamification in a business and help expand brand awareness. Successful contests drive customer interaction by improving the visibility of the brand **[Neverbounce, 2017]**.

2.6 Original Bins

On the internet it is hard to find some already existing designs of bin that open with an original way. The idea is to make this bin a piece of art to attract people and use it to promote our company.

Examples of fun and good looking bins are:

1. Recycling stickman holds a trash bag that fits perfectly in the bin so it can be used on the lid. By pressuring with a foot, the stickman lifts up the bag to open the bin. The lid closes by gravity by itself. The advantages of this solution are that it can be made with various materials and personals touches can be added to make it unique. Also, not many workshops are needed and the building is accessible to all groups.
2. Artistic lid is the only interactive part of the bin. Focusing on the experience of opening the bin seems a good way to promote the campaign. With this reason, there is thought about a lid that transforms into a statue. The advantages of this solution is that it does not require a lot of materials. However, this solution represents a lot of engineering studies that might not be accessible for all the team members.
3. Trash parkours provide a different waste disposal experience. The advantages of this solution is that it requires basic engineering knowledge and a good looking bin is buildable. However, not every one might be interested in it while disposing their trash and not every type of garbage will fit in.

In the end the first solution seems a good way to attract people to the campaign. This solution does not require a large investment of time by consumers and is part of the daily urban experience.

2.7 Conclusion

In this chapter, several existing aspects and solutions of recycling in public spaces around the world are highlighted. There are many existing solutions for smart bins. Existing solutions compress the waste to increase the waste volume that can be collected and make use of solar power. Some even automatise recycling by using AI to recognise the material of waste and sort it accordingly. The disadvantage of existing smart bins is the high cost. It is assumed that maintenance of such bins in public spaces would be too expensive and not sustainable in the long term.

Recycling in public spaces is a challenging topic to address. Due to the complexity of recycling it is hard to explain how to separate waste correctly to people on the go. In public spaces, the contamination of recycling bins is high compared to domestic settings. Furthermore, separating waste does not have the same rules across cities, areas and countries. Each location has their own waste management in place and different requirements for waste separation. There is no common rule in

place for marking bins — cities and communities across the world use different colour coding for bins. Providing verbal explanation can pose a barrier for people who do not speak the local language. Therefore, there is concluded that using symbols and signifiers eliminates language barriers and is more accessible for the color blind at the same time.

Cities usually combat pollution by expanding the volume of bins, increasing the emptying intervals, adjust design of the containers or invest in campaigns that raise awareness and education of the topic. There are campaigns that focus on cleaning up already polluted spaces. However, the importance of pollution prevention is recognized.

In the project, the focus will be on educating people and reach a wide audience of all classes. By focusing on the people, the problems that arise from cooperations with municipalities will be eliminated. Municipalities and cities have budget constraints and are usually slow to act.

The idea is to create an educational-focused digital platform. Data will be gathered on recycling procedures and local regulations governing waste separation. A campaign will additionally be created to inform people about this platform and to promote it. The usage of gamification approaches will boost user interaction. The project seems to be interesting for the educational gamification paradigm.

3. Project Management

3.1 Scope

In the scope the boundaries of the project are documented. This contains a documentation of the project scope and the product scope.

The project scope is explained in Figure 2 and the product scope in Figure 3.

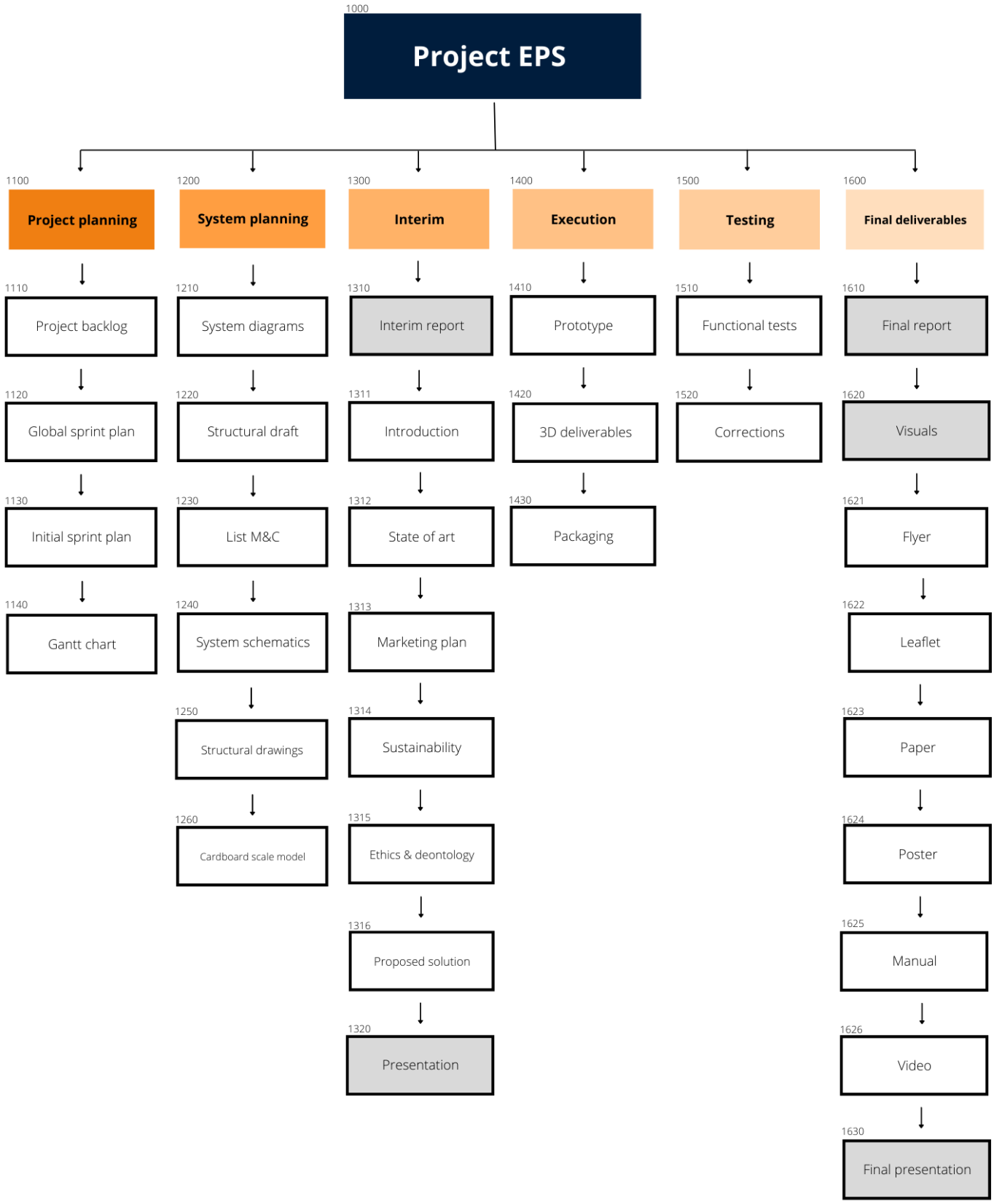


Figure 2: Project scope

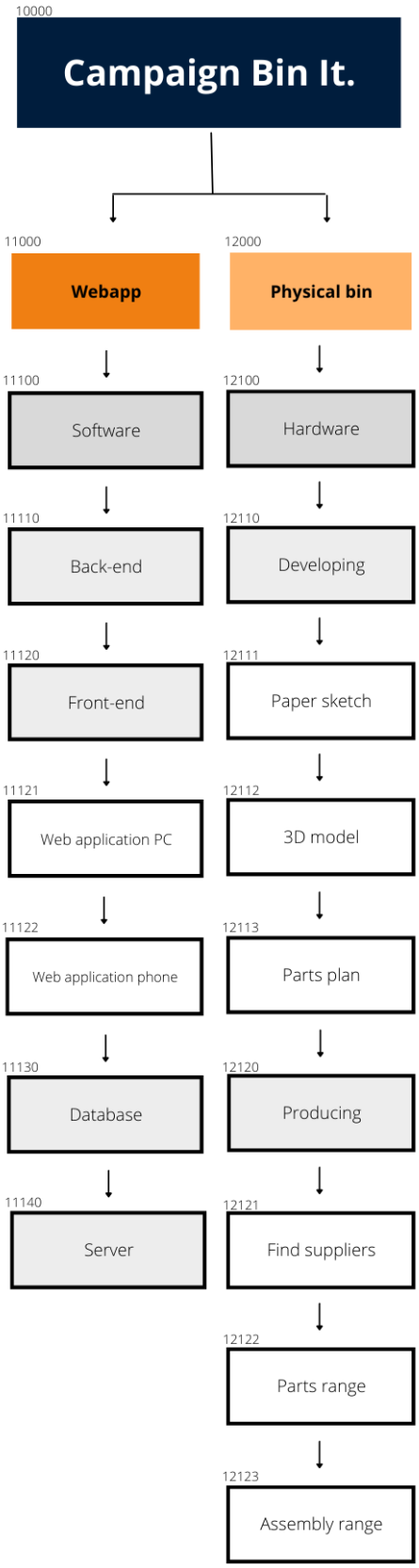


Figure 3: Product scope

3.2 Time

The Gantt chart helps to manage the different project steps in time. Figure 4 shows the Gantt chart of the project.

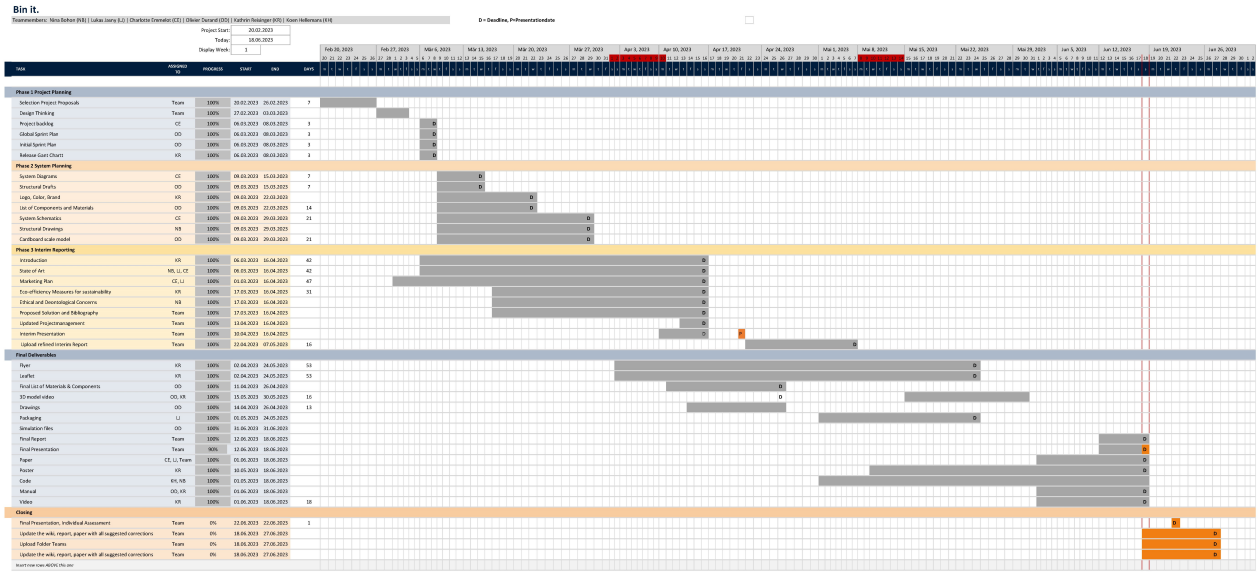


Figure 4: Release Gantt chart
gantt_chart_5_.pdf

3.3 Cost

To build the structure several components needs to be purchased. In Table 7 you can find the materials that needs to be purchased for the Garbage Gladiator bin, the differents suppliers and in addition the cost of each of the items.

Table 7: Project Cost

	Type	**Diameter (mm)**	**Size (mm*mm)**	**Thickness (mm)**	**Qty**	Supplier	Cost
	STEEL BAR	-	80×40	2	8 m	Megasa SN Maia	80€
	STEEL BAR	-	20×3	FULL	3 m	Megasa SN Maia	35€
	ALUMINUM BAR	-	80×40	2	1 m	Makprofiles	10€
	ALUMINUM BAR	-	60×44	2	2 m	Makprofiles	15€
	ALUMINUM BAR	-	40×20	2	0.5 m	Makprofiles	5€
	WOOD BAR	-	40×20	FULL	20 m	Maxmat	40€
	STEEL SHEET	-	-	5	1 m^2	Megasa SN Maia	50€
	STEEL RING	520	50×2	-	2 units	Megasa SN Maia	45€
	STEEL RING	475	50×2	-	2 units	Megasa SN Maia	40€
	ALUMINUM SHEET	-	400×200	5	1 unit	Makprofiles	10€

	ALUMINUM ROD	20	-	FULL	0.6 m	Makprofiles	10€
	H Screw	M12*25			12	RationalStock.pt	5€
	H Screw	M10*80			3	RationalStock.pt	1.50€
	H Nut	M12			12	RationalStock.pt	0.60€
	H Locking Nut	M10			4	RationalStock.pt	0.40€
	Washer	M12			8	RationalStock.pt	0.16€
	Washer	M10			6	RationalStock.pt	0.12€
Total							347,79€

3.4 Quality

When it comes to quality metrics for the Garbage Gladiator which is made out of aluminum and steel, there are several key factors to consider. These include factors such as durability, strength, corrosion resistance, and aesthetic appearance. There are some quality metrics to consider **[Markus Richter, 2020]**:

1. Durability: A high-quality bin should be able to withstand frequent use without showing signs of damage or wear;
2. Strength: The strength of the bin is an important metric, as it will determine its ability to hold heavy loads without buckling or collapsing. A strong bin will be able to hold up under pressure and will not easily deform or break;
3. Corrosion Resistance: Aluminum and steel are both prone to corrosion over time. A high-quality bin should be made with materials that are resistant to rust and other forms of corrosion, ensuring that it remains in good condition even after years of use;
4. Aesthetic Appearance: Since the garbage gladiator is part of the campaign, it should fit the brand style and vision.

3.5 People

The people who are included in a project are a key factor for a project's success. These stakeholders need to be pointed out so that relevant person groups, communities of interest and organizations can be figured out. For the project implementation it is important to identify them for a proper management. Table 8 outdraws all project-related stakeholders including their roles, their influence and their power.

Table 8: Project Stakeholders

Stakeholder	**Role**	**Power**	**Influence**
Team members	Owners	High	High
Benedita Malheiro	EPS coordinator	High	High
Supervisors	Supervising the project development	High	Medium
Teachers	Providing resources and support	High	Medium
ISEP	Main sponsor	High	Medium
Public Administration	Benefiter	Medium	Medium
LIPOR	Benefiter	Medium	Low
Teenagers/Young Adults	Main target group	High	High

Stakeholder	Role	Power	Influence
Parents	Influence main target group	Low	Low
Local Business	Cooperations/Sponsors	Low	Medium
Competitors	External influence	Medium	Low

3.6 Communications

Communication is a key function in project work. Effective and goal-oriented communication leads the project to success. It should be noted that proper communication is necessary not only for teamwork, but also in communication with the ISEP team and external stakeholders. Different groups of people should be considered differently in the communication strategy. For this purpose, different communication styles and communication channels are considered. A regular exchange between the project participants is the basis for a successful project.

Therefore, the communication channels can be found:

- In the team: online and offline meetings on WhatsApp or Microsoft Teams and the Wiki for presenting the project steps;
- Between supervisors and team: weekly jour fix on Thursdays at ISEP; Wiki as presentation platform;
- Between team and external stakeholder: online campaign (more information about in marketing chapter).

Table 6 elaborate the communication management.

Table 9: Communication management

Stakeholder information requirements	Timeframe/Frequency/Trigger	Prefered communication chanel
Update on project progress with supervisors	weekly	oral in jour fix
Project deadlines and milestones	weekly	written in google calendar
Feedback on report	weekly	oral in class

3.7 Risk

Risk management typically involves **[A. Arrais De Castro, 2023]**:

- Risk identification;
- Risk evaluation;
- Risk handling;
- Risk controlling.

Risk management process in the context of PMBOK **[A. Arrais De Castro, 2023]**:

1. Plan risk management;
2. Identify risks;
3. Qualitative risk analysis;
4. Quantitative risk analysis;

5. Plan risk responses;
6. Implement risk responses;
7. Monitor risks.

The risks at project level are elucidated in Table 10.

Table 10: Risks at project level

Risk event	**Probability**	**Impact rating**	**Risk handling**
Lack of information	Possible	Severe	Keeping track of the necessary and/or missing information, so that it can be collected
Lack of needed prior knowledge	Very likely	Significant	Assigning different roles to “expert” team members, who will be able to inform team members and share learned skills
Lack of time	Possible	Severe	Creating sprint-, global plan and Gantt chart, so that time can be efficiently allocated. Weekly scrum sessions to discuss progress and make adjustments if necessary
Project does not receive the needed support	Possible	Severe	Making good use of the weekly teacher meetings, by sharing project progressions and asking questions. If too little required support is received, indicate in a timely manner
Absences team members (absenteeism)	Possible	Severe	Drawing up and maintaining clear agreements and, when someone is absent too much, make it a subject for discussion within the team in a timely manner
Absences team members (stopping EPS)	Unlikely	Severe	Because the team consists of six members in total, the team should also manage with five members, just as other teams. When someone stops making clear agreements and division of tasks of the remaining work
Coordination problems between team members	Possible	Moderate	Weekly scrum-meetings prepared with shared agenda, use of Kanban board and published minutes
Deadlines are not kept	Possible	Significant	Creating sprint-, global plan and Gantt chart, so that time can be efficiently allocated. Weekly scrum sessions to discuss progress and make adjustments if necessary

The risks on product level are elucidated in Table 11.

Table 11: Risks at product level

Risk event	**Probability**	**Impact rating**	**Risk handling**
Off budget	Unlikely	Severe	Considerately planning the list of materials and components including pricing
Not in possession of the required capacity	Possible	Severe	Making a sprint plan, global plan and Gantt chart, so that it is clear what the expectations are and the requirements can be identified in a timely manner
Failing building the web app	Unlikely	Severe	Map out the necessary steps and conditions in advance, so that extra support can be sought in good time where necessary

Risk event	Probability	Impact rating	Risk handling
Failing designing the bin	Unlikely	Severe	Map out the necessary steps and conditions in advance, so that extra support can be sought in good time where necessary
Technical issues	Unlikely	Severe	Using functional tests, so that when issues are found they can be resolved
Design issues	Unlikely	Significant	Using functional tests, so that when issues are found they can be resolved
Accidentally spreading miss educational information	Unlikely	Significant	Carrying out thorough research, using fact-checking and citations
Public does not achieve the desired participation	Possible	Severe	Conducting market research and drawing up an effective marketing strategy, so that the target group is effectively involved

3.8 Procurement

Most of the parts for the Garbage Gladiator are made from rods that can be bought in many shops. All of the operations that are needed to create the parts are relative simple and can be made with basics tools. The choice is to make the parts from commercials items. Self making the parts will first reduce the cost and in addition reduce the time it takes to adapt the part if necessary.

The tools needed are basics tools that many workshop have: an arc welder, a table, a mobile grinder and some 17 mm wrenches. The estimated time for the delivery of the materials and the creation of the structure is around one week, considering one individual working. This represent around 700 € of salary expense.

Multiple places in and around Porto sell what is needed to create the structure.

3.9 Stakeholders Management

As in any project, there are stakeholders who have an impact on the project. For this reason, there are identified some key stakeholders. Graphic X shows all Stakeholders including team members, Benedita Malheiro, Supervisors, Teachers, ISEP, Public Administration, LIPOR, Teenagers/Young Adults, Parents, Local Business and Competitors. Since different stakeholders relate to the project in different ways, Graph X shows their power and influence. This graphic representation helps to specifically address the individual stakeholders. This allows the team to efficiently work out the overview of the goals, the interests, the risks and possible conflict potentials.

In Figure 5 the stakeholdermanagement map is shown.

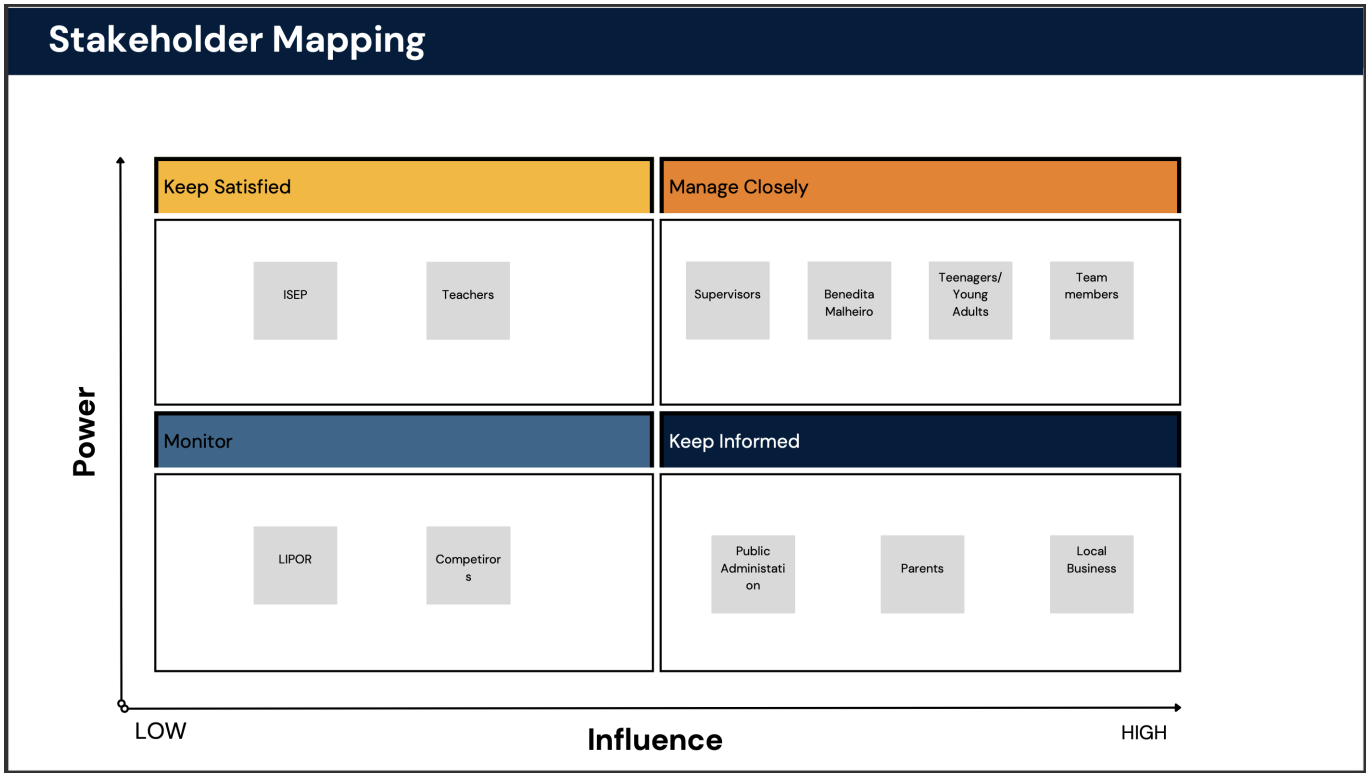


Figure 5: stakeholdermanagement map

3.10 Project Plan

Table 12 shows the sprint plan to manage the different packages in time.

Table 12: Global Sprint Plan

Sprint	Start	Finish
1	20/02/2023	26/02/2023
2	27/02/2023	05/03/2023
3	06/03/2023	12/03/2023
4	13/03/2023	19/03/2023
5	20/03/2023	26/03/2023
6	27/03/2023	02/04/2023
7	10/04/2023	16/04/2023
8	17/04/2023	23/04/2023
9	24/04/2023	30/04/2023
10	01/05/2023	07/05/2023
11	15/05/2023	21/05/2023
12	22/05/2023	28/05/2023
13	29/06/2023	04/06/2023
14	05/06/2023	11/06/2023
15	12/06/2023	18/06/2023
16	19/06/2023	25/06/2023
17	19/06/2023	25/06/2023

Table 13 shows the project backlog.

Table 13: Project Backlog

PBI	Title	Status
A	Choosing a projectproposal	Done
B	Project backlog	Done
C	Global & initial sprint plan	Done
D	Gant chart	Done
E	System diagrams & structural drawings	Done
F	List of materials	Done
G	Cardboard scale model	Done
H	Marketing	Done
I	Sustainability	Done
J	Ethics & deontology	Done
K	Interim report and presentation	Done
L	3D model video	Done
M	Packaging solution	Done
N	Functional tests	Done
O	Flyer	Done
P	Leaflet	Done
Q	Paper	Done
R	Poster	Done
S	Manual	Done
T	Final report and presentation	Doing

Beginning sprint planning is shown in Table 14.

Table 14: Sprint Plan

Sprint	Task	Duration (d)	Responsible	Involved
1	Choosing project proposal	5	Team	Team
2	Design thinking	3	Team	Team
3	State of the art	2	LJ, NB, CE	-
3	Gantt chart	2	KR	Team
4	Project management	2	LJ, CE	
4	Branding, logo, colors	2	KR	-
4	User stories	2	NB	KH
5	Market analysis	2	LJ, CE	-
5	Leaflet	2	KR	-
5	Wireframes	2	NB	-
5	Structural drawing	2	OD	-
5	List of materials	2	OD	-
6	Marketing plan	2	LJ, CE	-
6	Sustainability	2	KR	OD
6	Ethics	2	NB	Team

Sprint	Task	Duration (d)	Responsible	Involved
6	Cardboard scale model	1	OD	-
7	Flyer	2	KR	-
7	Packaging	2	OD	LJ
7	Presentation	2	KR	-

The progress register is shown in Table 15.

Table 15: Project Progress Register

Sprint	PBI	Responsible	Involved	Status
1	A	Team	Team	Done
2	B	CE	-	Done
3	D	KR	Team	Done
5	P	KR	-	Done
5	E	OD	-	Done
6	F	OD	-	Done
6	G	OD	-	Done
6	H	LJ, CE	KR	Done
6	I	KR	OD	Done
6	J	NB	OD, KR, LJ	Done
7	C	CE	KR	Done
7	K	Team	-	In progress

3.11 Sprint Outcomes

The outcomes of all sprint reviews are explained in the following tables.

Sprint 1 - week 9

Table 16: Sprint 1 - week 9

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	4:40	4:40	Team	Done
Project	Choosing a project proposal	3:50	4:10	Team	Done

Sprint 2 - week 10

Table 17: Sprint 2 - week 10

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	10:40	10:40	Team	Done

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Design thinking workshop	Design creation	11:30	11:30	Team	Done
Project	Design thinking	3:50	3:50	Team	Done

Sprint 3 - week 11

Table 18: Sprint 3 - week 11

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	16:20	16:20	Team	Done
Report	State of the art	09:00	09:00	LJ, NB, CE	Done
Project management	Gantt chart	02:00	02:00	KR	Done
Marketing	Team logo	01:00	02:30	KR	Done

Sprint 4 - week 12

Table 19: Sprint 4 - week 12

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	20:40	20:40	Team	Done
Project management	-	03:00	08:00	LJ, CE	Done
Marketing	Brand, colors, logo design	03:00	04:00	KR	Done
Product design & development	User stories	01:00	01:30	NB	Done
Product design & development	User story mapping, defining requirements	03:00	03:00	NB	Done
Structural draft	3D model	05:00	05:00	OD	In progress

Sprint 5 - week 13

Table 20: Sprint 5 - week 13

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	16:30	16:30	Team	Done
Marketing	Market analysis	08:00	12:00	LJ, CE	Done

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Programming	Back-end programming	...	...	KH	In progress
Marketing	Design leaflet	03:00	03:00	KR	Done
Product design & development	Figma files set up	01:00	01:00	NB	Done
Product design & development	Lo-fi wireframes (app)	03:00	03:00	NB	Done
Structural draft	3D model	06:00	06:00	OD	In progress

Sprint 6 - week 14

Table 21: Sprint 6 - week 14

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	17:10	17:10	Team	Done
Marketing	Marketing plan	03:00	08:00	LJ, KR, CE	Done
Programming	Front-end elements added + solving back-end errors	...	09:00	KH	Done
Sustainability	Sustainability chapter report	03:00	04:00	KR	Done
Report	Finish introduction chapter	01:00	01:00	KR	Done
Ethics	-	03:00	03:00	NB	Done
Product design & development	Log in and sign up screen design	02:00	02:00	NB	Done
Structural draft	3D model	04:00	04:00	OD	In progress
Cardboard model	-	03:00	03:00	OD	Done
List of components	Dress up the list	02:00	02:00	OD	Done

Sprint 7 - week 16

Table 22: Sprint 7 - week 16

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	11:40	11:40	Team	Done
Project management	Sprint plans	02:00	05:00	CE	Done
Report	Revision of project management, marketing & tables/graphics	01:00	02:00	LJ	In progress

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Marketing	Flyer, new leaflet	04:00	06:00	KR	Done
Report	Project development	02:00	02:00	NB	Done
Product design & development	Bin map	03:00	01:00	NB	In progress
Product design & development	Bin detail page	02:00	01:00	NB	In progress
Product design & development	Add bin	03:00	01:00	NB	In progress
Project management	Cost estimation	01:00	01:00	OD	Done
Project management	Procurement	01:00	01:00	OD	Done
Project development	Packaging	01:00	01:00	OD	Done

Sprint 8 - week 17

Table 23: Sprint 8 - week 17

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	06:40	06:40	Team	Done
Programming	Adding an image in post	1:00	2:00	KH	In Progress
Programming	Manage posts	2:00	03:00	KH	Done
Programming	Login	8:00	10:00	KH	In Progress
LCA	Do the life cycle analysis	03:00	03:00	KR/OD	Done
Stress Analysis	Identify the cases and start	03:00	03:00	OD	Done
Product Design & Development	Screen Design	06:00	06:00	NB	In Progress
Interim Presentation	Preparations Meeting + Slides	04:00	04:00	Team	Done
Packaging	Setting requirements	01:00	03:00	LJ	Done

Sprint 9 - week 18

Table 24: Sprint 9 - week 18

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	11:50	11:50	Team	Done
Programming	Login + error solving + alg	7:00	13:00	KH	In Progress

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
3D printable model	1st sketch and model version	04:00	04:00	OD	Done
Product Design & Development	Screen Design	06:00	06:00	NB	In Progress
Marketing	Research + Collecting Ideas	02:00	02:00	KR, CE, LJ	Done
Interim Presentation	Integration General Feedback	03:00	03:00	Team	Done
Campaign	Define campaign details	02:00	04:00	CE, KR, LJ	Done
Marketing + Ethics	Implement feedback from	02:30	03:30	CE, NB, LJ	In Progress

Sprint 10 - week 19

Table 25: Sprint 10 - week 19

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	10:10	10:10	Team	Done
Programming	Finishing authentication	30:00	25:00	KH	Done
Programming	Bin confirmation	01:00	01:00	KH	In Progress
3D printable Model	Modify it based on	06:00	06:00	OD	Done
Programming: Frontend	Log In, Register, Sign Up	03:00	03:00	NB	Done
Marketing	Sponsorships, Country Glossary	03:00	03:00	KR	Done
Marketing	Social Media Grid Design	03:00	03:00	KR	In Progress
Packaging	Finish packaging solution	02:00	05:00	LJ	Done
Campaign	Education: Glossary & Trends	02:00	05:30	LJ	In Progress
Campaign	Ranking system and rewarding	02:00	04:00	CE	Done

Sprint 11 - week 21

Table 26: Sprint 11 - week 21

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	10:40	10:40	Team	Done

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Programming	Bin confirmation	3:00	-	KH	In Progress
Stress Analysis	Lead the analysis	03:00	03:00	OD	Done
Programming: Frontend	City map, adding bins, profile, general information, cities information, bin details	12:00	06:00	NB	In Progress
Product Design & Development	Clickable prototype	02:00	02:00	NB	Done
Communication	Include Mrs Barata Feedback	01:30	02:00	KR	Done
Marketing	Logo Animation	02:00	02:00	KR	Done
Marketing	Poster Design Draft	02:00	01:00	KR	In Progress
Paper	State of Art chapter	02:00	03:00	LJ	Done

Sprint 12 - week 22

Table 27: Sprint 12 - week 22

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	10:50	10:50	Team	Done
Marketing	Social Media Grid Design	02:00	02:00	KR	Done
Marketing	Poster (Serie) Design	02:30	03:30	KR	Done
Project Development	3D Animation Intro	01:00	01:30	KR	Done
Marketing	Gif Animation	02:00	02:00	KR	Done
Marketing	Garbage Gladiator “Shirt”	02:30	02:30	KR	Done
Programming	Image	3.0	3.0	KH	In Progress
Paper	Ethics summary	01:00	02:00	LJ	Done
Report	Rewrite chapter 7.1	01:00	02:00	LJ	Done
Report	Rewrite Packaging	01:00	02:00	LJ	Done
Campaign	Brainstorming Tik Tok	02:00	02:00	LJ, KR, CE	Done
Campaign/Report	Writing part about Tik Tok	02:00	02:00	LJ	In Progress
Paper	Substainability Summary	1:00	01:30	KR	Done
Paper	Add references	02:00	02:00	LJ	Done
Programming: Frontend	City map, adding bins, profile, general information, cities information, bin details	12:00	06:00	NB	Done

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Report	Redo and detail the cost Analysis	02:00	02:00	OD	Done
Report	Write the possible improvement	00:30	01:00	OD	Done
Report	Detail the concept of the Bin	01:00	01:00	OD	Done
Manual	Verificate the manual	02:00	02:00	KR, OD	Done
Manual	Create the content of the manual	02:00	02:00	OD	Done
Paper	Marketing summary	01:00	02:00	CE	Done
Report	Concept project development	01:00	02:00	CE	Done

Sprint 13 - week 23

Table 28: Sprint 13 - week 23

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	07:30	07:30	Team	Done
Project Development	3D model import + video animation	6:00	7:00	KR	Done
Project Development	Manual Design	3:00	3:00	KR	Done
Video	Brainstorming + Planning	3:00	3:00	KR	Done
Post	Programming	-	2:00	KH	In Progress
Campaign	Filming TikTok & video	3:00	4:00	LJ, KR, CE, OD	Done
Report	Meeting about last chapters	0:30	0:30	KH, NB, OD, KR, LJ	Done
Campaign	Rewrite TikTok part	2:00	2:00	LJ	Done
Report	Proof reading chapter 7	3:00	3:00	LJ	Done
Programming	Review, final changes	3:00	3:00	NB	Done
Report	App further development	1:00	1:00	NB	Done
Product Design & Development	Clickable prototype	3:00	3:00	NB	Done
Prototype	Paint and assemble bin prototype	4:00	6:00	OD	Done
Paper	Abstract, introduction and project development	4:00	8:00	CE	Done
Programming	-	-	9:00	KH	In progress

Sprint 14 - week 24

Table 29: Sprint 14 - week 24

Subject	Task	Estimated duration (h)	Real duration (h)	Involved members	Status
Courses	-	10:10	10:00	Team	Done
Video	Video Cut + all included Animation	8:00	11:00	KR	Done
Report	Writing chapters 7.6 + 8.1	3:00	3:00	LJ	Done
Final presentation	Presentation slides	2:00	5:00	Team	Done
Post and details	Programming	3:00	3:00	KH	Done
Programing	Review + final touches front end	3:00	3:00	NB	Done
Prototype	Finish to assemble the bin prototype	2:00	2:00	OD	Done
Report	Prototype development bin	2:00	2:00	OD	Done
Paper	Proposed solution, project outcome + rereading and rewriting	3:00	6:00	CE	Done
Report	Rereading and rewriting	5:00	10:00	CE	Done
Report	Sprint outcomes and evaluations + future developments campaign	2:00	3:30	CE	Done

3.12 Sprint Evaluations

The summary of all the sprint retrospectives, including any actions implemented as part of the team's continuous improvement strategy, is shown in Table 30.

Table 30: Sprint evaluations

Sprint	Positive	Negative	Start doing	Keep doing	Stop doing
1	Chose a project proposal	-	Think about ideas	Get to know each other	-
2	Created an problem statement and brainstormed about ideas	First hard to find something that appealed to everyone	Think about solutions	Brainstorm and being creative	-
3	State of the art gave us a direction	Smart-bin (first idea) is expensive and already many different options	Clear intern meetings and applying roles	Brainstorm	Work without structure

Sprint	Positive	Negative	Start doing	Keep doing	Stop doing
4	Started building the app	Not all team members up to date about the work in progress	Incorporate scrum-meetings	Product development	Communicating too less
5	Made a 3D model	List of materials had the wrong structure	Update the list of materials	Maintain work drive	-
6	Market analysis presentation	Time pressure for the deadline	Communicating earlier about possible blocks	Programming app	Waiting
7	Good final sprint	-	Rehearsing presentation	Being critical	-
8	Presented the interim report	-	Think about the oral feedback and integrate	Thinking about the “Bin It” story	-
9	Received feedback on the interim report	Had some errors programming	Process the given feedback	Define campaign details	-
10	Received recommandations for the 3D printable model	-	Stress analysis	Programming	-
11	Stress analysis was successful	-	Finishing the graphic deliverables	Finishing the design of the app	-
12	Did a lot of writing on the report	We had to redo the details of the cost analysis	The end sprint	Working together	-
13	Made an final sprint plan for the last two sprints	-	Rereading and possible writing of the report	Working on the paper	-
14	There was zero time stress, because of all our planning	-	Practicing for the end presentation	Discussing about BinIt	Working on the report

3.13 Conclusion

In conclusion, effective Project Management helped to organise the project successfully. From identifying project goals to managing resources and timelines, project management is essential for delivering quality results on time and within budget. By following a structured approach and leveraging project management tools and techniques our team can streamline processes, increase efficiency and improve communication. Moving forward, the Marketing chapter will explore strategies for promoting the campaign to the relevant target group. First of all, a market research will be conducted to cover the key elements for a successful marketing strategy. In this way, there will be an understanding of the target audience consumer behaviour.

4. Marketing Plan

4.1 Introduction

First of all, the micro- and macro-environment of the market needs to be analyzed. Moreover, there needs to be look at the self-owned resources and take them in relation to the competitors. After analyzing the market situation, awareness needs to be created about BinIt's role in the market. In the context of the customer needs, there need to be thought about how they can be best fulfilled. On this basis, recommendations will be derived for actions to implement.

4.2 Market Analysis

4.2.1 Macro-Environment Analysis

To analyze the environment for the project the PESTEL analysis is used, including political, economic, social, technological, environmental and legal aspects which influence waste management regarding the campaign with the bin and the application the most.

In Figure 6 the PESTEL analysis is shown.

P	E	S	T	E	L
Political	**Economic**	**Social**	**Technological**	**Environmental**	**Legal**
• European Union goal: Circular Economy • 2035: 65% of trash in member states must berecycled • Portugal just recycles around 50%	• Waste as the raw material of the future • European economy depends on import • Deglobalisation and trade wars as challenges	• Sustainable Development Goal 11: sustainable cities and communities • Clean cities improve quality of life • Growing political participation in Europes youth (target group)	• Recycling technologies are expensive • Member states need to invest more • Goal: finfing cheap solutions	• Garabage effetcs eco systems • Garbage chain: animals eat trash, humans eat animals • English Channel: Microplastics detected in 36.5% of fishes	• European waste frame directive 2008/98/EC

Figure 6: Pestel

Political

The political orientation of the European Union regarding waste prevention is clearly moving in the direction of a circular economy. For this reason, the EU Parliament is calling on member states to recycle a greater proportion of the waste they produce. Incentives and guideline for waste prevention and recycling were adopted as a guideline in the different member states. The EU parliament has the goal that in each member state the recycling quote will be 65 % until 2035. A milestone towards this

goal was to reach a quota of 50 % in all countries by 2020. Portugal failed it but right now in 2023 they can reach a quote of 50 % **[Reiner Wandler, 2020]**.

Economic

Waste is seen as the raw material of the future. Due to deglobalization, Europe is dependent on finding new ways to procure raw materials. Existing raw materials should therefore be recycled to start the journey towards a sustainable economy. European companies can thus secure competitive advantages. According to Eurostat, the EU imports about half of the raw materials it consumes. Recycling raw materials mitigates supply risks such as price volatility, availability and import dependence **[Verena Demary, 2021]**.

Social

In the context of waste disposal, it is important to involve the people who produce it. Clean cities are a goal of the UN agenda sustainable development goal 11. People in cities want clean cities to improve the quality of life. A clear trend can be seen throughout Europe. Young people want to get involved in politics. Young people feel particularly connected to the issue of sustainability, as the younger generation will feel the effects of climate change the most. Movements like Fridays for Future underline this. In conclusion our target group recognizes the importance of our campaign **[United Nations, 2023]**.

Technological

To stick to the political requirements, the individual EU states must invest more money in recycling technologies. In addition to political measures to expand recycling technologies, it is important as a first step that the people who produce the waste also dispose it properly **[Nell Lewis, 2019]**.

Environmental

The environmental impact of waste is serious. Garbage that is not disposed of properly causes massive damages to the environment. Through food chains, humans reabsorb the remains of garbage that has not been properly disposed of. Garbage that is disposed of in nature is used by animals as a food source. Microplastics were detected in 36.5 % of the fish from the English Channel **[Stefanie Werner, 2021]**.

Legal

The European Union parliament has passed several legal directives to combat the waste problem for example the European waste framework directive 2008/98/EC. The aim of the Waste Framework Directive is to increase the promotion of the circular economy through the prevention and, above all, the increased recycling of waste. The individual member states must transpose these requirements into their national law **[European Union, 2008]**.

4.2.2 Micro-Environment Analysis

Porter's five forces model was used to highlight the microenvironment of the campaign. This includes the analysis of the bargaining power of the suppliers and the customers. In addition, possible threats from potential competitors and substitute products must be analyzed as well. The difference between the products and the current offers on the market should stand out.

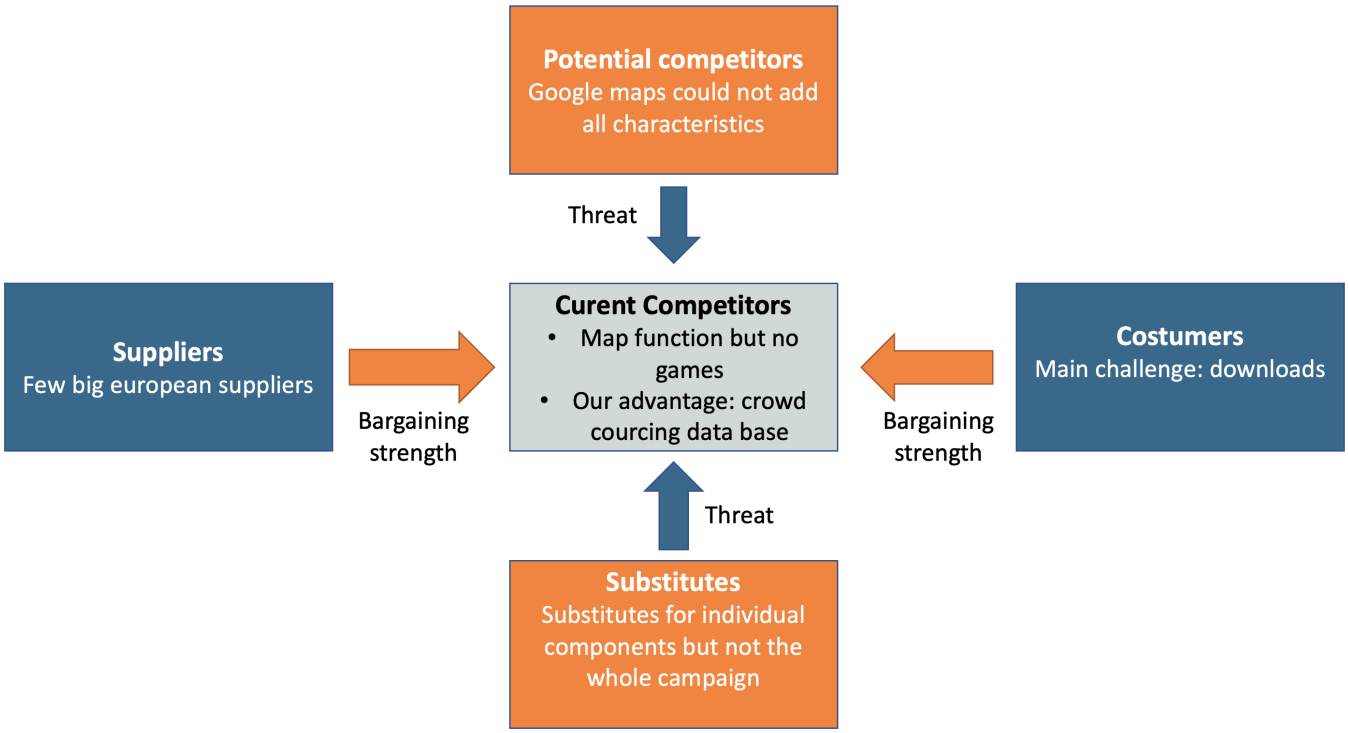


Figure 7: 5 Forces

Potential Competitors

The biggest threat at the moment would be if the global player google were to introduce a function with google maps that would allow users to search for garbage cans on google maps. Nevertheless, there are currently no signs of any plans from Google that would indicate that they are working on such a feature. Even if this should be the case one day, the core competence of BinIt consists of the playful approach to motivate people to dispose their garbage into trash cans.

Suppliers

For the development of the garbage bin, BinIt depends on the suppliers by purchasing the needed raw materials. Since the goal to produce sustainably and accordingly locally in Europe, there are no worries about supply shortages from foreign suppliers and external influences from bottlenecks. The bargaining power of suppliers becomes clear when it comes to price negotiations, as sustainable materials that are more expensive are being used.

Substitutes

As mentioned in the State of Art, there are already several solutions for the elimination of waste. These include various trash cans, apps and campaign ideas. Nonetheless, there are no signs of any substitute product at the moment that would compete the BinIt combination of the garbage bin and app. Customers The biggest challenge will be to convince the potential customers of the product. In this context, it means downloading the app in the first place. There is a firmly believe that the playful character of the app will appeal to customers. However, customers have to be convinced of the concept at the beginning.

Conclusion

In summary, there are already many different approaches to addressing the litter problem in cities. However, through Porter's five forces analysis, there is found that the game-changing impact of the BinIt idea is the strongest competitive advantage, giving it a strong unique selling point in the market.

4.2.3. Company analysis

To find out the strengths and weaknesses of the product and company, the business model canvas is filled out (Hoekstra, 2022). The BMC consists of nine subjects that cover all aspects of BinIt. The subjects are about the organization, value proposition (description of the product and service), customers, suppliers, costs and revenues.

The business model canvas is explained in Figure 8.

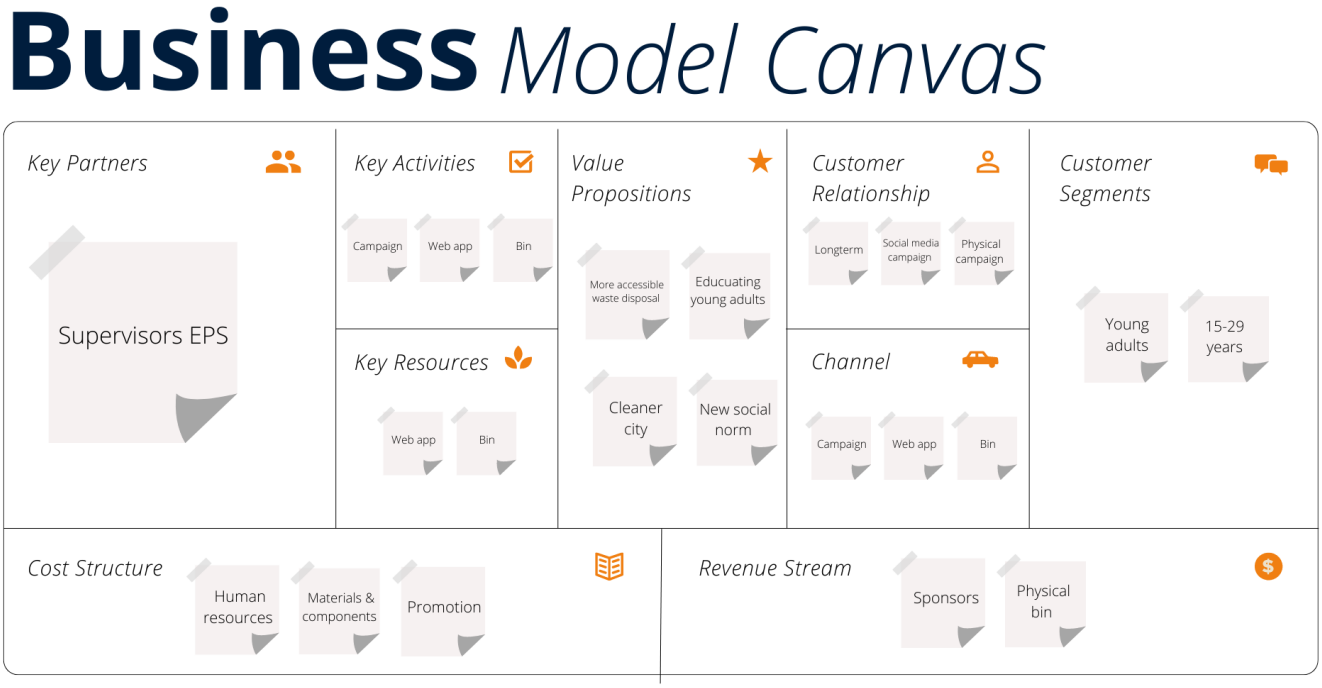


Figure 8: Business model canvas

- **Key partners:** The key partners are the EPS supervisors at ISEP, because they help to achieve the goals.
- **Key activities:** The key activities contain the campaign, web app and designed garbage bin to achieve the goals to educate people about waste and recycling to work towards cleaner cities.
- **Key resources:** The key resources contain the web app with city garbage bins map and the educational platform and the garbage bin. The materials, components and manufacturing are externally done. For the EPS project the budget contains 100 €, but to realize the product there will be more money needed.
- **Value propositions:** The value proposition is to tackle pollution and waste at the outset by making disposal and information about different options easier and more accessible. With BinIt working towards a cleaner city by preventing waste and pollution will become the new social norm.
- **Customer relationship:** The aim is to create longterm relationships with users, by targeting young adults via the social media campaign and the physical campaign with the garbage bins. By educating users and simplifying preventing waste and pollution Bin It is creating a pattern for users to incorporate in their daily lifestyle.
- **Channel:** The used channels to reach (potential) users are the campaign, web app and garbage

bins.

- **Customer segment:** The targeted customer segment is young adult between 15 and 29 years old.
- **Cost structure:** The cost structure includes the costs for human resources, materials & components and promotion.
- **Revenue stream:** The revenue stream contains sponsorships and the profit from the sale of the physical bin.

4.3 SWOT Analysis

A SWOT analysis shows in a glance where opportunities may lie for BinIt and which points require extra attention. SWOT stands for strengths, weaknesses, opportunities and threats. The analysis is used to investigate how BinIt can grow.

The SWOT analysis is explained in Figure 9.

Figure 9: SWOT analysis

4.4 Strategy

4.4.1 Strategic Objectives

The balanced scorecard considers four perspectives: financial, customer, internal processes and people (learning and growth) **[T. Jackson, 2023]**. The strategic objectives are SMART (Specific, Measurable, Achievable, Realistic and Time-bound) formulated.

Financial

- Become a non-profit organization by June 18, 2023;
- Stay within the budget of 100 euros during the project until June 18, 2023;
- Find three sponsorships and/or cooperations with local businesses by June 18, 2023;

Customer

- Reduce the city waste of Porto with 30 % by December, 2026;
- Educate users about correct waste disposal and recycling options by June 18, 2023;
- Build a longterm relationship with customers where 40 % of the users are using the app for at least 3 months by December 2025;

Internal processes

- Develop the desired web app with city map, ranking score and educational platform by June 18, 2023;
- Create a city map with 80 % of the city garbage bins locations pinned by December 2025;
- Create a gamification by ranking score with points for pinning and validating garbage bins locations and proper disposal of waste by June 18, 2023;
- Create an educational platform with correct city waste disposal and recycling options, the importance of it and the consequences of waste and pollution in the city by June 18, 2023;
- Create a physical bin with a visual feature to attract people by June 18, 2023;

Learning and growth

- Become a sustainable brand by producing the products as sustainably as possible while maintaining ethics and deontology by June 18, 2023.

4.4.2 Segmentation and Targeting

The segmentation is based on demographic criteria based on age and place. The target group contains young adults between the ages from 15 to 29 years old living in Porto, Portugal. There are approximately 38 414 citizens between the ages of 15 and 29 years old living in Porto, Portugal **[Zhujiworld.com, 2023]**. With a total of 245 403 citizens in Porto this would give the percentage of 15,7 % of the total city population.

Young adults are in need of efficient waste management since it preserves the environment, public health, livability, and aesthetics of a city **[B. Sharma, B. Vaish, V. Srivastava, S. Singh, P. Singh, R.P. Singh, 2017]**. Improper waste management can harm the environment and surroundings, cause pollution, and lead to the spread of infectious diseases and harmful bacteria. Living in clean cities with efficient waste management would increase the quality of life, and young adults who do so are more likely to be environmentally conscientious.

In conclusion the campaign can lead to a more responsible approach to waste management and encourage individuals to reduce, reuse, and recycle.

Problem statement

Young adults are in need for education about correct waste disposal and recycling options, with the result that they can live in a cleaner city and their quality of life will increase.

Value proposition

The value proposition is elaborated in table 31.

Table 31: Value proposition

For	Young adults between 15 and 29 years old.
Who	Want to live in a cleaner city to increase their quality of life.
With Bin It.	A campaign, a web app, including a city map and educational platform, and a physical bin.
That	Simplifies and stimulates proper waste disposal and recycling for young adults.
Unlike	Other campaigns that target the problem at the end of the cycle where the city is already polluted.
Our	Campaign tackles the beginning of the problem and creates a new social norm.

4.4.3 Positioning

To analyse the company's position relative to competitors, the unique selling points were stated and the competitors analyzed during the market analysis and the SWOT analysis. The results are elaborated in the positioning diagram featured in figure 10, with focus on the features garbage disposal and recycling campaign and city map.

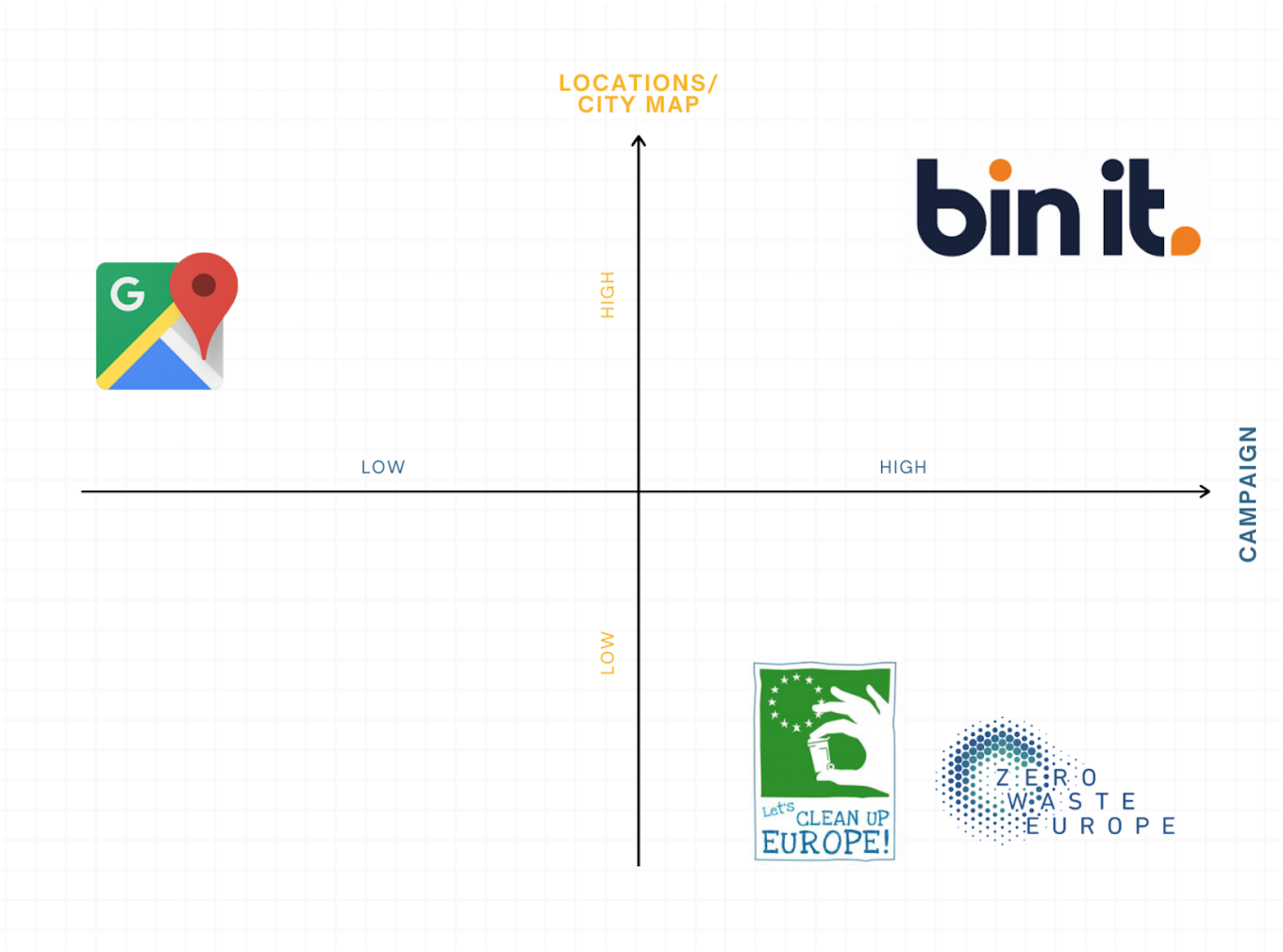


Figure 10: Positioning matrix

Explanation figure

Google Maps has city maps of all the cities over the world, including global satellite pictures. Google does not have a function special for locations of waste disposal options and they do not have a campaign for cleaning up the cities. On the other side, there are big European clean up campaigns, like Let's Clean Up Europe and Zero Waste Europe, but they do not have city maps nor pinned locations of waste disposal options. Therefore BinIt is an unique product because it covers all the various components to not only tackle the problem, but also to simplify the solution.

4.4.4 Marketing-Mix

The marketingmix is a part of the strategic marketing plan. The marketingmix contains the four P's: Product, Price, Place and Promotion.

Product

BinIt is a campaign to educate young adults about correct waste disposal and recycling options, with the result that they can live in a cleaner city and their quality of life will increase. BinIt consists of a campaign, web app and physical design bin. The campaign is to promote the platform and create more awareness about correct waste disposal options. The campaign contains the web app, physical bin and social media campaign. The web app helps users to find the nearest garbage bin and to incorporate gamification. The gamification consists of a ranking score by a point giving system with points for pinning and validating locations and correct disposal of waste. The web app also contains an educational platform to educate users about different waste disposal and recycling options and the importance of it. The special designed garbage bin is produced to attract people to dispose their waste, to create waste disposal awareness and to promote the "Bin It" brand.

Price

The goal for BinIt is not to make profit, but to simplify and stimulate waste disposal and recycling. Therefore the web app will be free to use. The goal for the physical design garbage bin is to place it in an accessible public place, to attract attention and provide a waste disposal option. The plan is to achieve this with the help of sponsors in order to cover the costs and there is no need for profit here neither.

Place

The web app is designed for the city Porto, Portugal. The physical design garbage bin is for an accessible public place in Porto, Portugal. The launching product is made for the city Porto, Portugal, but the aim is to make it a concept that can be used for cities throughout Europe. Waste disposal and recycling options can vary by country and even by cities within a country, therefore BinIt can simplify proper waste disposal everywhere and achieve a cleaner Europe.

Promotion

The message that BinIt wants to sent out is that clean waste disposal and recycling is easy and important. In addition, the goal is also that young adults feel stimulated and attracted to do so. The brand name and slogan are in line with this. "Bin It, to win it" reflects the brand in a glance: simple and attractive. The BinIt campaign consists of a social media campaign to reach the target group of young adults. The communication channels that are going to be used are TikTok and Instagram. The goal is to be consistently active on social media, to keep an eye on current trends and to respond to them in order to reach as many young adults as possible. In addition, there is a goal to create a self-

owned challenge, to which young adults can respond and share their own attempts. In this way, brand awareness is created and a new social norm will arise by the multiple implementations the more participants there are. In addition, the goal is also to use the communication channels to distribute educational information about the correct waste disposal and recycling options and the importance of it. In this way, fun and education are combined to reach the target group. The aim is to encourage as many young adults as possible to use the web app from the communication channels.

4.4.5 Brand

4.4.5.1 Name

The brand that is developed is named “Bin it”. This catchy and simple slogan helps to identify the company and all the different components. “Bin It” is one of the main messages to spread regarding waste separation. The research on color selection had shown that most brands around the theme of recycling use the color green. BinIt wants to be different, therefore the colors orange and dark blue are chosen. Orange stands for action and that reflects that mission to encourage people to act.

The simple map symbol is used as a symbol. It is placed in the logo and should show the connection to the map in the app. This symbol is also used throughout the project for all presentations and products.

Figure 11: Symbol

4.4.5.2 Logo

In Figure 12 the final logo design is presented:

Figure 12: Final Logo

More detailed information about the logo design can be found in Chapter 7.3.1.

4.5 Marketing Programmes

4.5.1 Programmes

The following overview, given in Figure 13, gives a first impression of the different aspects of the marketing programme.

MARKETING PROGRAMME

COMPONENTS OF OUR MARKETING CAMPAIGN

SOCIAL MEDIA

Our biggest focus in our marketing campaign is to generate attention on social media. Since our target audience is teenagers and young adults, we decided to advertise mainly on TikTok and Instagram. These two social networks are the biggest component of our advertising

BIN

The bin itself has the function of connecting people on the street locally with our campaign. This is the first starting point to raise awareness about the consequences of littering.

LEAFLETS

In our leaflet you can find all important information about our campaign. This allows customers to better understand our overall campaign and become part of our vision.

APPSTORES

If we managed to address a larger group of users, then there is a possibility that we will get a better placement in AppStores. Maybe we will make it to the AppStore charts or find a good placement in a niche category like sustainability.

LOCAL BUSINESSES

Sponsorships with local businesses help to promote our campaign. Local businesses like for a example small shops can draw attention to our campaign while placing promotion in their shops.

Figure 13: Marketing Programme

Most of the marketing campaign will take place on the social media platforms TikTok and Instagram, because a report of Pew Research Centre stated these are the most populair platforms among young adults **[E. A. Vogels, R. Gelles-Watnick, N. Massarat, S. Atske, 2023]**. In this way, the target group will be addressed the most effective. Since the goal is to create a well known brand with our campaign, the goal is to have the brand channels close to the customers, interact with them and increase the public relations. In addition, there is the possibility to get relatively cheap advertising on TikTok, in which can be managed to get relatively many followers and go viral with the posted videos. In this way an own promotion platform can be obtained.

For this reason a research was done to find out how to become successful on TikTok **[Andreas Baulig, 2023]**. Here is the guideline for the brand account:

- First impression is important;
- Starting videos with suspense;
- Using optimum lengths (short videos are better);
- Using a lot of creativity;
- Hop on trends, challenges and sounds;
- Using hashtags;
- Interactions with followers is important;
- Collaborations with other users;
- Constant activities.

4.5.2 Budget

In order to reach the audience effectively there will be ads displayed on TikTok and Instagram **[B. McClure, 2023]**. In the following the costs will be presented.

Tik Tok

Tik Tok ads are measured by the number of views. For this purpose, there is the unit CPM. One CPM is equal to thousand views. However, TikTok has a condition of investing at least 500 dollars in campaigns. The minimum costs for one CPM is 0,50 dollars on TikTok. For influencer marketing on Tik Tok exist other pricing categories. The following listing shows approximate costs for influencer marketing on Tok Tok.

Table 32: Influencer marketing costs on TikTok

Number of followers	Costs (in US dollars) per post
1 000- 10 000	800
10 000- 50 000	1 500
50 000- 500 000	3 000
500 000- 100 000	5 000
1 000 000+	7 000

Instagram

Compared to TikTok, marketing costs on Instagram are more expensive. One CPM costs about seven dollars on Instagram. Table 32 shows the costs for influencer marketing on instagram.

Table 33: Influencer marketing costs on Instagram

Number of followers	Costs (in US dollars) per post
1 000- 10 000	1 000
10 000- 50 000	2 000
50 000- 500 000	5 000
500 000- 100 000	7 500
1 000 000+	10 000

4.5.3 Control

Since the goal is to permanently improve the campaign, the PDCA cycle method is being used to monitor success. In this way, aspects which are positively received by customers and which have potential for improvement can be measured. The overview is shown in Figure 14.

Figure 14: PDCA Control

Plan

The conducted market analysis is used to develop a marketing strategy. After the creation of the marketing strategy, specific actions will be planned to satisfy the customers. Chapter 4.5.1 “Marketing Programmes” describes all concrete marketing executions.

Do

In this phase the project will be executed. That means that the Garbage Gladiator will be placed in the city to generate public attention. Furthermore, the educational part of the campaign will be starting, while presenting the Garbage Gladiator as well as the social media advertising will be starting.

Check

Since “Bin It” is a campaign including the Garbage Gladiator and the web app, there is need to do a performance review for the several parts. Therefore, there a some important KPI’s which need to be controlled.

Campaign KPI’s

- Amount of press traffic
- Number of followers on social media accounts

App KPI's

- App downloads
- Reviews in app stores
- Duration of stay in app

Bin KPI's

- Number of visitors
- Feedback interviews on the spot

In general, it is important to observe the customers and do an exchange, so that information about improvement proposals can be obtained in order to change the customers behavior and way of thinking to decrease littering. Based on these KPI's, actions should be taken to reinforce the success of “Bin It”.

Act

Customer surveys and customer observations enables the company to find out how to better respond to customer needs. Moreover, recommendations for action can be identified from the analysis of the KPI's. This gives a starting point from which the campaign can be adjusted to achieve greater success.

Possible adjustments:

App

- Change rewards;
- Change app interface;
- Work on communication policy so that customers understand the benefit of the bin better.

Bin

- Change place of bin;
- Change design/features.

4.6 Conclusion

Based on this market/economic analysis, the team decided to create a campaign for cleaner cities, this is intended for young adults between 15 and 29 years old, because young adults are in need for education about correct waste disposal and recycling options, with the result that they can live in a

cleaner city and their quality of life will increase. Consequently, the team decided to create a campaign with the web app, physical bin and social media campaign. The web app contains a citymap with pinnend locations of garbage bin and an incorporation of gamification. In addition, the web app contains an educational platform to educate users about different waste disposal and recycling options and the importance of it. The special designed garbage bin is produced to attract people to dispose their waste, to create waste disposal awareness and to promote the “Bin It.” brand.

5. Eco-efficiency Measures for Sustainability

5.1 Introduction

The term georesources covers all resources that serve as the basis of life for human society. These include energy resources, geothermal energy, water resources, minerals, and soils. Parts of them are threatened because humans overused these georesources during all the years. That is why society is now faced with the challenge to fight against overuse and act in a more sustainable way. In the design of the product, there will be taken care to use geo-resources very carefully and contribute in producing sustainable. According to the Brundtland report of the World Commission on Environment and Development, sustainable development is a ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs.’ It seeks to reconcile economic development with the protection of social and environmental balance.

This is why sustainability is based on the constant search for a balance between the three key areas: social development, environmental protection and economic development. A visualisation of the three pillars can be seen in Figure 15 below. This will be discussed this in more detail later.

Figure 15: 3 Pillars of Sustainability

For improving objectivity and the creation of an approach to measure of sustainability, different sustainable development indicators (SDI) are used. A number or a value is used to describe the relation between the three pillars of sustainability. One of them is the Happy Planet Index. It is a measure of sustainable well-being or the ecological efficiency with which good lives are achieved.

However, another method of measuring the environmental impacts of a product is the Life Cycle Analysis (LCA). This Method takes the total lifetime of a product into account.

The LCA is divided in six different parts:

- RAW Materials;
- Manufacturing;
- Packaging;
- Distribution;
- Use;
- Disposal.

The product will be examined in more detail with reference to these issues later on in the study.

Finally, the Primary Goals of Sustainability will be examined. Education is a leading aspect to achieve success. The Education in the Goals of Sustainability is defined as followed: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all **[United Nations, 2023]**.” As can be seen in Figure 16 education has a direct impact on decent work and on economic growth as well as on the industry, innovation, responsible consumption and production. The result can be more sustainable cities and communities, action in climate topics and wellbeing of the population.

Figure 16: Primary Goals of Sustainability

During the project the main goal is to educate young adults about the proper waste disposal and recycling.

The following chapters show how the project “Bin It” approaches and includes environmental, social and ecological concerns. At the end the product regarding the life-cycle analysis will be analyzed.

5.2 Environmental

Environmental sustainability focuses on the well-being of the environment. Everyone is committed to protect the environment and live in a way that uses as few resources as possible and generates as little waste as possible. The environmental pillar also requires that the environmental impact of a company's activities be measured. This ensures greater transparency and clarity.

Reduce, reuse and recycle are three main aspects concerning environmental protection.

The product and campaign should educate people to recycle conscientiously and take waste disposal seriously. For this reason, it is very important to produce the campaign and the garbage bin as sustainably as possible.

The product has an environmental impact that is tried to minimize as much as possible, especially when designing the bin for the campaign and when planning the deliverables of the campaign. The focus is on a social media campaign, that means resources will be saved by producing many flyers and posters. The campaign includes posters and flyers, but most of them are only for digital use. When something needs to be printed, it will be done locally and sustainably in order to minimise the carbon footprint.

For the bin the materials carbon steel and aluminum are used. Carbon steel is a low-cost and robust material that guarantees a long life and can be completely recycled by melting it. Aluminum is equally sustainable and recyclable as steel. The special bin is based on a mechanical system, so when using it, no energy or electricity is necessary. Just the power of the person pushing the handle to open the bin. Aluminum is used for all the moving parts, as it is lighter and requires less human effort when the person steps on the pedal for opening the bin. To transport the bin, it will be packed in a wooden box with wheels and foam inside as a protection.

5.3 Economical

The pillar of economy is based on companies' ability to contribute to economic development and growth. This means that a company or policy should not only focus on profit maximization, but in addition on the well-being of society and the environment. The recycling of products and the use of renewable energy are some fundamental aspects of the development of the economic pillar. Businesses are encouraged to use their resources efficiently and carefully. Economic sustainability contains job creation, profitability, and proper accounting of ecosystem services for optimal cost-benefit analyses **[Irene Bouwma, Christian Schleyer, Eeva Primmer, Klara Johanna Winkler, Pam Berry, Juliette Young, Esther Carmen, Jana Špulerová, Peter Bezák, Elena Preda, Angheluta Vadineanu, 2018]**.

The aim is to ensure the quality of life for current and future generations which requires long-term policies. Some examples could be:

- Fair trade;
- High-quality raw materials;
- Fair payment;
- Promoting education.

The strategies also strengthen companies. By investing its profits in the areas of ecology and social welfare, a company can grow and be sustainable in the long term.

In order to become more energy efficient as a company, there is the possibility to be certified for the ISO 50001 standard. The ISO 50001 standard is a certification created by the International Organization for Standardization (ISO). The standard supports organizations in establishing an EMSn or energy management system. This system is designed to enable more efficient and wise use of energy resources. One of the levers of the ISO 50001 standard is to reduce the greenhouse gas emissions of organizations. The standard is reviewed every five years to ensure that it still meets current requirements **[Dametis, 2022]**.

ISO 50001 certification has many advantages and benefits for companies **[Dametis, 2022]**:

- Set up systems allows to optimize energy consumption and use.
- Achieve a better brand image through environmental commitment.
- Engage employees and associates by encouraging them to use energy more responsibly and rationally. In this way, whole teams can be mobilized.
- Financially, expenses are optimized and you benefit from a 20 % bonus on the CEE (energy saving certificates).
- Benefit from a reduction in TGAP (General Tax on Polluting Activities).
- Improve competitiveness compared to competitors.

The main goal is to invest in sustainable measures for the project, such as using renewable energy sources and recycling materials, to reduce costs and environmental impacts. The focus is to achieve a positive result and a wide reach, but not at any cost. Environmental protection is important and therefore BinIt acts sustainably. By prioritizing economic sustainability, there can be created a successful product/campaign that benefits both the organization and the environment.

5.4 Social

The social pillar focuses on people and its wellness. It includes environmental justice, security, fair pay, the protection of employees' interests, human health and opportunities for training and professional development. Moreover, having access to basic resources without compromising the quality of life is important. Sustainable states or companies should also act in the public interest. Efforts to increase social sustainability can also benefit the environment.

The project is based on the education of the population. Encouraging people to participate in environmental sustainability is the focus. The aim is to raise awareness about the consequences of not contributing to environmental protection. But much more, the goal is to show how easy it can be to contribute! BinIt teaches young adults to take responsibility for waste disposal.

With the campaign the aim is to draw more attention to the topic of waste. Recycling is easy and so is proper waste disposal! With this campaign the aim is to achieve more openness towards waste disposal and encourage the population to act. In the app users can also interact with others, which should inspire more people to act. The app will also educate about different waste separation rules in different countries. The user experience is made as simple as possible and provide the information in the international language English. Various symbols are used to make the understanding vivid and easier to remember.

Additionally, can be said, that the Garbage Gladiators treats everyone fairly and equally. Health and safety for the employees is a big concern.

5.5 Life Cycle Analysis

Life cycle analysis (LCA) is a method used to evaluate the environmental impact of a product through its life cycle encompassing extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal **[Mehmet Ali Ilgin, Surendra M. Gupta, 2010]**.

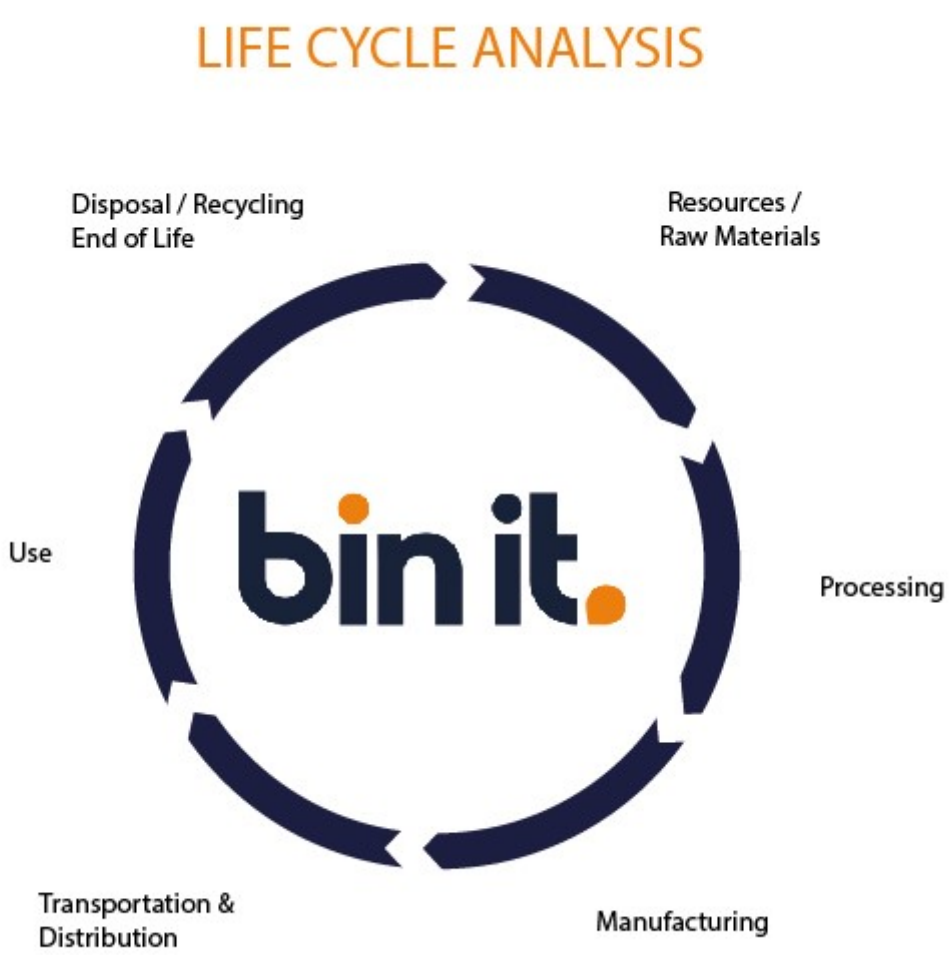


Figure 17: Life Cycle Analysis

In the following part, the Garbage Gladiator bin will be analyzed according to the six different stages of the LCA.

RAW Materials

- Steel and aluminum from the neighbor country Spain will be used.
- Some companies are working on the development of a green production of steel in Portugal or in Spain. There can be considered about supporting this work by purchasing their product when it will be available.

Manufacturing

- The Garbage Gladiator bin will be produced locally and with the use of renewable energy.

Packaging

- For transportation a reusable wooden box will be used with wheels and foam made of renewable raw materials as protection.

Distribution

- The purpose of the bin is to promote the campaign and the app. For now, the aim is not to create multiple bins and to distribute them, the Garbage Gladiator is an unique product.

Use

- The bin is made as long-lasting as possible.
- Also, easily repairable and all components can be exchanged separately.

Disposal

- The components of the bin as well as the packaging materials are recyclable or reusable.
- The correct disposal points for all components are ensured.

5.6 Conclusion

With the project,the pollution and carelessness of people in terms of waste disposal and separation will be reduced. Therefore, as a company and founder of this project, it is a great concern to work as environmentally friendly and resource-saving as possible. It is of great importance to use resources that can either be reused or completely recycled. As already described in the previous chapters, BinIt is active in all three pillars of sustainability and to produce efficiently. In the next chapter, the ethical and deontological issues associated with the product will be discussed.

6. Ethical and Deontological Concerns

6.1 Introduction

There is awareness of the responsibilities when developing Bin It. The goal is that the product is consistent with public interest. Each individual of the team maintains integrity and independence in their professional judgment. Team members shall be fair and supportive of each other. All products and campaigns of BinIt should meet the highest professional standards possible. It is ensured that the software product adds a value to users while being safe to use an easy to interact with. In text below, ethical concerns that may arise will be addressed.

6.2 Engineering Ethics

General

BinIt complies with the Code of Ethics by the National Society of Professional Engineers (NSPE). It provides guidelines for ethical behavior in engineering. It emphasizes the protection of public safety, the importance of professional competence and learning, and the need for integrity and ethical conduct. Engineers must prioritize public well-being, continually improve their skills, and act with honesty and impartiality. The code ensures that engineers uphold high ethical standards and contribute to the integrity of the profession.

Data protection

Globally, the amount of data being collected and stored is increasing. While users interact with the software solution, data is going to be collected. It is in the best interest to ensure data security, data availability and suitable access control. Data should only be accessible to only those who need it. All solutions must comply with the General Data Protection Regulation (GDPR).

Data selling

User data is valuable. It is in the best interest to protect this data. Data that is not necessary for the functioning and further development of the software will not be collected. It is against the company values to sell data tied to the users and it is the priority to find different ways to fund the development and maintenance of the software product.

Dark patterns

Deceptive design patterns are a practice in which the user interface of a software product is designed to trick users into making decisions they would normally not make **[David Nield, 2017]**. In the software, there is obligation to avoid using such techniques. The responsibility is to create a product users want to interact with and are not manipulated into making decision against their will.

6.3 Sales and Marketing Ethics

Sales and Marketing

Sales and marketing ethics involve adhering to moral principles and values in all aspects of the marketing process. Ethical marketing practices involve being transparent, honest, and fair in advertising, pricing, and product information. The key ethical principles in sales and marketing include respecting the autonomy and dignity of customers, avoiding harm to customers and society, and promoting sustainable and environmentally responsible practices. Businesses that operate with strong ethical values are more likely to build long-term, sustainable relationships with their customers and earn their trust and loyalty **[Jumpseller, 2023]**.

In order to comply with the guidelines of Sales and Marketing Ethics, the principle of “Bin It” is open communication with customers. The aim is to give customers an overview of the company's background and goals. For this purpose, the educational section of the app includes a part that provides information about the company. The main aim here is to communicate the values of transparency, honesty and fairness so that customers can have trust in the company. Furthermore, the use of cookies in the app should be explained for which marketing purposes they are used.

6.4 Environmental Ethics

Environmental ethics is the process of general ethics to a specific area of human life, namely the

environmental sphere. Environmental ethics questions the proper way for humans to deal with the environment and with nature. It refers to moral issues in dealing with the living and non-living environment of humans **[Corina Seidl, 2017]**.

For “Bin It” it is essential to have a positive market image regarding the environment. Since the aim to educate people to care about the environment and act properly, BinIt be a good role model and behave accordingly in the manufacture of the product. Also, importance to energy efficiency in the company is attached. One principle is to make the production process and energy consumption within the company “Bin It” transparent and reliable. The use of recyclable and reusable materials can be assumed wherever possible. Regarding advertising, unnecessary printed products are avoided and online marketing will be used instead.

In the “Bin It” company the following guidelines to be energy efficient are observed:

- The use of energy efficient lighting;
- Good, isolated windows and doors to avoid heating or cooling a lot;
- All used computers work efficiently. There will be taken care of shutting down all technical devices on the working space before going home.

In the supply chain related to the bin, there is taken care of to choose companies that share the same values as BinIt. There will be tried to work with local companies to avoid long transport routes, but only as long as it is within the budget. There will not be looked for big profit, but the product must remain profitable. With the materials that will be used for the bin, there will be achieved a maximum product lifetime. More about the LCA can be read in Chapter “Eco-efficiency Measures for Sustainability” above.

However, the company is young and ambitious, and always ready to go one step further to contribute to the positive development of the environment and achieve harmony between humans, plants, and animals in the environment.

Furthermore, attention will be payed to liabilities issues in the next chapter.

6.5 Liability

As with any technology product, software products are not exempt from ethical concerns. As software continues to advance and become more embedded in the daily lives, it is imperative to address the ethical implications and potential liabilities associated with its use. In this chapter, some of the key ethical concerns that software product developers and users should consider will be discussed, and outline potential liabilities that may arise.

1. Data Privacy and Security: Software products often collect and process vast amounts of data, including personal and sensitive information. Ethical concerns arise when this data is used inappropriately or without proper consent. For example, if a software product collects user data without explicit consent or uses it for purposes other than what was disclosed, it may result in violations of privacy laws and potential legal liabilities.
2. Bias and Discrimination: Software products are built by human developers, and they can unintentionally introduce bias and discrimination into the software. For instance, biased algorithms in machine learning models can perpetuate existing biases, such as racial or gender bias. This can result in unfair treatment of certain groups of people, leading to ethical concerns and potential legal liabilities related to discrimination.

3. Accessibility: Software products should be accessible to all users, including those with disabilities. Ethical concerns arise when software products are not designed with accessibility in mind, and certain groups of people are unable to use the product or experience difficulties in doing so. This can result in potential legal liabilities related to violations of accessibility laws and regulations.
4. Ethical Use of Technology: Software products can be used for both positive and negative purposes. Ethical concerns arise when software products are used for unethical purposes, such as cybercrime, misinformation, harassment, or surveillance. Software developers should consider the potential misuse of their products and take measures to prevent or mitigate such unethical uses.
5. Transparency and Explainability: Ethical concerns arise when software products lack transparency and explainability. Users should be able to understand how the software works, what data it collects, and how it makes decisions. When software products lack transparency and explainability, it can result in potential legal liabilities related to consumer protection laws and regulations.
6. Intellectual Property Rights: Software products often involve intellectual property, such as copyrights, patents, and trademarks. Ethical concerns arise when software developers do not respect the intellectual property rights of others, including plagiarism, copyright infringement, or patent violations. This can result in potential legal liabilities related to intellectual property laws and regulations.
7. Social Impact: Software products can have a significant impact on society, and ethical concerns arise when software products contribute to negative social impacts, such as addiction, social isolation, or inequality. Software developers should consider the social impact of their products and strive to create software that promotes positive societal outcomes.

6.6 Conclusion

In conclusion, ethical concerns are a critical consideration for software product developers and users. It is important to address these concerns to ensure that software products are developed and used in a responsible and ethical manner. Failure to do so may result in potential legal liabilities, including violations of privacy laws, discrimination laws, accessibility laws, consumer protection laws, intellectual property laws, and other relevant regulations. By proactively addressing ethical concerns and taking appropriate measures to mitigate potential liabilities, software product developers can build trust with users and promote the responsible use of their products.

7. Project Development

7.1 Introduction

The chapter “Project Development” focus on the detailed elaborations of “Bin It”. This chapter describes the structure and design of the Garbage Gladiator, as well as the prototype of the app. Furthermore, the execution of BinIt's vision becomes clearer. For this reason, the brand will be presented with the logo and the campaign on social media. Therefore, exemplary posts will be used. The goal of the campaign is making BinIt better known and the overriding goal of raising awareness to reduce waste in cities. The concepts and elaborations will show how BinIt can become a success

story. This chapter is of high importance in order to convince the stakeholders that BinIt's vision can be realistically achieved.

7.2 Ideation

The ideation process involved several key steps that helped create an innovative and user-centric concept for a digital product. Here's an overview of the process:

1. Design Workshop: It started with a design workshop, where the team brainstormed and collaborated to define the product vision and goals. Input was gathered from stakeholders, identified user needs, and outlined the main features and functionalities of the product. This workshop set the foundation for the rest of the development process.
2. User Story Mapping: After the design workshop, a user story map was created. This is a visual representation of the user's journey through the product, from initial awareness to achieving their goals. User story mapping helped identify gaps in the user experience, prioritize features, and define the product's scope.
3. Market Analysis: A market analysis was conducted to understand the market landscape and identify similar products or competitors. Their strengths, weaknesses, and unique selling points were analyzed to gain insights into the market trends and opportunities. This analysis helps to position the product effectively and make informed decisions during the development process.
4. Product Exploration: Once there was a clear understanding of the user's needs and the competitive landscape, different concepts and ideas for the product were explored. This involved creating wireframes, mockups, and prototypes to visualise the product's look and feel.
5. Design: On the basis of the product investigation phase, the design phase was initiated. The design team creates detailed mockups, visual designs, and interactive prototypes that reflect the finalized product vision. There is closed attention payed to the user experience, interface design, and usability to create a product that is visually appealing and easy to use.
6. Development: Once the design is finalized, the development team takes over and begins coding the product.Throughout the development process, the team maintains close collaboration and communication, regularly reviewing progress and making adjustments as needed.

7.3 Concept

In the design workshop, the persistent issues of waste disposal and waste separation in public spaces faced by many cities were addressed. Recognized was the lack of consistency in waste disposal guidelines and the need for pollution prevention. To tackle these challenges, an app was conceptualized that allows users to locate nearby bins, provides information on correct waste disposal practices, and offers guidance on local waste disposal guidelines. The app also includes interactive features like gamification and rewards to encourage sustainable waste disposal habits and promote environmental responsibility. Overall, the app aims to empower individuals to make environmentally responsible choices, contribute to a cleaner and more sustainable future for our communities.

7.3.1 Logo

The name of the project is “Bin It”. With this catchy title the message that will be spreaded is that

proper waste disposal is easy. The message that the title contains is essential in the project, that is why there was decided to use a font logo. To make the font logo more unique, a map symbol was created at the first letter and at the end. This element will be used throughout the project.

Some insights in the creation process can be seen in Figure 17.

Figure 18: Creation process

The logo consists of two different colors, orange and dark blue. The colors can be seen in Figure 19. Orange is a very young and eye-catching color. Moreover, the color was chosen because it is often associated with garbage persons. Dark blue is a complementary color of orange. By using complimentary colors, a very high contrast will be achieved. In addition, dark blue looks high quality, and this should reflect the project.

Figure 19: Color and font

In Figure 20 are some logo variations.

Figure 20: Logo variation

The final logo can be seen in Figure 21 below.

Figure 21: Final logo

7.3.2 Bin

BinIt also features a unique bin to promote the campaign and the app. This bin will be placed in popular public spaces in Porto to be seen by as many people. The aim is to make people curious about the concept, so an original design of the bin is chosen. Figure 22 represents the concept of the bin. Part 7.4.1. of this report explains the development of the design.

Figure 22: Bin concept

7.3.3 App

The app “Bin It” can be used to find the nearest garbage bin on the city map to properly dispose of waste to help build a cleaner city. Users can also add locations of bins and validate the pinned locations. In addition, there is an educational platform on the app, where people can learn more about the different waste disposal and recycling options in the city and the importance of it.

To add stimulation for using the app, a gamification will be incorporated where users can receive points. The points will be used for a general ranking score where the users can compete with each other to receive a position on the leaderboard, therefore a competition and competitiveness will be

introduced. Users can receive points by pinning locations of bins, validating the pinned bins and to dispose waste in a correct way.

Table 34: Rewarding system app

Action	Points
Pinning bin location	30 points
Validating bin location	5 points
Correct waste disposal	10 points

During the project a general ranking score is incorporated in the web app, where the ranking score of all the users in Porto is shown. In the future if the app will be realized an extra function can be added of a ‘friends’ ranking score. In this way users can compete in smaller scales and the mutual competitiveness will increase by the will to win from friends. With this it will be possible to add friends and invite people on the app. With this an extra point giving rule will be added, where users can receive points by inviting friends. Both users, the sender and invitee, will receive an amount of 20 points when the invitee has created an account and earned their first points by correct disposal of garbage.

Furthermore, BinIt's mission is to educate people, especially teenagers and young adults, about pollution. That is why the app has a special focus on education. The educational part includes following aspects:

- Latest trends posts about environmental protection, recycling innovation, political movements etc.;
- Country glossary about waste disposal in different countries/cities;
- Glossary with definitions about important ecological terms;
- Literature to related topics like recycling, waste management, climate change etc.;
- Educational articles with a quiz at the end so that users can review their knowledge and receive extra points.

7.3.4 Campaign

BinIt concludes a campaign, a web app, including a city map and educational platform, and a physical bin. The BinIt campaign simplifies and stimulates proper waste disposal and recycling for young adults, unlike other campaigns that target the problem at the end of the cycle when the city is already polluted. This campaign tackles the beginning of the problem and creates a new social norm. The message BinIt wants to convey is that clean waste disposal and recycling are easy and important. The brand name and slogan reflect the simplicity and attractiveness of the campaign.

Social media campaign

BinIt will employ social media platforms TikTok and Instagram for a targeted social media campaign to reach young adults. By staying active on these platforms, monitoring current trends, and creating challenges, the campaign aims to raise brand awareness. Educational information about proper waste disposal and recycling will also be distributed through these channels, combining fun and education to

engage the target audience.

Instagram

In Figure 23 the feed with some sample posts of the Instagram page is shown.

Figure 23: Instagram Feed

This platform will be filled with different kind of posts:

- **Information posts:** Information on the current state of the environment and waste management will be provided.
- **App description posts:** The app will be promoted and all the advantages and features will be showed.
- **Sponsor posts:** The companies that helped to make the awards possible will be highlighted.
- **Recommendation posts:** To make the account more personal, we will survey users about the app and provide the opinion in public.
- **Promotion Garbage Gladiator:** To motivate people to visit the Garbage Gladiator, it will be announced in various posts.
- **Reels:** All the TikTok videos will be provided on Instagram as well. Also, small promotional videos make the content more diverse.
- **Lifestyle posts:** Trendy upcycling ideas to follow will be posted. The goal is to motivate people to a more conscious way of life.
- **Country/City glossary:** With the country glossary, the rules of waste separation per country graphically will be presented.

An example of the country glossary Portugal is shown in Figure 24.

Figure 24: Country Glossary

BinIt also displays some company's own GIFs that people can use for storys or reposts. GIFs help to increase brand awareness, strengthen branding and boost engagement and interaction with the

audience. An example animation of how BinIt GIFs will look like can be seen in Figure 25.

Figure 25: Sample GIF

TikTok

The TikTok Account of BinIt will be used to raise awareness towards littering in cities as well as to promote the organization Binit. By posting videos which use viral sounds, BinIt tries to go viral too. The account will be used to interact with the costumers and show that waste disposal and recycling are important and interesting topics. To reach a larger target group funny and informative videos will be posted. As an example, the project team created a TikTok video to the viral sound “Show the lifehack you randomly saw one day, that is now an unconscious standard practice in your life”. With this sound it is hoped that the BinIt TikTok account will go viral too, because as mentioned in chapter 4.5.1 using viral sounds promotes going viral on that platform. In this video there is shown that friends are using BinIt to throw trash away. The TikTok can be seen in Figure 26 below.

tiktok1.mp4

Figure 26: TikTok Example 1

The chosen sound fits perfectly to the vision BinIt wants to realize. BinIt wants to decrease littering by promoting how easy it is to throw the trash correctly. As mentioned in the state of the art, it is important that correct waste disposal becomes a social norm. The sounds promote this message by saying that the shown lifehack is now an unconscious standard practice. The TikTok also shows the social aspect of BinIt that friends are telling each other about the app so that they can compete against each other through the gamification aspect of the app. BinIt uses adds with peer groups to promote the social norm for correct waste disposal.

The project team has also created another TikTok that promotes the fun part of BinIt. The video with the viral sound “Do you ever look at someone and wonder what is going on inside their head” shows that the campaign of BinIt is in his head and he is thinking about the disposal of waste in the park. This implies that in his head proper waste disposal is the norm. The video can also imply that a person/users collect and dispose of waste into a bin, to earn more points on the app to receive a better place on the ranking system. Therefore, this TikTok video is perfect to combine the message of BinIt with the fun gamification part of it. The TikTok can be seen in Figure 27.

tiktok2.mp4
Figure 27: TikTok Example 2

Sponsorhips

Three potential sponsors are McDonald's, City Porto, and Continente. Each of these companies has unique values and brand identity that align with the app its mission and target audience. By partnering with these companies, the aim is to achieve, reach and increase the appeal of the app in the market. In the following sections, each sponsorship opportunity will be discussed and explain why exactly these companies are attractive for the campaign.

McDonald's

McDonald's is a well-known brand that is recognized around the world and highly consumed by the target group. Through cooperating with this company, BinIt will reach a larger audience and get more attractiveness.

As can be seen while walking around, a conspicuous amount of waste is from fast food chains like McDonald's. It does not reflect positively on the image of a company when packaging ends up in ditches, parks and other public places. Therefore, a cooperation with BinIt could also be attractive for McDonald's.

It is essential that all the cooperation partners and sponsors show initiative in climate protection and follow similar sustainable and ethical aspects. McDonalds puts a lot of emphasis on making the packaging as sustainable as possible. As of 2021, approximately 82.7 % of their primary packaging materials, and 96.8 % of their primary fiber packaging comes from recycled or certified sources, aiming for 100 % certified, recycled or renewable materials by the end of 2025 **[44]**.

By partnering with McDonald's, attractive incentives can be offered for participants. McDonald's offers many reward systems and promotions, therefore there could be an agreement deal for rewards related to the ranking score in the app. By offering small, attractive rewards at the beginning, there is an ability to motivate people to participate in the project and take action to reduce waste and recycle.

Overall, McDonald's can bring a lot of value to the project as a sponsor. Their brand recognition, environmental initiatives, and reward systems can help reach a wider audience and encourage positive behavior changes towards waste reduction and recycling.

The local authority services City of Porto

Another interesting cooperation partner is the local authority services City of Porto.

One of the main goals of “Bin It” is, to work for a cleaner city and get people familiar with the waste separation system. For the City Porto it is important to be attractive and clean for tourists and inhabitants, with the result that people rate the city as livable. The interest is mutual again, which is a good base to start a cooperation.

The local authority services Porto are running a portal where they inform Porto inhabitants and visitors of the most important and positive events in Porto and about Porto, giving them the opportunity to fully participate in all sectors, namely social, economic, cultural, political, sports and recreational life of the city **[Porto.pt, 2023]**. Porto.pt portal is a place of dissemination and promotion of third-party information, such as institutions of the city; information about Porto, disseminated by the media in Portugal or abroad; as a best means to disseminate activities, initiatives, programmes and projects within the municipal framework.

For BinIt a good opportunity to get seen by all the population and spread information more easily.

In the last year Porto again exceeded all recycling targets with each Portuense (people from Porto) separating, on average, about 80 kg/inhabitant per year from packaging waste, a growth of 10 kg compared to 2021, and above the target of 60 kg/inhabitant per year. The rate of preparation for recycling also grew compared to 2021 (39.26%), reaching 42.2% **[F. Brito, 2023]**.

These facts confirm that Porto is committed to improving waste management. However, everything starts from the behavior of the population. This is where “Bin It” focuses on. If the population pays attention to throwing waste away properly, a big step towards a cleaner city will be done.

Regarding the rewards for the ranking store, the cultural sector in the city is especially interesting. With BinIt, the educational aspect will be strongly pursued, therefore rewards could be, for example, discounts on various cultural offers. This also benefits the city of Porto, if there is a higher interest in cultural offers.

When the app is going to be implemented in other cities in the future, then the respective city councils and tourism associations will also be considered as sponsors or cooperation partners.

Continente Missao

Contintente is a leading retailer in Portugal, this means the company has a big responsibility to raise the awareness of the customers, partners and suppliers of an increasingly healthy and sustainable lifestyle. For that, they implemented “Continente Missao”.

The mission of “Continente Missao” is, to help positively to transform everyday life in the communities, raising awareness and encouraging people to make better choices, pursuing the United Nations’ Sustainable Development Goals and helping those in need in difficult times.

Through partnerships with 333 schools, they actively promote environmental education and awareness. They organize recycling competitions and similar projects. It is very attractive for a partnership with BinIt, because “Continente Missao” is well known in the population and takes actively part in the lives of the people.

By raising awareness about the importance of recycling and encouraging eco-friendly behavior, “Continente Missao” is taking significant steps towards a greener future.

Moreover, they take initiatives to reduce plastic and waste and look for innovative ways to give products a second life. Many goals of “Continente Missao” overlap with those of BinIt. Two main goals are **[S.A. Modelo Continente Hipermercados, 2020]**:

- Communicate and raise awareness for the importance of recycling;
- Encourage each consumer to adopt an eco-friendly behavior.

What is missing in this program so far is teaching people to be aware of correct waste disposal. “Continente Missao” focuses mainly on waste reduction and conscious living. Nevertheless, people produce waste every day and therefore it is equally important to know how to dispose of waste properly so that it can be recycled accordingly. A partnership with BinIt would be a good addition to make waste disposal more attractive with using the app.

7.4 Design

7.4.1 Bin

7.4.1.1 Structure

There is chosen to develop a bin that opens mechanically by the foot pressure of a person.

The main idea was to create something interesting that will attract people and promote the campaign. There was a focus on the idea developed in the state of the art called “Recycling Stickman”. This is a first sketch of the structure:

In Figure 28 the first drafts of the structure can be seen.

Figure 28: First drafts

There are several materials available for constructing this building. All of these materials—wood, steel (carbon or stainless), or aluminum—are simple to process, widely available, environmentally friendly, and affordable. Water, humidity, and sunlight are the primary restrictions. There can also be considered salty wind for cities near the ocean like Porto.

In Table 35 different possible materials are compared.

Material	**Water resistance**	**Sun resistance**	**Cost (€/Tons)**	**Weight (kg/m3)**	**Others properties**
Carbon steel	Rust on the surface	Really good	10300	7800	Can be welded → Stronger structure
Stainless steel	Really good	Really good	11700	7800	Can be welded → Stronger structure
Aluminum	Really good	Really good	5670	2700	Hard to weld
Wood	Good	Good	1800	800	Can crack, parts needs to be full → uses a lot of material. Mechanicals properties decrease due to rain and sun

Table 35: Table material

The appearance of the construction must be considered while selecting a material. It is preferred to use rusted steel colours. The primary material for the structure is then considered to be carbon steel. To make the build as accessible as possible, it was decided to use rods that can be purchased in many stores, as can be seen on the detailed drawing and on the 3D model. Additionally, it was decided to use aluminium for the moving elements to reduce weight and, consequently, user effort to open the bin.

In Figure 29 the first 3D Model is shown.

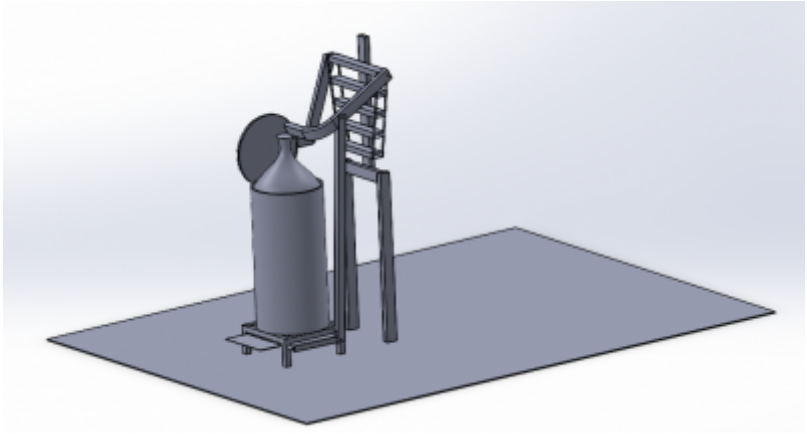


Figure 29: 3D Model

Figure 28 shows the second 3D model that has been produced. There can be seen here that the bin has been improved. A mechanism allows the bin to open on the side to help the employer to collect and change the bag.

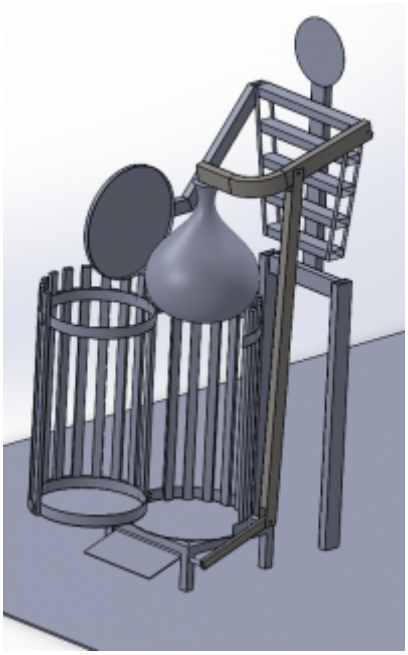


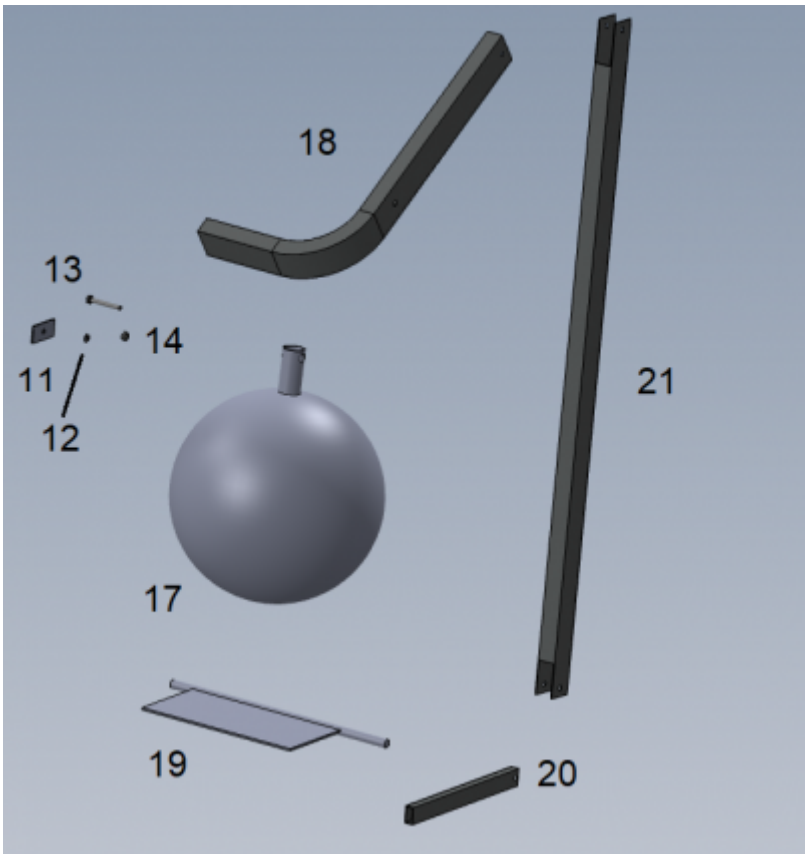
Figure 30: 3D Model 2

Solidworks made it possible to compile a list of the materials and parts that were used to assemble the model. Table 36 shows the nomenclature of the model.

No.Article	**Part name**	**Description**				
1	RLEG	STEEL				
2	LLEG	STEEL				
3	HIP	STEEL				
4	CENTRAL BONE	STEEL				
5	RIB1	STEEL				
6	RIB2	STEEL				
7	RIB3	STEEL				
8	RIB4	STEEL				
9	RIB5	STEEL				
10	SIDE	STEEL				
11	PLATINEEP	STEEL				

No.Article	Part name	Description				
12	WASHER	M10 WASHER				
13	SCREW	H SCREW M10*80				
14	NUT	H M10 NUT				
15	ARM	STEEL				
16	LID	STEEL				
17	TRASH	STEEL/ALUMINUM				
18	ARM-T1	ALUMINUM				
19	LEVER	ALUMINUM				
20	LINK	ALUMINUM				
21	LIFT	ALUMINUM				
22	BIN_SOCKET	STEEL				
23	BASE PLATE	STEEL				
24	FRAME	WOOD/STEEL				
25	OUTSIDE RING	STEEL				
26	BASE_CHARNIERE	STEEL				
27	BOTTOM PLATE	STEEL				
28	INNER RING	STEEL				
29	OUTSIDE RING MP	STEEL				
30	PM_CHARNIERE	STEEL				
31	HEAD	STEEL				

Table 36: Nomenclature



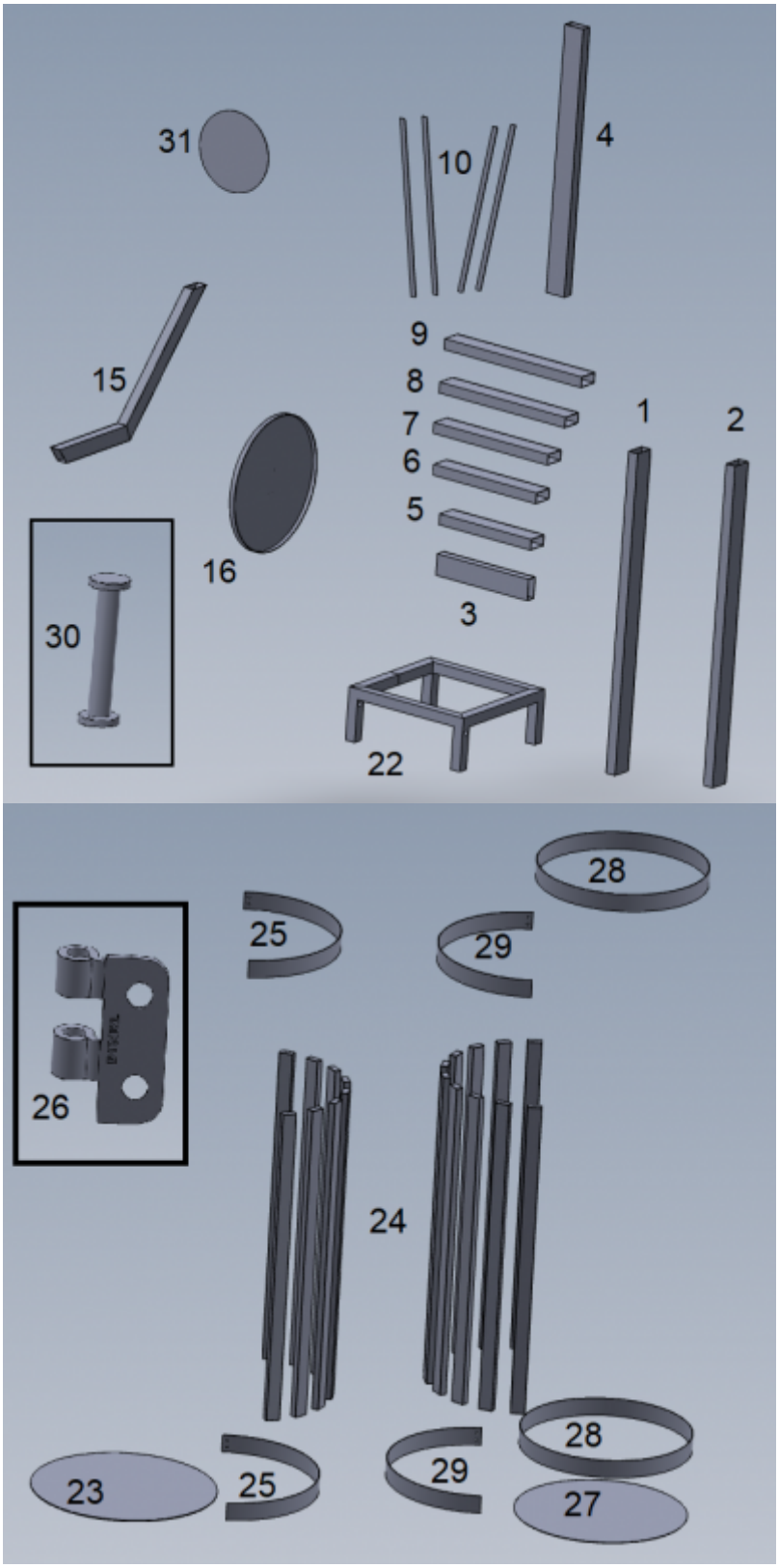


Figure 31: Detailled Nomenclature

All the parts are produced from different type of rods and sheets. In Table 37 there is a summary displayed of the raw parts that needs to be bought in order to build the structure.

Type	Diameter (mm)	Size (mm*mm)	Thickness (mm)	Qty
STEEL BAR	-	80×40	2	8 m
STEEL BAR	-	20×3	FULL	3 m
ALUMINUM BAR	-	80×40	2	1 m

Type	Diameter (mm)	Size (mm*mm)	Thickness (mm)	Qty
ALUMINUM BAR	-	60×44	2	2 m
ALUMINUM BAR	-	40×20	2	0.5 m
WOOD BAR	-	40×20	FULL	20 m
STEEL SHEET	-	-	2	1 m²
STEEL RING	520	50×2	-	2 units
STEEL RING	475	50×2	-	2 unit
ALUMINUM SHEET	-	400×200	5	1 unit
ALUMINUM ROD	20	-	FULL	0.6 m

Table 37: List of raw parts

Figure 32 is the detailled drawings of the structure.

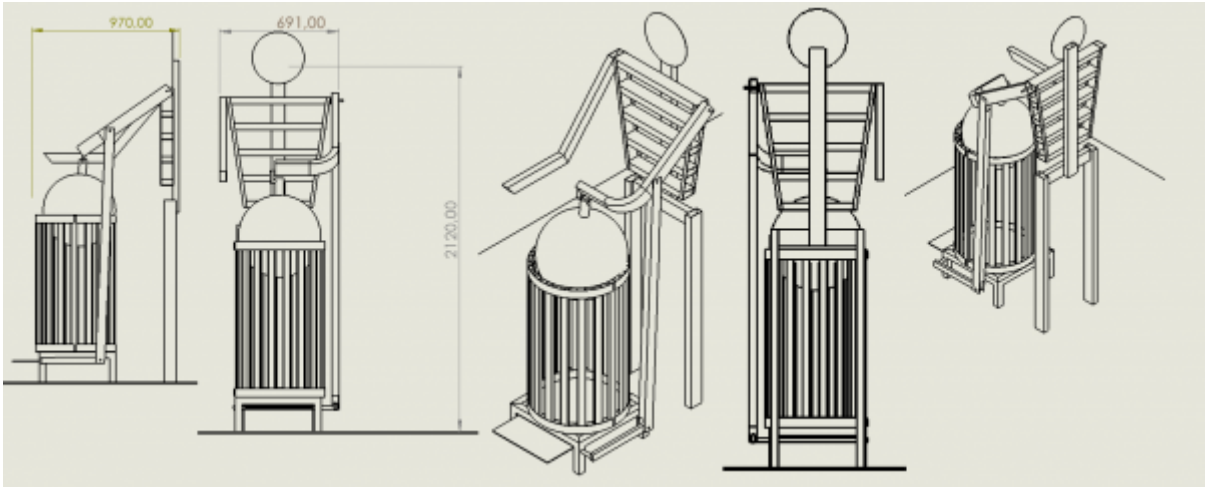
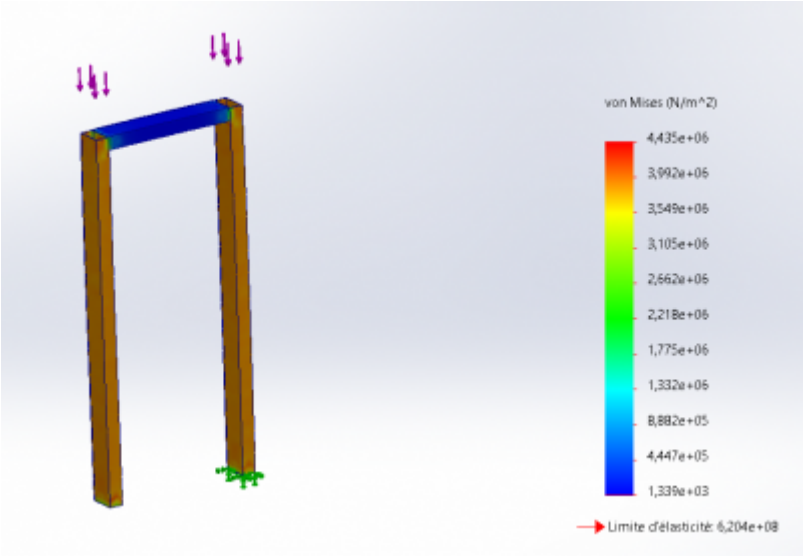


Figure 32: Detailled drawings

Three atypical uses of the system were taken into consideration in order to validate the structure, and stress analysis was conducted on those.

The first case that is considered is two 90 kg individuals standing on each leg, one person per leg.

This force is applied and obtained. The results are shown in figure 33.



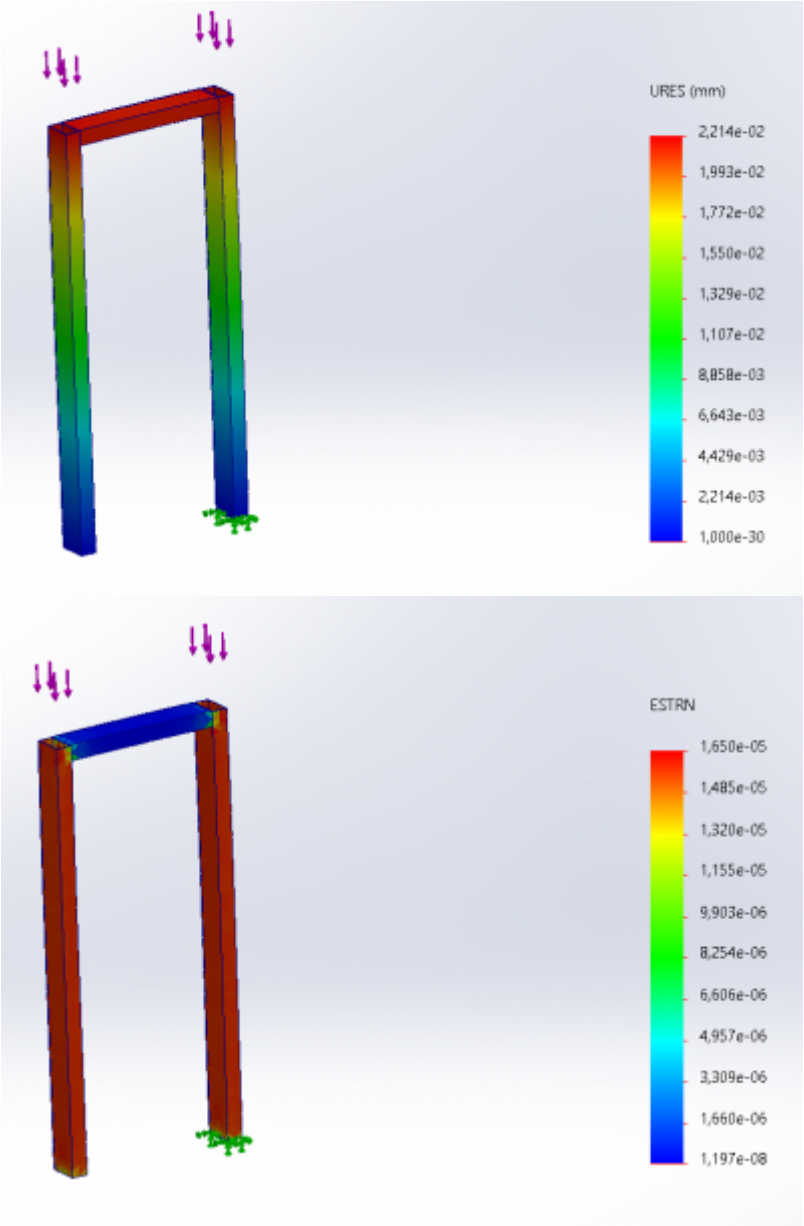
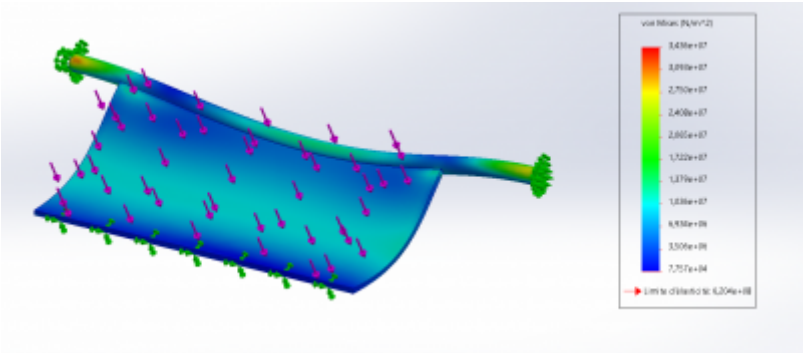


Figure 33: Leg Analysis Results

The results shows that the elastic limit of the material is not under the maximum stress and that the displacement and deformation are negligible.

The other two scenarios involve a 90 kg individual standing with both feet on the paddle. A buckling analysis on the section labelled “lift” is shown in Table 36.

These two analysis leads to the results shown in the next two figures. In figure 34 the paddle analysis. And in figure 35 the lift analysis.



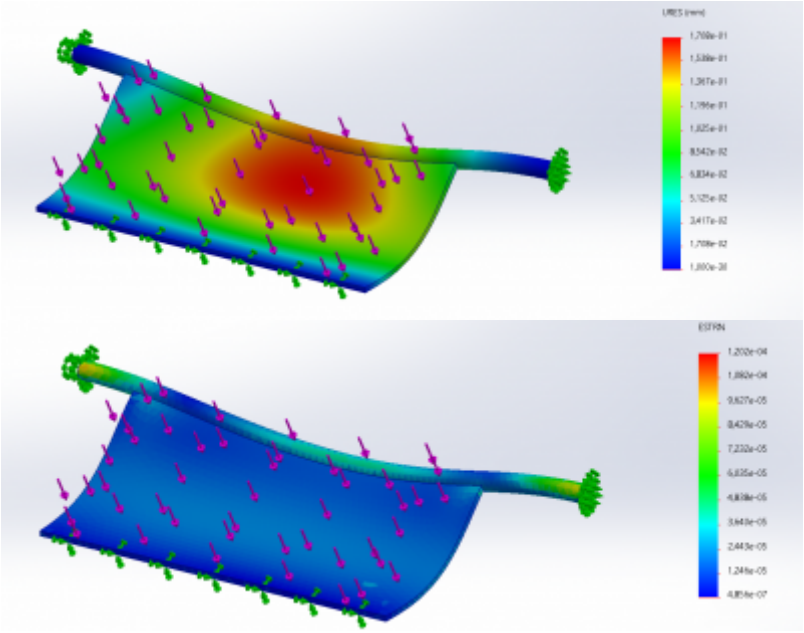


Figure 34: Paddle Analysis Results

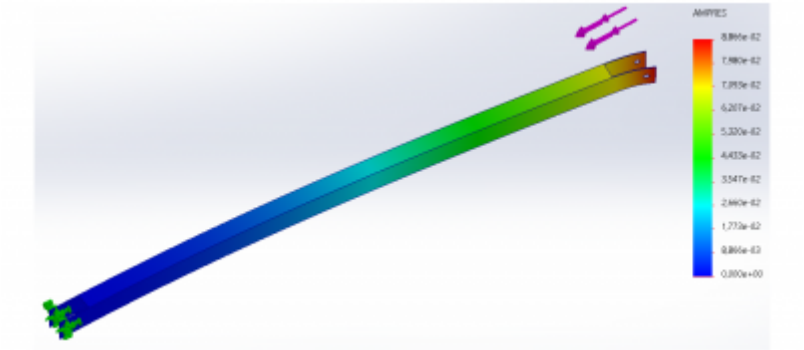


Figure 35: Lift Analysis Results

Again, the results leads to the conclusion that the parts are strong enough and that those wrong uses of the product should not damage it.

7.4.1.2 Packaging

Since the Garbage Gladiator is not a product that is sold, the main function of the packaging is to protect the product. With a focus on sustainability and functionality rather than design, this packaging solution offers a practical and eco-friendly approach.

The outer packaging of the Garbage Gladiator is a reusable wooden box with wheels, providing ease of transportation in city centers. Crafted from wood sourced from sustainable European forestry, it upholds the principles of sustainability by ensuring the preservation of forests. Furthermore, this wooden box is free from chemical wood preservation, making it a safe choice for the environment and those handling it. The wood used in the packaging also possesses natural heat properties, offering protection against pest infestation. By opting for a reusable packaging solution, the Garbage Gladiator minimizes waste and contributes to the overall goal of sustainability. In terms of production, the Garbage Gladiator's outer packaging is manufactured in Europe using solar energy. This commitment to renewable energy sources reduces carbon emissions and promotes the use of clean energy. By utilizing solar energy, the packaging solution aligns itself with sustainable practices and reduces its environmental impact.

Moving to the inner packaging, the wooden box features foam inside as a protection. The foam will be made of renewable raw materials which are free from toxins. It effectively cushions the Garbage Gladiator, absorbing shocks and impacts that may occur during transit. This choice of materials not only ensures the recyclability and reusability of the packaging but also promotes the use of sustainable resources. By utilizing waste materials and renewable sources, the Garbage Gladiator reduces its ecological footprint and contributes to a circular economy.

Considering the dimensions of the Garbage Gladiator, which measure 90 cm in width, 230 cm in height, and 100 cm in depth, it is evident that a packaging solution capable of accommodating heavy weight is required. The combination of the robust wooden outer box with the foam inside supports and protects the Garbage Gladiator, even with its weight of approximately 120 kg. This ensures that the package remains intact and undamaged throughout the transportation process, providing peace of mind to both the sender and recipient.

In summary, the Garbage Gladiator offers a sustainable packaging solution that meets the requirements of reusability, transportation in city centers, protection from damages, and accommodation of heavy weight. Through the use of a reusable wooden box, sourced from sustainable European forestry, and produced with solar energy, the Garbage Gladiator demonstrates a commitment to sustainability and eco-conscious practices. The foam made of renewable raw materials, provides excellent protection while remaining recyclable. By focusing on functionality and sustainability, the Garbage Gladiator sets a benchmark for responsible packaging solutions in a world where environmental consciousness is paramount. Figure 36 shows a visual overview about the outer packaging and Figure 37 shows a visual overview about the inner packaging.

Figure 36: Outer Packaging Solution

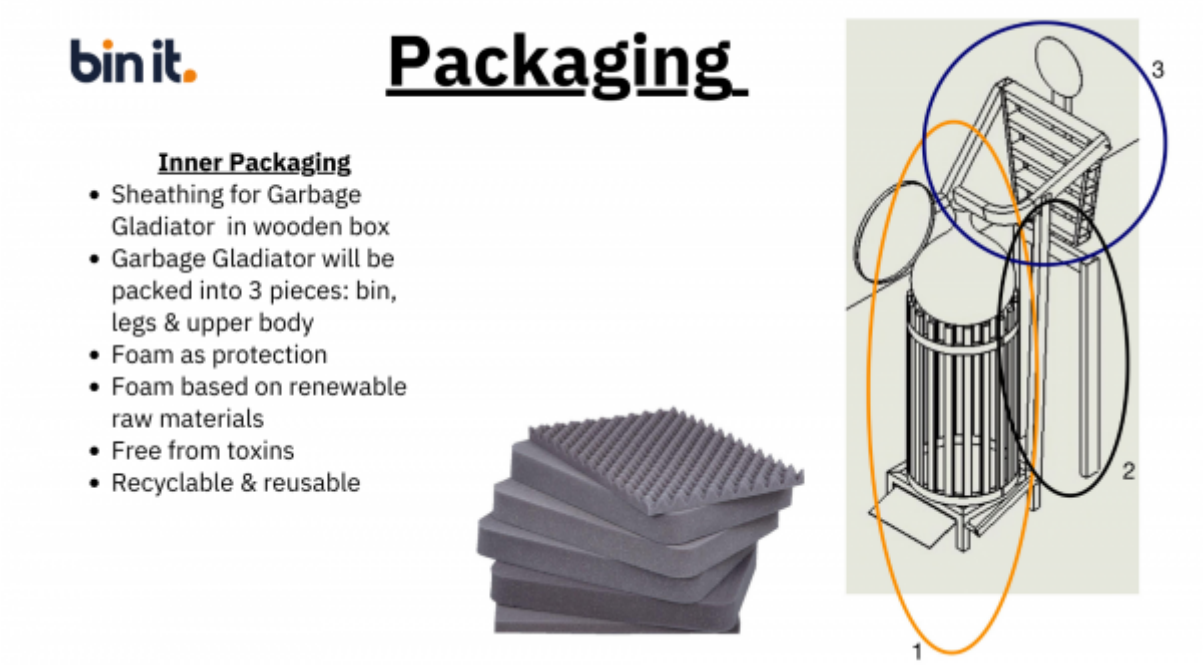


Figure 37: Inner Packaging Solution

7.4.2 App

7.4.2.1 Smart System

Software

Describe in detail the:

- As a user, I want to be able to login because I want to access my account;
- As a user, I want to add bins;
- As a user, I want to be able to find the closest bin in the app so that I do not have to walk around with trash for too long;
- As a user, I want to see what type of bin is close to me, so I know what trash can be disposed there;
- As a user, I want to find information about recycling and waste disposal practices in my location so I can dispose trash correctly;
- As a user, I want to find information about recycling and waste disposal practices in other cities or while travelling so I can dispose trash accordingly to local practices;
- As a user, I want to be rewarded when I add a bin to the map or validate its existence so I have a reason to do so;
- As a user, I want to see how many points I have so I can compare myself with other users and compete with them;
- As a user, I want to be able to change my profile information, so my info is always up to date;
- As a admin, I want to be able to upload recycle information so I can help educate people.

In Figure 38 the use case diagram is shown.

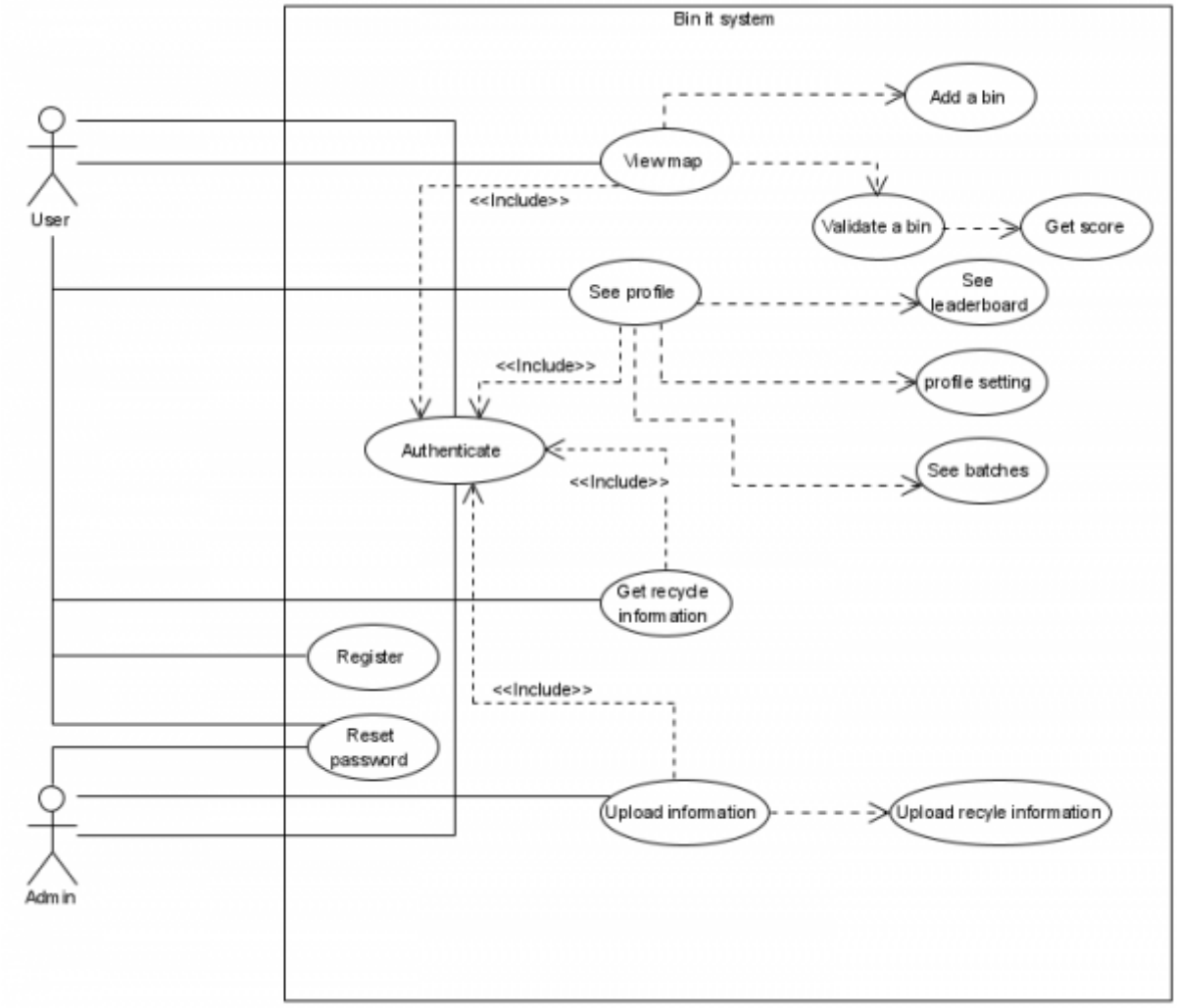


Figure 38: Use case diagram

In Figure 39 the Class diagram is shown. In this diagram the structure of the program with its connections is displayed. Users can validate if the pinned location of a bin is true. And it is possible to earn badges if a specific score is retrieved. There is also a second part of the diagram, the admin can add posts with images so that the users can read these.

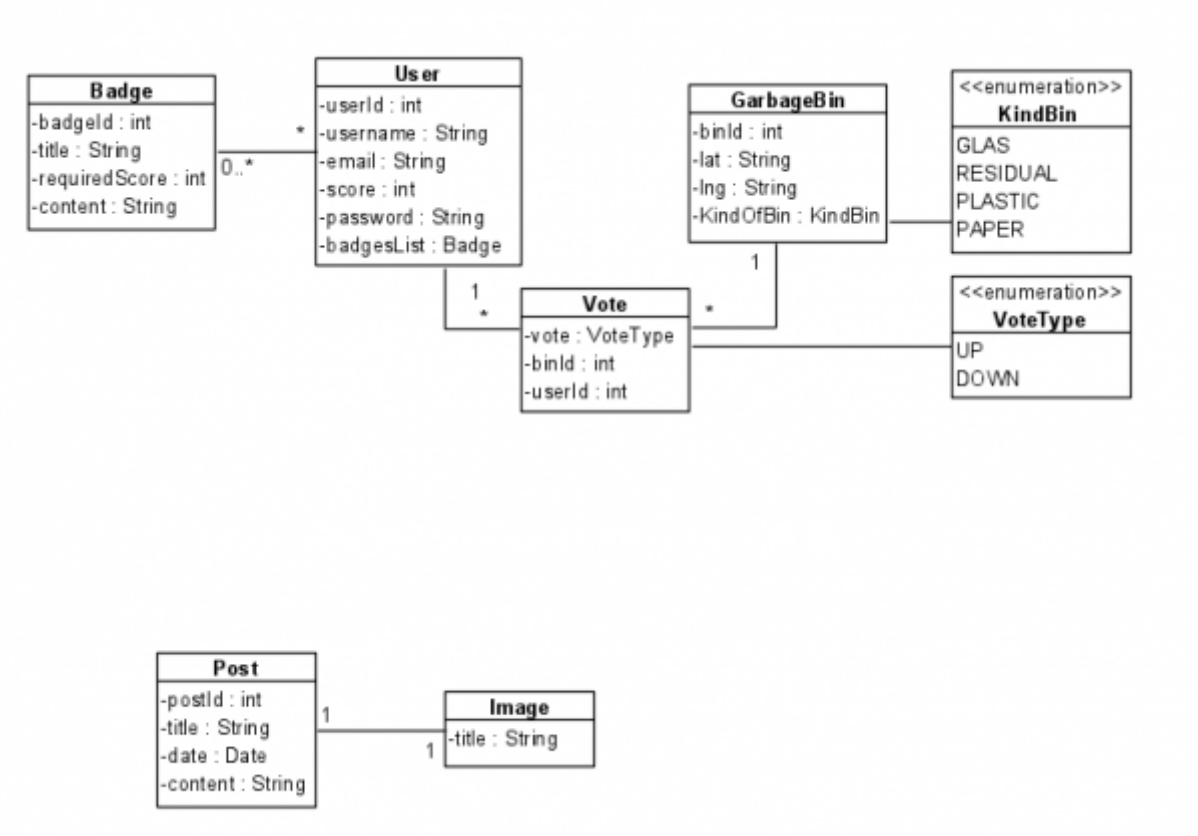


Figure 39: class diagram

In Figure 40, user stories and tasks are mapped.

Figure 40: User Story Map

In Figure 41, initial wireframes for the application are shown.

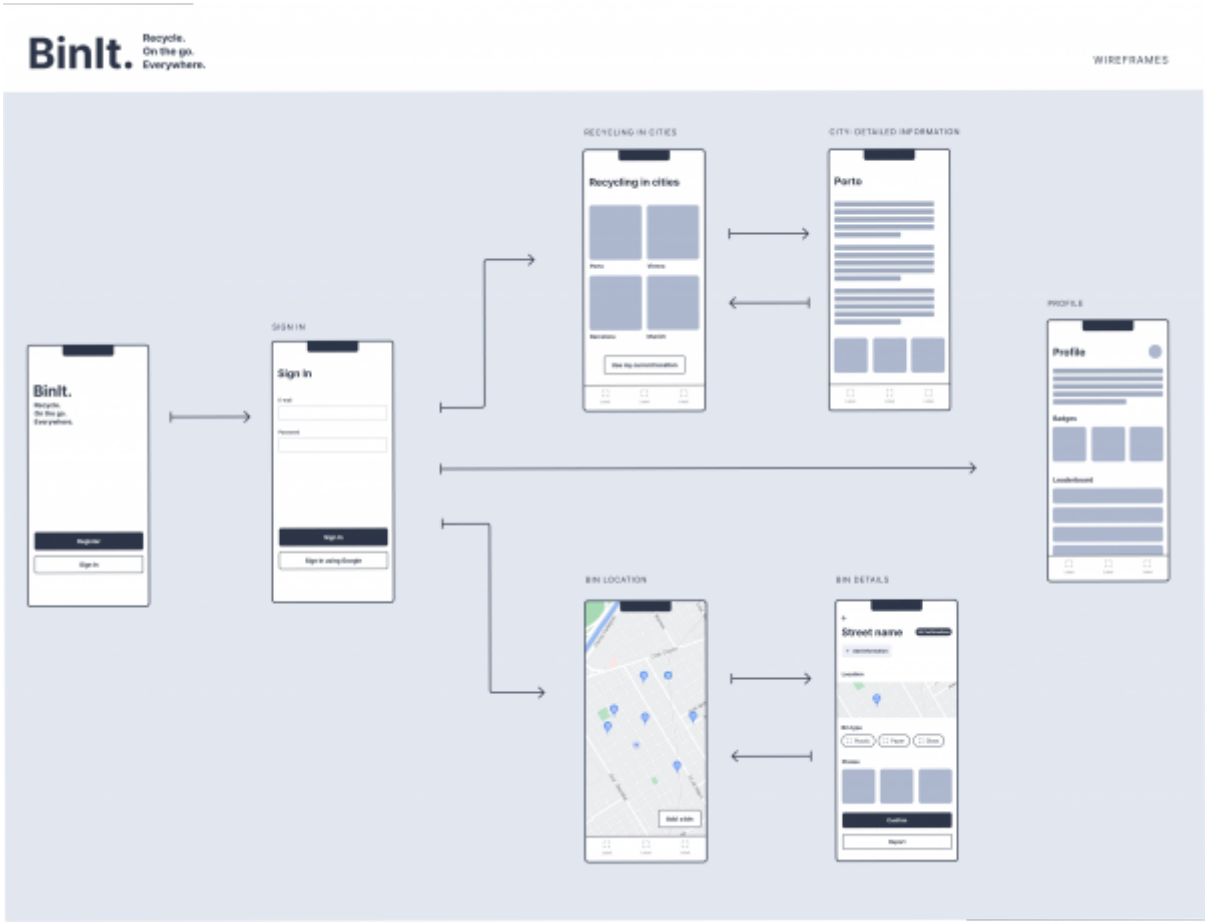


Figure 41: Wireframes

In Figure 42, clickable prototype which showcases design of the application is shown.

binit_prototype_walkthrough2.mp4
Figure 42: Clickable Protoype

Front-end

In Table 38 the preferred front-end frameworks are shown.

Platform	Advantages	Disadvantages
Ionic **[ukad, 2020]**	One codebase, multiple apps. Developer friendly. It's flexible.	Slower performance.
Cordova **[gangboard, 2019]**	Easy to start with.	Not native. Issues with plugins

Table 38: Front-end

Back-end

In Table 39 the preferred back-end frameworks are shown.

Platform	Advantages	Disadvantages
C# **[altexsoft, 2021]**	Inbuilt garbage collector. Thorough documentation. Large community	Dependence on .NET platform.

Platform	Advantages	Disadvantages
Java Springboot **[adserevio, 2022]**	It reduces lots of development time and increases productivity. Large community, No XML configuration required.	Large deployment files from unused dependencies

Table 39: Back-end

7.4.2.2 Conclusion

Ionic will be used for the front-end, because it is a complete framework with a lot of Advantages. For the back-end Java Springboot will be used, because the advantages and the experience combined form the best combination.

7.5 Prototype

Refer main changes in relation to the designed solution.

7.5.1 Structure

To verify the system, a 3D Print scale model of the structure is printed. To do so, there is a new 3D model created fitted for 3D printing. This modified model is one-tenth the size of the original construction. To have something solid and 3D printable, the shapes of the parts have also been revised.

Figure 43 show the differents parts of this new model.

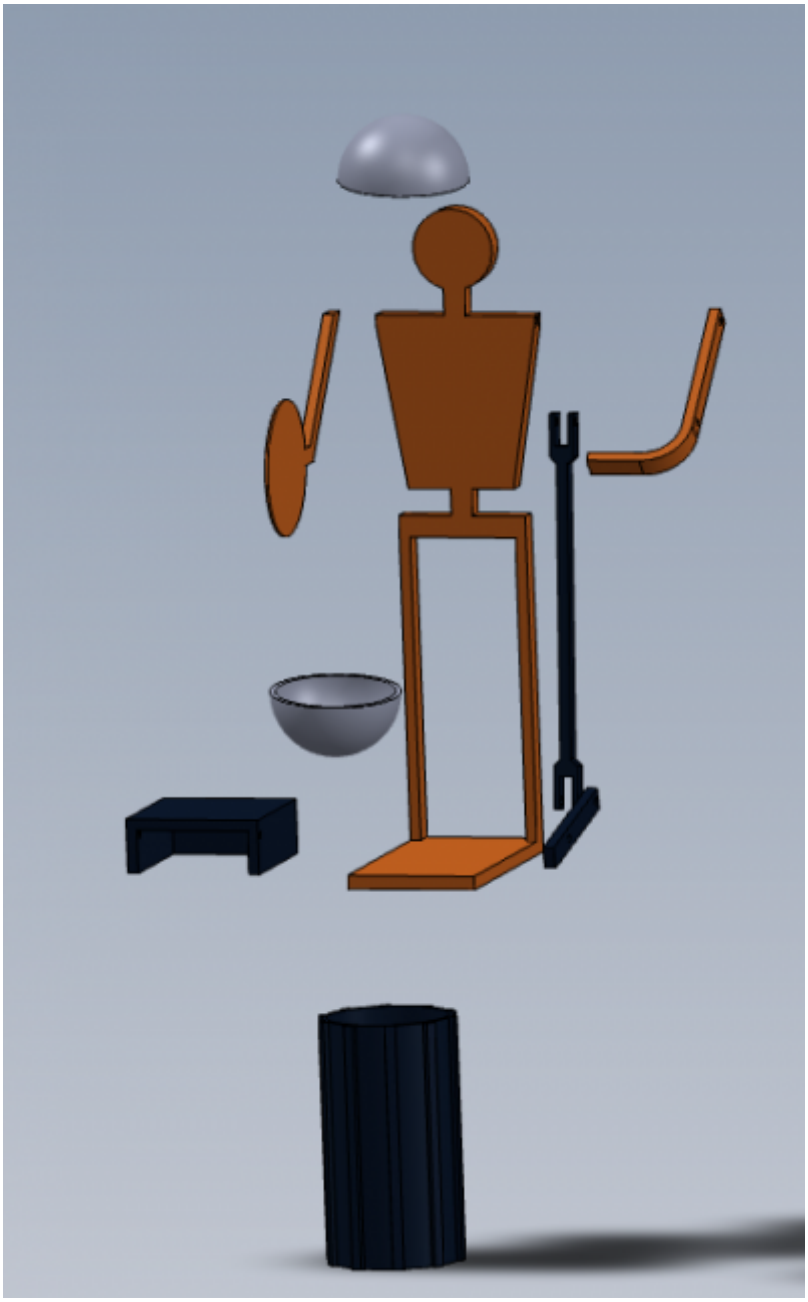


Figure 43: 3D Print Model

After printing the parts, the prototype has been assembled using screws and glue. Figure 44 show the model assembled.

Figure 44: 3D Prototype

The paddle is used to open and close the lid as intended. The system is validated by this prototype. To have a well-sealed bin, care must be used when assembling the framework with the lid in the proper location.

7.5.2 Software

There are no changes made that were made on the app during the development process. The app fulfills to almost all of the use cases made in the start.

7.5.3 Tests & Results

Software tests

The tests were all succcesfull in the cases that are developed. The app is in addition tested with someone that is in the target group and this test turned out to be positive.

In diagram 40 the results of the tests are shown.

Table 40: Test diagram

User story	Method	Result	Size in Bites	Average time in ms	Standard divisia

User story	Method	Result	Size in Bites	Average time in ms	Standard divisia
When a user registers, the account is saved in the database	Post	Working	388	28.70	3.69
When a user changes their password, it is changed in the database	Put	Working	430	31.50	2.69
As a user I want to add a bin, so all the users can see the closest bin	Post	Working	395	6.20	1.83
As a user I want to change my settings	Not working				
As a admin I want to upload posts so that all users are updated with the latest info	Post	Working	388	20.3	5.00
As a user I want to validate a bin so I can receive points	Post	Working	430	27.70	5.80

7.6 Conclusion

In conclusion, chapter 7 showcases significant progress in the development of the “Bin It” campaign. Several key milestones have been achieved, including the establishment of the brand concept and logo for BinIt. Additionally, the chapter highlights the creation of engaging social media posts designed to promote the campaign and raise awareness about proper waste disposal. Furthermore, potential sponsorships have been identified, indicating promising opportunities for financial support and collaboration. These partnerships have the potential to enhance the reach and impact of the BinIt campaign.

A major accomplishment of this chapter is the development of the Garbage Gladiator prototype. The prototype not only demonstrates the practical implementation of the BinIt campaign, but also showcases the team their commitment to sustainable and environmentally conscious products.

Moreover, the chapter outlines the creation of a user-friendly and visually appealing UI/UX design for the BinIt app. This design ensures that users can easily navigate the app's features and engage with its content effectively. Lastly, the development of the web app marks a significant step forward in expanding the accessibility and reach of the BinIt campaign. The web app provides a platform for users to access campaign resources, educational materials, and interactive features, contributing to a more comprehensive and engaging user experience.

Chapter 8 gives an overview about the further development of BinIt.

8. Conclusions

8.1 Discussion

In conclusion, significant achievements have been made in the development of the project “Bin It.” Social media posts have been created for popular platforms such as TikTok and Instagram, generating awareness and engagement among users. Additionally, essential features for the app have been successfully developed, ensuring a robust user experience. Furthermore, a prototype of the Garbage

Gladiator has been created, drawing attention for the campaign.

Looking ahead, several important next steps and changes need to be addressed. Firstly, it is crucial to explore different ways of promoting the campaign, such as creating more educational content to raise awareness about pollution and waste disposal. Secondly, shifting the focus from a web app to a mobile application would enhance accessibility and user convenience. Based on the supervisors and teachers feedback there needs to be implemented an accurate identification of proper waste disposal in the app.

Furthermore, establishing cooperation with public administration is essential. This collaboration would enable users to enter the filling level of trash cans, providing valuable data for public administration to efficiently manage waste collection and disposal. This interaction between the app and public administration would foster an environment of shared responsibility and enhance the effectiveness of waste management systems. Public administrations could also use the platform to share information about their correct way of waste disposal because there are differences between cities.

Additionally, producing the Garbage Gladiator in larger quantities and developing more variants would further support the project's objective of encouraging responsible waste disposal practices. This would help more people engage with BinIt and increase the commitment to stand up against pollution.

Throughout the project development, difficulties were encountered due to a lack of capacity among IT-developers. Despite these obstacles, the achievements made thus far demonstrate the project's potential to make a significant impact in promoting proper waste disposal and environmental consciousness.

In conclusion, the project “Bin It” has achieved notable milestones, and with the necessary next steps and improvements, it has the potential to become a powerful tool in tackling the issue of pollution and waste management. By addressing the outlined areas and leveraging the project's strengths, BinIt can contribute to a cleaner and more sustainable future.

8.2 Future Development

8.2.1 Bin

The Garbage Gladiator bin is almost done, but it can still be improved. Depending on the closing time and speed of the lid of the 1/1 model, controlling the closure by adding a spring system on the arm can be considered.

In addition, the bin only allows one trash bag so far, which means only one kind of litter can be collected. The next version can feature multiples bags in order to sort and recycle that will be disposed. Last, BinIt should not be limited to one bin in one city. In order to develop the impact of the campaign, differents design of bins should be created for different cities.

8.2.2 App

In this project, the first prototype is created. However, due to the scope of the project, limited time,

and a shortage of developers in the team, certain functionalities have not been implemented. Implementing these features would be a possible next step in the development of the BinIt application:

- Adding the ability to place bins in locations where you are not currently present;
- Including images of bins on the bin detail pages;
- Allowing users to assign multiple categories to a bin (e.g., paper, plastic, etc.);
- Enabling users to capture real-time images of waste disposal to earn more points;
- Conceptualizing and developing a reward system and badges;
- Providing admin access for managing bin information;
- Creating regional scoreboards for a leaderboard and highlighting the logged-in user.

To enhance the user experience of BinIt, the development of a mobile application is an important next step. During the design process, there is created a design and a clickable prototype that adhere to iOS Human Interface Guidelines. This design serves as a foundation for developing a native mobile application. Conducting user testing is crucial to identify pain points and opportunities for improvement. Continuous research and adaptation to the market are vital for the survival of any company. The significance of research and continuous development are acknowledged by the team and it is considered an important next step.

In addition to technical aspects, the BinIt concept and application can be effective worldwide. To ensure global usability, it is necessary to add support for multiple languages.

8.2.3 Campaign

Through social media, it is intended to create a supportive network with the target group for the campaign in the future, giving young adults a sense of community. A strong online community provides a platform for BinIt to connect with the audience, form relationships, gain insights, and encourage customer loyalty. It is an effective tool for increasing consumer engagement, support, and advocacy and helps in enhancing the BinIt's visibility online. This can be accomplished by being active on social media and engaging with the audience frequently, such as by asking for input on the initiatives or encouraging others to reply. By doing this, the impression is given that they are cooperating rather than exerting pressure.

In order to really make a difference locally, it is important to actually develop and realize the sponsorships/cooperations with the specified companies. Additionally, as the business expands, keep looking for potential new sponsorships to increase the platform.

Finally, the goal is to expand the BinIt concept beyond Porto to other European cities. The concept must always be adjusted to the appropriate input for each city. On this basis, progress towards a cleaner Europe can be made.

Bibliography

Will be added automatically by citing, in the body of the report, entries specified in BibTeX format and stored in the https://www.eps2023-wiki2.dee.isep.ipp.pt/doku.php?id=refnotes:bib file

PS - *If you have doubts on how to make citations, create captions, insert formulas, etc. visit this page with examples and select "Show pagesource" to see the source code.*

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