A Work Project, presented as part of the requirements for the Award of a Master's degree in Management from the Nova School of Business and Economics.

# Incentivizing composting and tracking $CO_2$ emission reductions – Conceptualizing gamification features and scenario journeys

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## Abstract

Household composting represents a sustainable solution to deal with the negative externalities connected to food waste such as $CO_2$ emission and pollution. However, only a small number of households in Portugal have integrated home composting into their daily habits. On that basis, this report documents the conceptualization and implementation of Compostuga, a mobile habit tracker developed in collaboration with the impact start-up Mudatuga using low-code technology. Compostuga incentivizes households to the continuous practice of composting through gamification and tracking of $CO_2$ emission reductions. Therefore, Compustuga will help to mitigate climate change by fostering low-carbon behavior among households.



Keywords: Product Development, App Development, Low Code, Sustainability, Composting

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# 1. Introduction

The world's population has grown steadily in recent years, and with it the global demand for food. Today, approximately 1.3 billion tons of food are wasted globally making up 45% of the total municipal solid waste in Europe and even reaching up to 55% in developing countries (Awasthi et al. 2020). The waste usually ends up as disposal on landfills or incinerations resulting in a high pressure on urban areas to manage waste and the environment. In recent years, this issue has led to many advances in this area and the introduction of more sustainable methods for dealing with food waste. Many countries decided to introduce new legislations regarding the management and final destination of organic waste. One popular solution for handling urban organic waste and therefore reducing the negative environmental impact is composting. The main advantage of composting over landfill disposal of organic waste is the reduction in greenhouse gas emissions. Given the fact that climate change has become a widespread issue in society, this method became more attractive not only for municipalities but also for private individuals. Through the practice of composting in their individual spaces, households can contribute to a lessening of organic waste and a reduction of greenhouse gases. Another advantage is that compost can be used as an organic fertilizer. Research states that composting outcomes at home result in an excellent stability of compost quality compared to varying results regarding industrial produced compost (Cerda et al. 2018).

Motivated by the positive impact of home composting on the environment, the Portugal based company “Mudatuga” was brought to life in 2020. The company's mission is to educate people about composting and to spread this practice throughout society. Mudatuga does this by conducting trainings, selling composting equipment, and educating people through their Instagram profile (Mudatuga 2022a). Although the company can look back on two successful years and has reached over 2000 people so far, it wants to further increase and accelerate its

reach. With the main goal of promoting composting and its environmental benefits while collecting composting data, the company came up with the idea of developing a mobile application. To support Mudatuga with its objectives we decided to develop an application (Figure 1) which focuses on the composting habits of people. Before the development of the app, we had to answer the following two questions:

1. What are Mudatuga's main objectives and how can they be achieved with an app while securing a good end-user experience?
2. How can an app be implemented within the given time frame and scope?

This thesis presents a solution for a compost habit tracker app. For the implementation of the app, we used the low-code platform *OutSystems*. The environment offers a variety of built-in features with high extensibility, such as data access or user interface design (Martins et al. 2020). By using *OutSystems*, we were able to develop an app in the given timeframe, which, through a gamified experience, motivates people to track their composting and enables them to monitor their environmental impact. We called the app "Compostuga" and will use this name to refer to the app throughout this report.

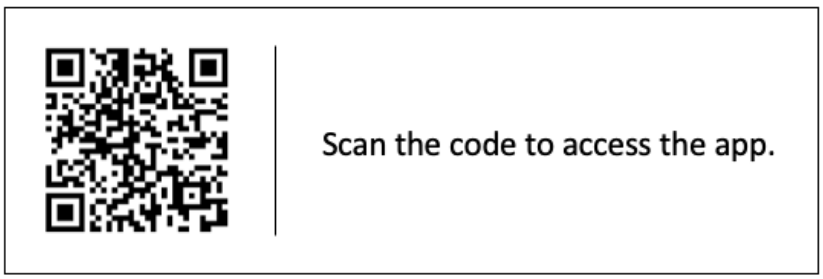


*Figure 1: Compostuga QR-Code*

# 2. Thesis Context

First, it is important that we explain the background of the present work in more detail. Our thesis focuses on the development of a composting app. Since the developed app and the related work was done in cooperation with the company “Mudatuga”, we start by briefly introducing the company, followed by an overview about composting and its impact on $CO_2$ emissions.

## 2.1 Mudatuga

For our thesis we decided to work together with a company called “Mudatuga”. Mudatuga is a startup based in Santo António dos Olivais, Coimbra (Portugal) that supports Portugal's waste management through training, awareness, and consulting related to composting in households and communities. The project was launched in 2020, shortly after the start of the Covid 19 pandemic. It was co-founded by Carolina Sapienza-Bianchi (a former environmental educator for Universidade de Coimbra), who has been the executive director since august 2021. Carolina led the incubation process of Mudatuga with a national Portuguese funding (Startup Voucher and IAPMEI) with a seed funding of 5,000 euros. Today, the company has three employees, was able to build a community of over 7,400 followers and trained more than 2,000 people about composting (Mudatuga 2022b).

Mudatuga wants to transform ordinary people into what the company calls "composting ninjas". This is done by raising awareness and consulting about composting in workshops and lectures for schools, companies, and municipalities as well as offering professional trainings regarding the teaching about composting. In addition to that, they offer educational content about composting as well as individual team building activities for companies with composting as a guideline. To promote composting, their services and to reach as many people as possible, Mudatuga makes use of social media and its website. The website includes information about

the company and their services as well as an online shop, which offers composting bins and supplementary products (Mudatuga 2022a). Next to their website, Mudatuga uploads videos, photos, and stories on their Instagram page, focusing on the translation of scientific knowledge to everyday language as well as the promotion of their workshops and online shop (Figure 2). The company was able to co-create and host a composting summer school ("Escola a Compostar") which included 40 workshops within the time frame of five weeks. It also prototyped a sustainable compost bin made from natural materials, whose final development was, however, postponed. Because of the company's impact, Mudatuga was selected as one of the European top three companies fighting climate change, won the "Urban Solutions" category in the European stage of the climate Launchpad 2021, and was selected to be part of the World Economic Forum's innovation platform (UpLink) for the Youth Climate Action Challenge in 2022 (Mudatuga 2022b).


*Figure 2: Mudatuga Social Media Appearance (Mudatuga 2022c)*

The company bases its actions and content on the following values: environmental awareness, commitment to the future, regenerative impact, community building, and ethics and integrity. In doing so, it supports the achievement of the Sustainable Development Goals of the EU which

were established in 2015 as part of the UN 2030 Agenda for Sustainable Development (United Nations 2022). It actively supports the following goals: sustainable cities and communities, responsible consumption and production, climate action, and life on land (Figure 3) (Mudatuga 2022a).


*Figure 3: Sustainability Goals 11, 12, 13, and 15 (United Nations 2022)*

Mudatuga now aims to create a platform for current and future customers. The objective is to create a compost habit tracker that encourages the continuous use of composting and complements it with interactive experiences and gamification. For this reason, Mudatuga approached NOVA SBE to create a Minimum Viable Product (MVP) together with our team as part of our master thesis.

## 2.2 Composting and its Impact on $CO_2$ Emissions

Now that we have some background on the company and its goals, it is important to develop a basic understanding about compositing. The following chapter therefore briefly explains the idea of composting and its environmental impact. Emphasis will be place on household composting, as our project was targeted at individual users who compost at home.

### 2.2.1 Composting

In general, the process of composting is referred to as the action of converting material into compost. More specifically, composting is the natural process of turning organic waste (e.g., yard waste, food scraps) into beneficial fertilizer that may improve soil and plants. In doing so, composting supports and accelerates the decomposition process by creating the perfect habitat for bacteria, fungus, and other decomposing organisms (e.g., worms) to carry out their

functions. The end product of the overall composting process is compost. Compost is therefore the term used to describe the final decomposed material, which frequently resembles fertile garden soil. Farmers affectionately refer to compost as "black gold" because of its richness in nutrients and usefulness in agriculture, horticulture, and gardening (Cowan and Stroud 2016).

Composting became increasingly popular in the last decade and rose to be the preferred option of treating organic waste. This development took not only place in municipal waste treatment plants, but also in individual households due to its downward scalability (Sayara et al. 2020). Composting at home is a resourceful way to recycle organic food scraps and yard trims in a sustainable way, while requiring minimal effort, expense, and equipment. On top of that, the compost generated can be used to build healthier soil, which prevents soil erosion, conserves water, and supports natural plant growth when reused. There are many different methods for composting at home, which can be done indoor using special composting equipment or outdoors. Each method should be closely analyzed and chosen in accordance with personal preferences and living situation. To understand composting and its needed steps, the overall process of composting will be described in more detail below (United States Environmental Protection Agency 2022).

Based on information by the United States Environmental Protection Agency (2022), the overall (home-) composting process can be divided into four steps (Figure 4):

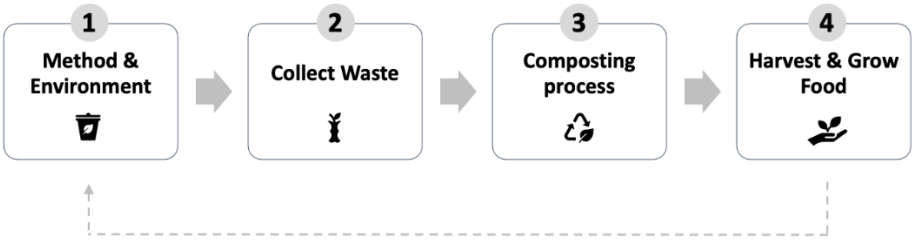


*Figure 4: Composting Process*

1) *Set Composting Method and Environment:* The first step of the overall composting process is the choice of composting method. Here it is important to assess the type of composting, the needed material as well as set the right environment.
2) *Collect organic waste:* The second step of the composting process is the collection of organic scraps in a separate container.
3) *Composting process:* The third step is the main step of the composting process. The food scraps can now be added to the chosen composting pile/bin. After the addition of the food scraps the focus should be on maintaining the composting pile.
4) *Harvest and grow more food:* The last and fourth step is the harvesting of the finished compost. It can be used immediately for gardening, soil amendment, and as mulch or stored for later use.

### 2.2.2 Impact on $CO_2$ Emissions

In addition to the overall process of composting it is also important to understand its benefits and its impact on the environment. Therefore, we decided to go into more detail about the impact factors regarding $CO_2$ emissions.

Organic waste is usually transported to big landfills since it can degrade naturally. However, in landfills the waste gets buried under massive amounts of other waste, cutting off a regular supply of oxygen. The degradation therefore takes place in the absence of oxygen resulting in a drastic release of greenhouse gases (GHG), especially of methane, which is 25 more potent than $CO_2$, and a possible contamination of ground water (Shukor et al. 2018). Taking a closer look on the current population developments with an estimated increase to 9 billion by 2050, we can expect an increase in demand for food and food waste accordingly. Due to those aspects, it is of great interest to find a solution that addresses proper food waste management (Ermolaev et al. 2013).

The overall benefits of composting are a reduction in emissions, waste stream, improvements in soil health, a decrease in erosion and personal food waste, as well as a higher conversation of water. The main reduction in GHG emissions is because in composting food decomposes aerobically (in the presence of oxygen). Another indirect reduction in $CO_2$ emissions of composting can be attributed to the usage of compost as an organic fertilizer, resulting in a drastic reduction in energy consumption needed to produce artificial fertilizer. This also results in a decrease in general pollution, because of the reduction of chemical runoff from artificial fertilizer, which stimulates the growth of toxic algal blooms in rivers. Finally, additional reductions in $CO_2$ emissions can be achieved due to the decrease of transportation of waste to landfills (Al-Rumaihi et al. 2020). A side-by-side comparison of the $CO_2$ emission from (home-) composting and landfills makes the positive impact of composting clearer. Home composting systems have an overall net emission of -75kg $CO_2$-equivalent/ton, whereas landfilling have 1,200kg $CO_2$-equivalent/ton (Figure 5). These numbers refer to the treatment of one ton of kitchen and garden waste (European Environment Agency 2022). The findings clearly state that home composting has a variety of beneficial factors that have a positive impact on the environment compared to landfills.

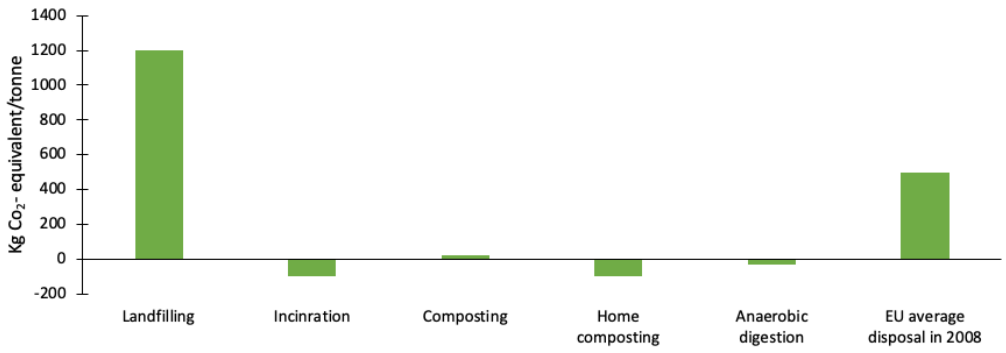


*Figure 5: Net Emissions in $CO_2$ Equivalents/ton (European Environment Agency 2022)*

## 2.3 Objectives

Following the previous introductions to the company and to composting we will go on by explaining the objectives of our project in more detail.

Although Mudatuga already has a website, is active on social media, offers e-books and workshops, it lacks a platform that customers could use and engage with on a regular basis. The overall goal of this project was to generate a mobile application (MVP) in form of a compost habit tracker in alignment with the companies' goals. To align on the overall objectives of the project, we conducted meetings with the company as well as our supervisor. During those meetings, we were able to identify the following objectives for our mobile application:

1) *Motivating people to start composting and making it a habit by creating game-like experiences within the app.*

   Composting in general is a process where no interaction with a community is needed. Creating a community and making the process more enjoyable and fun could increase the total number of people who compost. To design the app in a playful but educational manner, the implementation of a game-like features within the app could be leveraged. This would not only lead to more people taking up composting and increase their overall motivation, but also help them to uphold composting as a habit. Those factors would ultimately lead to a larger positive environmental impact.

2) *The measurement, display, and communication of the positive environmental impact of composting, with a focus on the $CO_2$ impact.*

   The collected data could also enable the company to study the impact of composting in Portugal per household. This data is currently not available, and the impact can hardly be measured. Potential impact data could have a positive influence on the development of

composting in Portugal. It could for instance be used to influence policy makers in initiating new legislatures or government initiatives. Additionally, the collected data and its impact could be shown to the user to highlight its' individual impact on the environment further encouraging regular composting.

3) *The collection of data about people and their composting habits.*

   Although the company already has a large pool of customers with whom they communicate via workshops or emails, they currently have little information about them. Obtaining more data about their customers and their composting behavior would significantly help Mudatuga to spread the practice of composting even further. This could be used to initiate new measures, launch new products/workshops tailored to their customers' needs, or get additional subsidies.

## 2.4 Challenges and Limitations

Having described the overall objectives of our project, it is now important to look at the challenges that go along with it. Therefore, the following chapter analyzes the challenges as well as the limitations we had.

*Challenges*

When working on the objectives of the app, we asked ourselves the following questions:

1) *Overall Layout and Composition:* How to provide an intuitive and user-friendly app framework with an informative cost optimized sign-up logic?
2) *Input Tracking:* How to align user experience and accuracy in compost weight tracking?
3) *Impact Tracking:* How to measure the $CO_2$ impact of composting while creating a strong impact narrative that makes composting more tangible?

4) *Gamification:* How to motivate and incentivize people to start tracking their composting regularly to foster a habit?

*Limitations*

In addition to the challenges, we had to face some restraints regarding the project's scope. Since we were creating an app as part our thesis, we had a very limited amount of time to develop and test the app. The second major limitation was that our group consisted of students that specialized in different academic fields before and had little to no previous programming experience. We therefore had to set some limitations regarding the overall scope of the app, specifically the number of implemented features and depth of the MVP. However, given these limitations, the result of the app exceeded our expectations in terms of complexity and quality and met the features most desired by the company.

## 2.5 Project Approach

During the project, we took the following approach: We started with a kick-off meeting with Mudatuga and our supervisor, where we got to know each other and identified the previously mentioned objectives, challenges, and scope of the project. Shortly after, we exchanged our visions and ideations and made sure to agree on an equal approach. This set the base for the app development which in the next step would involve the overall concept of the app as well as the ideation, concept, and display of each selected feature. After this was developed, we used low-code technologies (*OutSystems*) to implement the MVP. After the finalization of the MVP's first version, we decided to test the app to get additional feedback concerning bugs and content improvement.

### 2.6 Document Structure

This report is intended to serve as comprehensive documentation of our project and the MVP and is structured as followed: In Chapter 1 we introduced the topic of our thesis and gave a summary about its content. We then gave an outline of its context in Chapter 2. This included the company profile as well as information about composting, followed by the objectives, challenges and limitations. Chapter 3 goes into detail about the overall development approach by describing the overall ideation and feature prioritization of the app. We next describe the overall conceptualization of the app in Chapter 4, which analyses the navigation, composition, and main processes in the app. This is followed by the conceptualization of the Gamification feature. We then focus on the user of the app by featuring a persona, a customer journey as well as scenario journeys in Chapter 5. After having focused on the overall design and user of the app, we wanted to concentrate more on the technical aspects. We therefore go into detail about the entire technical implementation of our app, including the data model, the logic as well as the deployment in Chapter 6. After the technical implementation we made sure to test the app. This process is described in more detail in Chapter 7. The final chapter ends with a final conclusion (Chapter 7).

## 3. Ideation & Feature Prioritization

Now, that there is a general understanding about the context of this thesis, we will start to dive deeper into the development process of the app. Before we specify how the app is ultimately composed and how each of the individual features function, we want to explain how we got to the final concept of the MVP.

First, our general ideation methodology will be explained in Subchapter 3.1. Second, an overview of all features considered in the beginning of the project and of the features that were finally chosen will be given in Subchapter 3.2.

## 3.1 Ideation Methodology

We viewed the ideation process as a reflection on how to create a well-thought-out MVP considering and canceling out different kind of ideas. The initial approach was inspired by a framework from Rothe et al. (2020) and composed of two logics: An *exploration* and a *validation logic* (Figure 7). The *exploration logic* on the one hand dealt with academic literature research: Ultimately, some concepts for the features had to be researched and best practices had to be identified. Questions like how to measure $CO_2$ savings for composting waste or how to best determine the weight of the compost waste were looked for. Furthermore, we also benchmarked related apps with similar frameworks or user interfaces: Questions were explored like which apps can be used as inspiration for the most effective gamification logic or a suitable dashboard.

Once we had gathered enough substantial information, we further concretized the concepts in a *validation logic*. The associated goal here was to have a completely mature concept of all features for implementation. We also followed a two-pronged approach: First, we carried out such validation in the team internally. In so-called on-site working sessions, the ideas were discussed by getting inspiration from design thinking innovation (Figure 6).

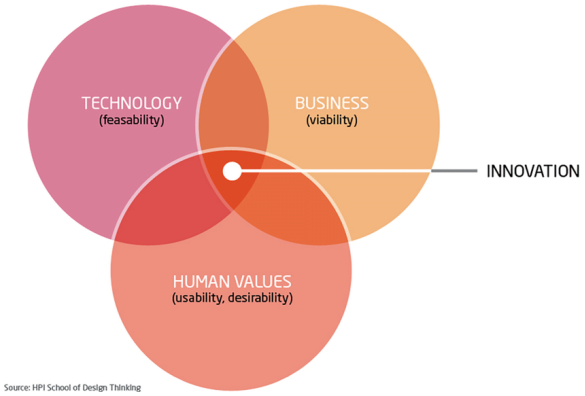


*Figure 6: Three lenses of design thinking*

For us, the main criteria were *usability, desirability,* and *feasibility*, i.e., how the app can be designed in the most user-friendly way and which ideas can be implemented technically. In that sense, we were able to benefit greatly from the interdisciplinary orientation of our team – covering both business and tech background. Financial sustainability (viability) was not that relevant looking at the scope of this project, although we also considered questions like how to design the app in a way that one could commercialize certain aspects or realizing potential business models at a later stage (Inder and Reay 2014). Moreover, external help was consulted for validation: In regular meetings with Mudatuga's founding team, we presented our ideas and were able to refine or adapt them very precisely based on their expertise in the field of composting. We also solicited ideas from industry experts such as product managers of startups who had experience in building a gamified app in the EdTech space.

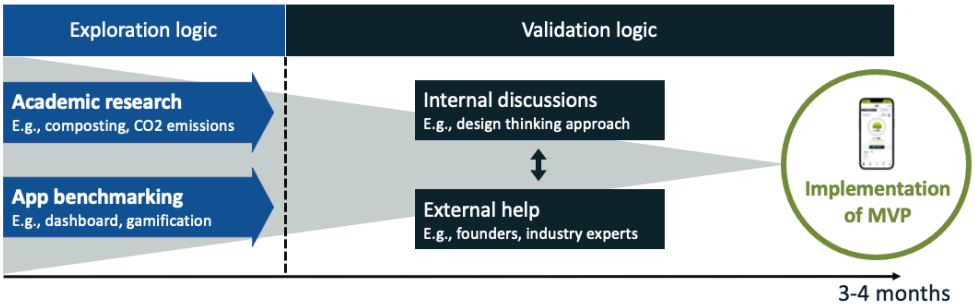


*Figure 7: Ideation methodology*

Thus, this structure of *exploration and validation logic* was used for achieving our objectives and tackling our main challenges stated in the previous chapter. Before we start covering this in higher detail, however, we briefly explain which features at choice were selected at the beginning of the project.

## 3.2 Feature Ideation & Prioritization

When selecting the main features to be integrated into the app, there were a lot of ideas from the founding team that could have been implemented. The following features were part of the discussion (Table 1):

**Possible features for implementation**

| Features | Description | Chosen? |
|---|---|---|
| *Input Tracker* | A tracker for entering weights of composted waste | Yes |
| *Impact Tracker* | A tracker for measuring $CO_2$ emissions saved | Yes |
| *Gamified XP-System* | A system, where users are getting rewarded by XP-points due to preferable composting behavior | Yes |
| *Education section with videos & lessons* | A database where users have access to educating video material about composting | No |
| *Visual map for sharing waste* | A map, where users see businesses, which they can donate their compost to | No |
| *Social-media feed* | Community section where users can post, like and comment about composting activities (of others) | No |
| *Integrated web-shop of composting* | A fully integrated web shop, where users can buy composting materials such as bins, container, … | No |
| *Quiz with questions about composting* | Educational section, where users learn about composting through a quiz format | No |
| *Chatbot* | Users can ask questions related to composting that are answered by a chatbot | No |

*Table 1: Possible features for implementation*

As can be seen on the table, at the end only three features were chosen for the implementation of the app. The rationale behind selecting fewer features for the final MVP was to develop them in the necessary depth and quality. The most important aspect was to choose the features that were closest to the objectives for the app (see Subchapter 2.3) and were feasible considering the challenges and limitations (see Subchapter 2.4). Therefore, an input tracker, an impact tracker, and a gamified XP-system were the most essential features for the vision of building an app that will make composting an enjoyable experience through environmental incentivization. All other features were excluded due to two types of reasons (see Smith 2017): Either they were less *impactful*, as they only contributed partly to the vision mentioned (e.g., the chatbot or a fully integrated web shop), or the amount of *effort* would have been beyond the scope of our project. For example, a fully elaborated map would have probably taken more weeks for implementation compared to an input tracker (Figure 8).

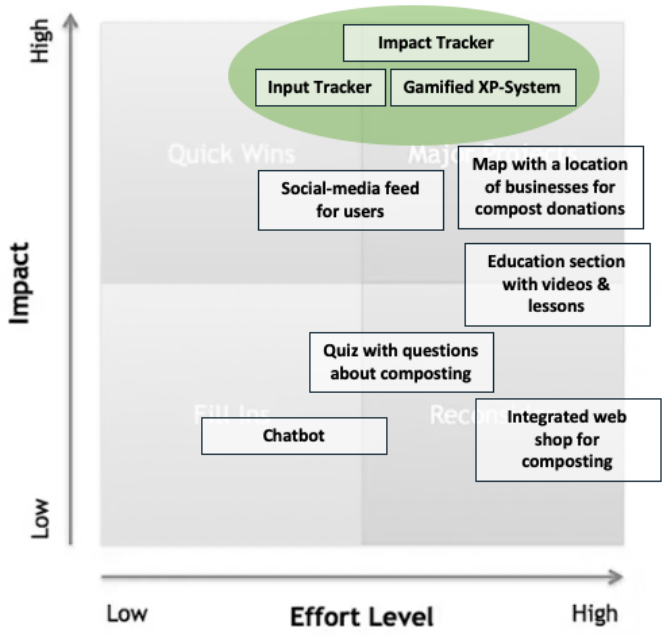


*Figure 8: Feature prioritization*

# 4. Overall Layout & Composition: How to provide an intuitive app layout with an information-cost optimized sign-up logic.

Now that we have established the ideation methodology and feature prioritization, we will start explaining the conception of the app. We follow a top-down logic by first showing in this chapter how we solved the general challenge of creating an intuitive and user-friendly app layout. This chapter should also serve as a guidance helping the reader understand the overview of all screens, the general navigation in the app and the sign-up & profile logic. In the proximate chapters (Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**-5), we will then specify on the challenges associated with the three main features of the app: The input tracking, impact tracking, and gamification.

## 4.1 Composition

To understand the app in its overall completeness, the following 8 screens (Figure 9) are relevant:

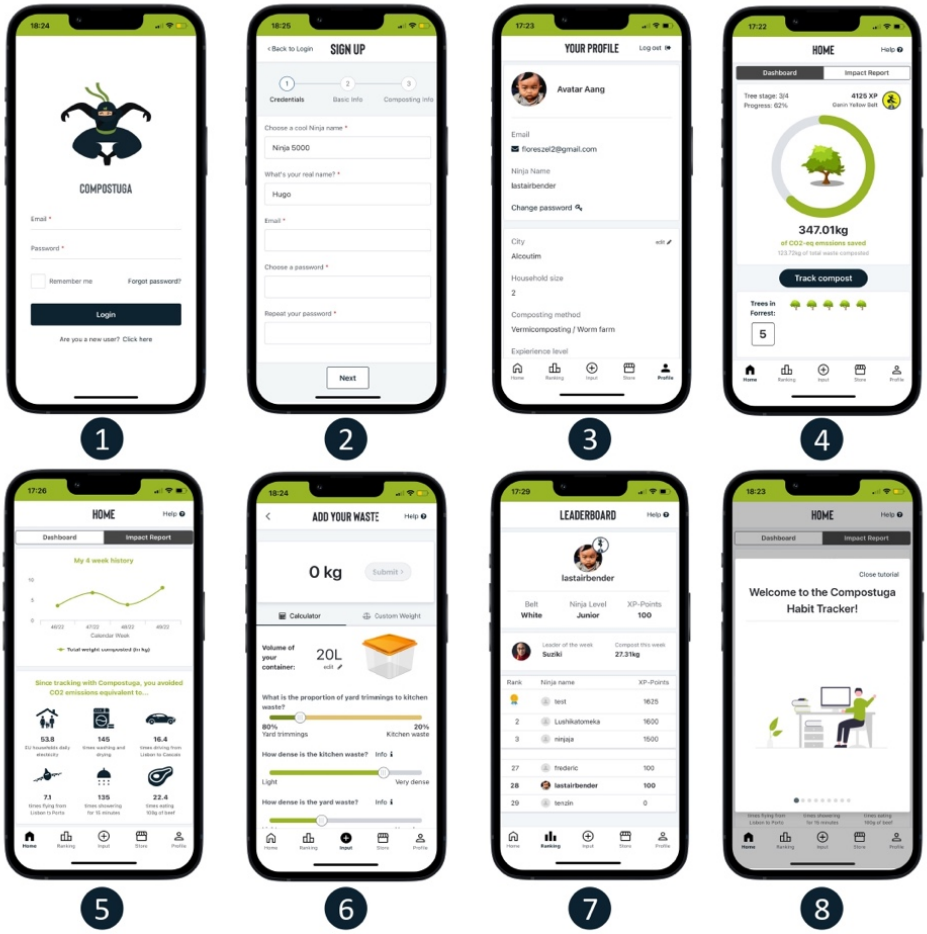


*Figure 9: Overview of screens*

*1. Login:* This is the first screen when a user opens the app.

*2. Sign-up:* If a user has not registered yet, this page will open. It consists of three individual pages (only the first page is shown in the graphic, see more in Subchapter 4.3).

*3. Profile page:* As shown above, this page is available in the menu. It displays all the information that the user provided in the sign-up.

*4. Dashboard of home screen*: This is the core page of the app. The $CO_2$ savings impact of each user is illustrated in the form of tree gamification.

*5. Impact report of home screen* (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**): This page constitutes the second part of the Home Page. The user is shown how much composting waste he has already generated, as well as other $CO_2$ equivalents.

*6. Input tracking* (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**): This page serves as the input for all processed data shown on the previous pages (dashboard and impact report), as well as the leaderboard. Any waste that is composted by the user is included here.

*7. Leaderboard* (see Chapter 5.4): This is where the gamification of the app is extended. On the one hand, the progress in XP points and ninja levels is shown to the user. In addition to that, there is also a ranking where users can compare their composting habits with other users.

8. *Tutorial pages / help buttons:* To avoid that the user is stuck in case of ambiguities on the main pages, there are help buttons on every screen. In addition to that, the user is shown a compelling tutorial when opening the app for the first time.

This information should serve as a guidance for the proximate chapters of the report. Since it is not only important what screens the app consists of, but also how the basic structure is built, the navigation of the screens is explained next.

## 4.2 In-App Navigation

For the general method of navigation, we decided to use bottom bar navigation (Figure 10), as used by many of the world's most popular apps, like Instagram, Spotify, and Google Maps. This method brings several advantages, as pointed out by studies and articles from Tsiodoulus (2016), Babich (2016) or Leonovas (2019): All menu items are easily accessible with one thumb, even on increasingly larger phones. Additionally, the user always knows which page is

currently shown and can access all other important pages with only one click. When opening the app for the first time, the user also immediately gets an overview, of what the app's main areas are. In the case of the app, we made five main *Screens* to be accessible from the bottom bar: The main dashboard (accessible under "Home"), the leaderboard or ranking page, the composting input page, the store, and the profile area.

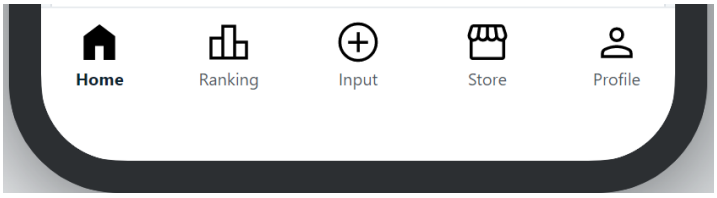


*Figure 10: Compostuga bottom bar navigation*

The header section of the app only contains a title of the current screen for further orientation (Figure 11). In case of the home page, ranking page, and input page, the header additionally contains a "Help" link that opens a tutorial pop up window, with general explanations about the app and/or instructions about how to use that specific page.

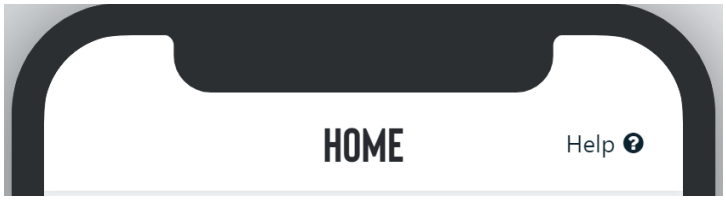


*Figure 11: Header section on home page with "Help" link*

### 4.3 Sign-up & User Profile Logic

Finally, it is important to explain the sign-up logic (Figure 12), otherwise one might not correctly understand the features described in the next chapters (Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**-5). Specifically, it is relevant to explain why which data was requested in this sign-up flow.

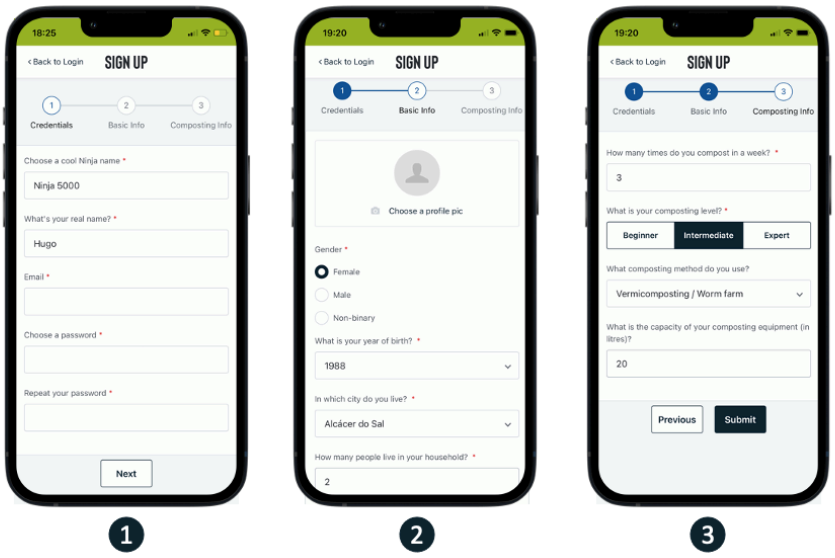


*Figure 12: Sign-up logic*

The main challenge of the sign-up flow was to identify and integrate the most valuable data of users (e.g., what data can Mudatuga leverage for product improvements or their future business model), while not making such process too tedious respectively diminishing the conversion rate from downloading the app to creation of the user profile ("information cost", see Balaji 2022 and Asatryan 2017). Considering this, we decided on the following data points and designed the sign-up process in three separate steps:

*1. Credentials:* Here we asked for data categories such as nickname (used as a gamer-handle), email address and password. This data is necessary for the authentication and identification of a user and his/her profile.

*2. Basic info:* To get a deeper understanding about the background of all users, we ask for their home city, year of birth, and gender. Furthermore, we implemented a question about how many people live in a household because Mudatuga wanted to interpret correlation of composting behavior with the number of people in a household.

*3. Composting info:* We extended this concept by asking questions about other composting behavior: What is the composting level of a user? And what kind of composting method do they use? Besides such questions, we were also interested in the tracking behavior of user who would do composting for a while already. The intuition here was to get data that would be useful in terms of predictive analysis (e.g., is the weekly composting frequency congruent with the data that will be collected in the app?).

Lastly, we made sure that this information is then transferred to the profile screen (Screen 3, Figure 12) of each user. Therefore, user can still edit their information, e.g., change their user profile picture.

# 5. Gamification: How to motivate and incentivize people to start tracking their composting regularly to create a habit.

The elaboration of the gamification feature relied on the challenge of designing the app in a way that would motivate and incentivize people to pursue their composting through gamification. This gamification was found in exactly three things: a) *An XP-System Logic* b) *A Ninja-Level Logic* c) *A Leaderboard*. Questions to be answered were:

*XP-System Logic*

- How is the logic structured (leagues, levels)?
- When do you get points (Streaks, Milestones, ...)?
- How fast should you get points?
- In which order of magnitude should the points be?
- How is the logic related to the Tree-Forest logic?

*Ninja-Level Logic*

- What names could the Ninja levels have?
- How is the logic related to XP-System Logic and Tree-Forest Logic?

*Leaderboard*

- How can a ranking look like?
- What information (name, XP points) should be displayed?

The initial research focused primarily on finding sources about what the most effective gamification logic could look like.

## 5.1 Research & Benchmarking

Gamification became more and more popular with the rise of technology. It can be defined as followed:

*"Gamification is an innovative approach to foster motivation. It refers to the use of game elements in non-game contexts."* (Sailer et al. 2013, 28)

The general idea is therefore to transform and leverage the motivation that comes naturally when playing games to a non-game context. Currently, gamification is especially used to influence environmental and self-driving behavior, to motivate people for physical workouts, and to improve learning in schools (Sailer et al. 2013). Especially the use of gamification in applications became more and more popular. One example would be the previously mentioned "Forest App" (see Subchapter **Fehler! Verweisquelle konnte nicht gefunden werden.**, *Tree & Forest Logic*) which rose to popularity in the last years. The app makes use of gamification in form of a tree to help users stay motivated and focused. Users can plant and grow a tree which they then collect to create a forest. As soon as the user leaves the app halfway (which is associated with an interruption of the focus) the current tree will die (Forest 2022). This type of gamification in apps has proven to be highly effective regarding motivation, user interaction, and social effects (Saleem, Noori, and Ozdamli 2022). Furthermore, Sailer et al. 2013 investigated how game elements can address different motivational mechanisms. They were able to prove, that gamification addresses different motivational mechanisms and thereby fosters motivation.

As we researched gamification and the best way to incorporate it into our app, we chose to analyze different existing apps that already make use of gamification or are pure gaming apps. We analyzed applications like Candy Crush, Subway Surfers, and video games like Fortnite. Additionally, we were going through different apps trying to find visual inspiration for the display of possible leaderboards (Candy Crush 2022, Subway Surfers 2022, and Fortnite 2022). In the following, the findings of this research process will be described in more detail.

*XP-System Logic*

While elaborating the gamification logic for the app, we wanted to make sure to include a system, where users could collect points. Our research showed that many apps offer users to collect points when achieving milestones. Hence, we quickly developed the idea of an XP system in which the user can collect points by fulfilling various requirements. Research has additionally shown that the XP points are usually greater numbers (e.g., "Congratulations! You just earned 500 XP points!"), as a higher score seems like a greater achievement to the user. Eventually, a system for structuring these points into leagues or levels is necessary. Lacking this structure in the final app, would otherwise lead to a missing incentivization for the user to collect points.

*Ninja-Level Logic*

When conducting research for a possible level logic linked to the XP system, we had analyzed different apps and were able to identify the structuring of levels, their names, and their timing. The level structure is designed in a way that levels are always in an ascending order with an increasing degree of difficulty. In doing so, reaching the first levels is relatively easy, whereas reaching higher levels is increasingly difficult and comes in hand with a more regular use of an app. This goes along with the timely distribution of levels. A very popular approach here is that the first couple of levels can be reached within the first hours/days/weeks (depending on the kind of app and the amount of usage). If an app can be used for several hours a day (e.g., Candy Crush), reaching a new level in the beginning will be possible after a couple of minutes. This ensures that the user will be rewarded for playing and motivates the user to continue to play. The higher the level the longer it then usually takes the user to reach the next level, due to an increase in difficulty or an increase in the needed XP points to reach the next level (higher gaps). Finally, there are two ways levels are named/displayed: The first option is to give level numbers (e.g., Level 1, Level 2) whereas the second option is to name them individually. When

giving names to level the names were either related to the game/company or they used generic terms (e.g., Beginner, Intermediate).

In addition, research demonstrated that different levels can also be categorized into e.g., different leagues. A user must go through all the levels in one league to move up to the next one. This categorization is used to add an additional classification to the level system and to incentivize and reward the user even more.

We also conducted a meeting with Mudatuga about a possible level logic. The company suggested to name the different levels “Ninja Level” as they call their customers “Ninjas”. In addition, they also proposed that it should not take the user a long time to reach the next level in the beginning, as they want to motivate and reward the user in the early stages to continue using the app. This is in line with our research.

*Leaderboard*

A lot of the apps using gamification on the market make use of a leaderboard showcasing the best users of the app as well as the current user’s position. We consequently decided that a ranking could be a valuable feature in the app to motivate and incentivize people even more. Beyond that, the creation of a leaderboard would also contribute to the creation/presentation of a composting community. Based on those findings, our research then focused on possible methods to display a leaderboard. Some examples of leaderboards in other apps can be seen in Figure 13. Generally, the name, rank and number of points are displayed with an additional visual highlighting of the user's position.


*Figure 13: Benchmarking of different leaderboards (Strava 2022)*

## 5.2 Ideation

The first draft of the overall gamification logic followed our research outcome closely. We decided to reward users with XP points for reaching e.g., a new tree stage. In addition to that, users should get points starting from 100 XP, to be coherent with our research that higher numbers are more rewarding than lower ones. We then implemented “Ninja Level” as well as different categories. Each category (bronze, silver gold) has four ninja levels, and it gets increasingly difficult to reach the next level/category. We changed this approach after we got feedback from Mudatuga, that they would prefer categories named after karate belt colors rather than the before mentioned categories. Finally, we came up with a draft of a possible leaderboard followed by an additional feature called “weekly leader”.

## 5.3 Concept

Based on our research and benchmarking we came up with the following gamification concept: The XP systems is a system, where every user can gain and collect so called “XP-Points”. Those points can be earned by:

- Reaching the next tree stage (125 XP per tree stage)
- Earning trees (500 XP per tree)

- Composting every week (100 XP for every week composted, plus additional 100 XP for composting every week in a row)
- Being the weekly leader (400 XP - user with the highest amount composted per week).

There are also different "Belt Categories", which you can move up to by going through different "Ninja Level" which are based on XP points. Every belt category has the same four "Ninja Levels": *Junior, Genin, Jonin,* and *Chunin*. The user starts in the *White Belt Category* and can move up to the next category by going through all four ninja levels. The next belt category is the *Yellow Belt Category*, followed by the *Orange Belt Category* and so on (based on the karate belt colors). Our numerical approach and the expected timeline of a user going through the different levels can be found in Figure 14. Additional details about the XP Logic and its calculations can be found in Appendix 1.

| Categories | Level | Ninja Name | Total Points<br>in XP | Time<br>in weeks | Tree Points<br>500 per tree | Tree Stage Points<br>125 points per level | Streak Points<br>First time 100 points<br>200 per streak | Leader Points<br>400 per leader |
|---|---|---|---|---|---|---|---|---|
| White Belt | 1 | Junior | 0 | 0 | / | / | / | / |
| | 2 | Genin | 325 | 1 | 0 | 125 | 200 | 400 |
| | 3 | Jonin | 650 | 2 | 0 | 250 | 400 | 400 |
| | 4 | Chunin | 1800 | 4 | 500 | 500 | 800 | 400 |
| Yellow Belt | 5 | Junior | 2450 | 6 | 500 | 750 | 1200 | 400 |
| | 6 | Genin | 3600 | 8 | 1000 | 1000 | 1600 | 400 |
| | 7 | Jonin | 4250 | 10 | 1000 | 1250 | 2000 | 400 |
| | 8 | Chunin | 5400 | 12 | 1500 | 1500 | 2400 | 400 |
| Orange Belt | 9 | Junior | 6375 | 15 | 1500 | 1875 | 3000 | 400 |
| | 10 | Genin | 7525 | 17 | 2000 | 2125 | 3400 | 400 |
| | 11 | Jonin | 8175 | 19 | 2000 | 2375 | 3800 | 400 |
| | 12 | Chunin | 9325 | 21 | 2500 | 2625 | 4200 | 400 |

*Figure 14: XP Logic*

The outcome of the XP system is a leaderboard within each belt category, which ranks the users in each belt color based on their total amount of XP points. Dividing the leaderboard in belt colors supports new users in having the opportunity to be displayed in the leaderboard despite having less XP points than user who have been using the app for a longer timeframe.

Finally, we also included a leader of the week. The leader of the week is the overall top performer with the highest composted amount overall (not connected to belt colors).

## 5.4 Design

Every user gets a round icon where a picture of a ninja is shown, the ninja level as well as the belt color. The picture of the ninja, the ninja level as well as the belt color will change according to the current amount of XP points and the connected ninja level as belt colors (Figure 15).


*Figure 15: Yellow belt level icons*

The app features a screen called “Ranking” (Figure 16) for the gamification element, which displays the users profile picture with its name as well as their ninja icon. The belt color as well as the ninja level and the total amount of XP points are displayed on the page, too. Below the ranking, the respective belt category is shown. There is a total of six users being displayed: the top three users, followed by the user in front of the current user, the current user (displayed in bolt font), and the user after the current user. In the bottom of the page the overall leader of the week gets displayed with its name and total amount of kg composted this week.

Additionally, the icon with the written ninja level and belt color as well as the total number XP points will be shown in the top right corner of the main dashboard (**Fehler! Verweisquelle konnte nicht gefunden werden.**).

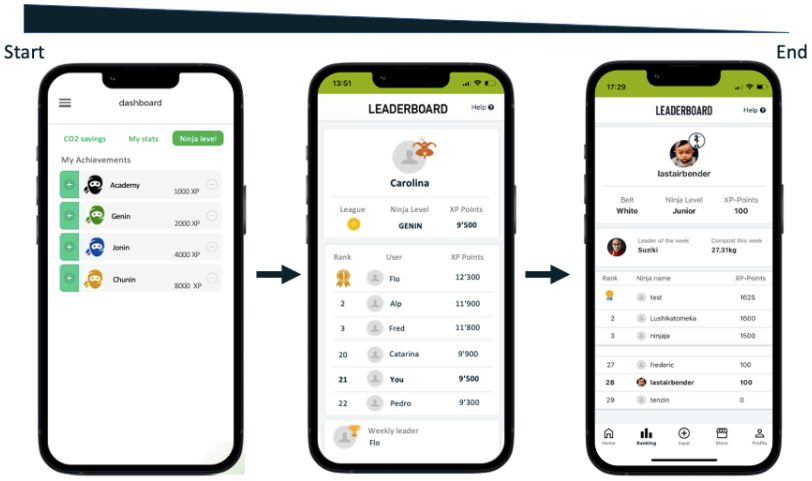


*Figure 16: Ideation of Gamification Concept*

# 6. Customer Journey

Having described the overall concept of the app and its main features, we now want to focus on the user of the habit tracker. The entire app was consciously designed to have a smooth and intuitive user experience. For this purpose, we have created pop-ups and tutorials that guide users through the app and avoid moments of frustration due to missing information. To guarantee the best user experience, we first had to come up with a persona of our potential customers, followed by a customer journey. The customer journey analyzes the process of a new user discovering and then starting to use the app. In addition, we also decided to include scenario journeys which describe the two main processes in the app step-by-step. The above-mentioned aspects will be explained in more detail in the following subchapters.

## 6.1 Persona

Mudatuga was able to give us some insights about their most common current costumers (based on 2,000 users in their data base). According to that their average costumer has the following characteristics:

| | |
|---|---|
| **Gender** | Female |
| **Age** | 30 – 40 years old |
| **Location** | Lisbon (including suburbs) |
| **Shopping behavior** | Online (Instagram, Facebook) |
| **Interests** | Sustainability |

While creating the app and especially doing the pop-ups/tutorial, we made sure to always pay attention to our target group based on the developed persona. This was done by for example choosing a modern but simple user flow, suitable language, illustrations as well as targeted content (e.g., what food scraps we mentioned as examples). Additionally, we also analyzed the customer journey as well as the main scenarios in the app and adapted them according to our persona.

## 6.2 Overall Customer Journey

The entire Customer Journey (Figure 17) focuses on customers specifically looking for a composting app, although it could include people who discover the app by chance without having any knowledge about composting. We decided to focus on a target group that is familiar with composting, as this is also the company's current target group. Eventually, the customer target group could be broadened to include a wider range of customers, such as people who are completely new to composting. In this case, it would be necessary to include more general information and maybe even a how-to about composting in the app. The following customer journey map focuses on customers who are familiar with composting and are explicitly looking for an app to support them in their composting journey.

| Process Steps | Awareness | Consideration | Decision | Retention | Advocacy |
|---|---|---|---|---|---|
| Activity | • App Store / Google Play Store<br>• Website<br>• Google search<br>• Word of mouth | • Compares app to different apps<br>• Downloads app<br>• Explores app | • Creates account<br>• Submits input<br>• Starts tracking composting | • Choosing to return<br>• Participates in gamification | • Returns to app repeatedly<br>• Recommends app |
| Customer Goals | Track impact and input of composting, find best app to fit user's needs | Compare options and choose best fit for user's composting goals/habits | Continuous tracking of composting, insights about impact | Get more involved with composting and making it a habit | Incorporating app in daily life, getting friends to use it, making it social |

*Figure 17: Customer Journey*

*Awareness*

The biggest goal for the company in the awareness phase is to draw the customer's attention towards the app. This can be done through social media advertising, e-mail newsletter, website or through word of mouth. The customer's main goal in this step is to find the best app for its composting needs.

*Consideration*

During the consideration process, the customer makes itself familiar with the app and tests the fit for its individual composting needs. Additionally, it compares the app with other apps available. Here, it is of great importance that the app differentiates itself from other apps with a high usability, an intuitive approach, and an appealing interface.

*Decision*

The user now decided to use the app and therefore registers and starts tracking its composting. The main objective now is to make the onboarding journey as seamless as possible to avoid the risk of losing the customer due to a lack of given information or support. Additionally, the user should already be able to see some changes in the app after the first use, since one of its main goals is to track its composting habits as well as its individual impact.

*Retention*

During the retention step, the apps main target is to keep the customer. The customer is now in a critical phase of deciding to keep using the app or not. Here, it is of great interest to leverage the gamification feature to keep the customer. This would ensure the encouragement of the user to continue using the app by incentivizing the user with XP points and level. Additionally, the user's main goal is to see the impact made, which will be displayed and leveraged in the impact report.

*Advo*cacy

The last step of the customer journey focuses on the repeated use of the app as well as on the advertisement of the app to potential new customers. This step only reaches customers who are committed and convinced about the app. Nevertheless, it is still important to implement new features in the future to keep the app entertaining for the customers.

### 6.3 Scenario Journeys

In addition to the main *customer journey,* it is also of great interest to outline some of the main processes a user goes through in the app. This will help with the overall understanding of the app and serves as a possible guide for potential users. While analyzing the app we found out that, despite the impact tracking, input tracking, and gamification features, there are not many set sequences or patterns the user must follow to use the app. We consequently elaborated the following two *scenario journeys* that every user goes through while using the app:

1. Registering and onboarding (Figure 18)
2. Adding a composting input (Figure 19)

*Register*ing and onboarding

After downloading and opening the app, the user can either login or register. In case the user is new to the app and does not yet have an account he/she would have to first create an account.

To do so the user must click on “Are you a new user? Click here” (1) on the login page. This opens the “Registration” flow where the user is asked to enter his/her credentials (2), followed by some personal information (3), and finally basic info about his/her composting practice (4). After finishing those steps, the user is directed back to the login page and can finally login with the chosen e-mail and password.

After the user logs into the app for the first time a pop-up (5) automatically opens, which contains a short onboarding explaining the app’s basic idea and functionalities. The user can go through the onboarding by swiping from right to left and end it by clicking the “Close tutorial” button on the top right. After closing the pop-up, the user is now on the main dashboard. If the user decides to click on “Ranking” or “Input” additional pop-ups (6) with information about each respective page will open. This is again only the case when the user uses the app for the first time.

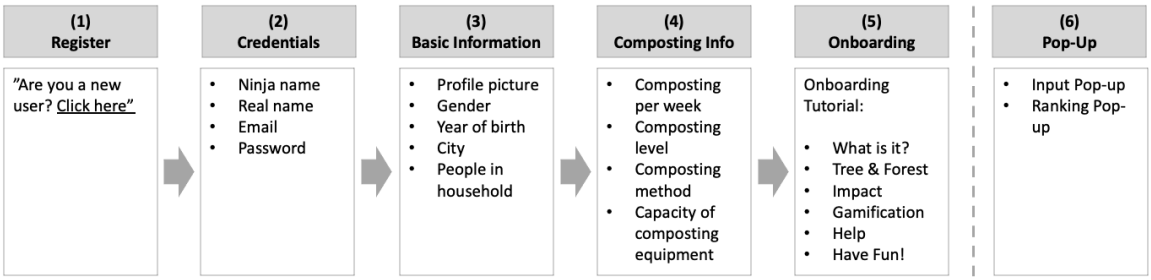


*Figure 18: Register and onboarding scenario*

*Add*ing a composting input

In order to track the composting, the user has to make an input in the app. To access the input page the user can either click on the “Track compost” button on the main dashboard or click on the “Input” page (1). In the input page the user has two options: 1) Use the calculator or 2) type in the custom weight. When using the calculator, the user can first edit the volume of the container by clicking on the “edit” button shown. Here, the user can either enter the size of its container in liters or enter the dimensions (2a). Afterwards the proportion of yard trimmings to

kitchen trimmings, the density of the kitchen waste as well as the density of the yard waste (2b) need to be specified using sliders. During this process the user can always click on the displayed "info" buttons to get more information. To see the composted amount and to submit it, the user needs to click on the "Calculate" button (4) which displays the composted amount in kg, followed by the "Submit" button (5). In case the user knows the total weight of its compost, the user can directly click onto the "Custom Weight" button (3a). There, the user can put in the exact amount of weight (3b) and continue with the before mentioned steps (4) and (5) to submit the input. After the submission the user will be directed to the main dashboard (6), where the progress will be visualized.

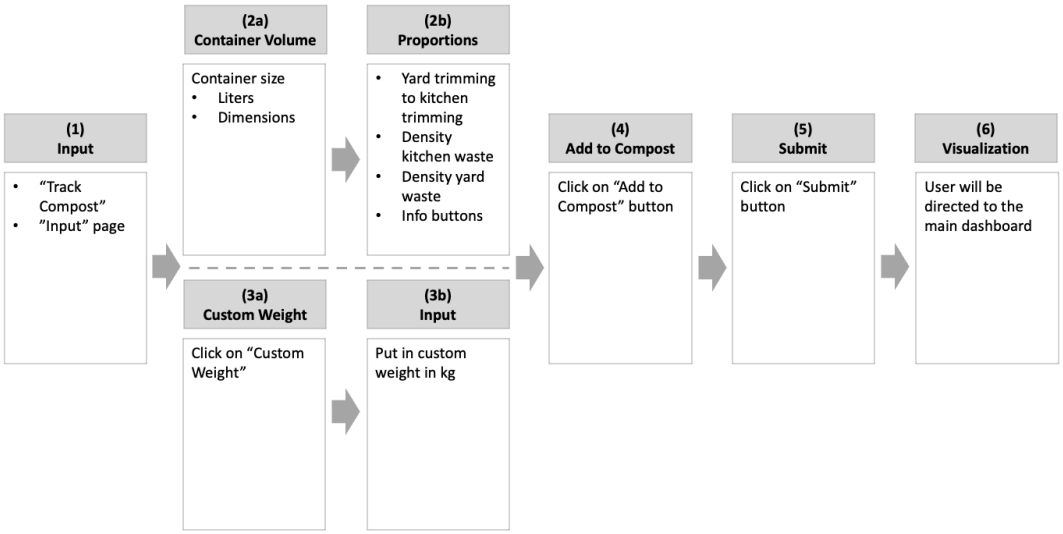


*Figure 19: Add input scenario*

The screens the user faces when going through one of the above-mentioned *scenario journeys* are displayed in Figure 9 (*Overview of Screens).*

# 7. Technical Implementation

In the beginning of this report, we have described the main idea, the *Screens*, as well as the features and their concepts of Compostuga. In the preceding chapter we also explained the most important aspects and mechanics of low-code platforms, with a focus on *OutSystems*, our platform of choice. We are now ready to dive deeper into the technical implementation of Compostuga. In the following chapter, we explain how we implemented the app, starting with the data model, followed by the logic, and ending with a brief explanation of our deployment strategy and the release of the app.

## 7.1 Data Model of Compostuga

As the data model is the basis for most applications it was also the starting point of our implementation. The first data *Entity* in any user-account based application, such as Compostuga, is usually the “User” *Entity* (Figure 20). *OutSystems* provides a pre-defined “User” *Entity*, with non-modifiable attributes. To define additional user attributes, specific to the Compostuga use case, we extended “User” by creating another *Entity* called “AppUser”. Note that, as of now, we defined a one-to-many relationship between “User” and “AppUser”. The reason for this was that we had originally planned for a "User" instance to have multiple "AppUser" instances, similar to Netflix where one user can have multiple profiles. If such logic will not be needed in the future, the “AppUser” *Entity* might be refactored to have a one-to-one relationship with “User”. Further we defined a “UserLoginInfo” *Entity*, which contains information about whether it is the first time a user accessed a specific screen to trigger the respective onboarding popup. Another *Entity* is “AppUserImage”, which stores the profile picture of each app user.

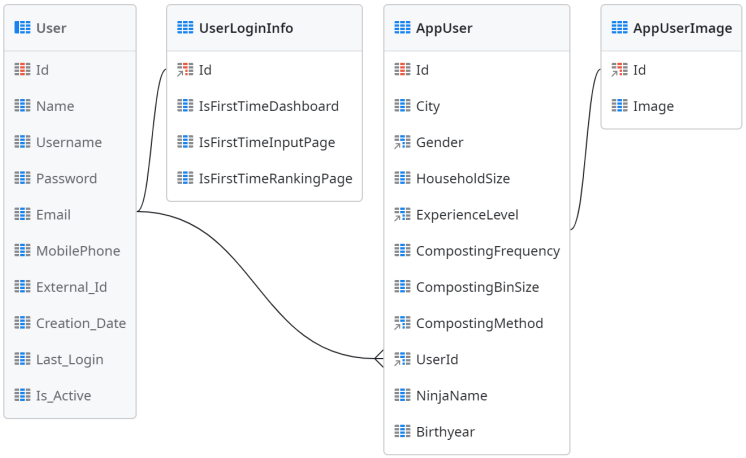


*Figure 20: Entity diagram for the Compostuga user logic*

The next business concept of Compostuga that needed to be represented in the data model was compost tracking. For this purpose, we defined two entities: "CompostPile" and "UserCompostInput" (Figure 21). The *Entity* “CompostPile” has a one-to-one relationship to “User” and stores the weight and $CO_2$ savings of the total amount each user has composted. Each time the user tracks his/her compost with the app an instance (or row) of type “UserCompostInput” is added to the database, containing information about this particular input, such as the volume, weight, and entry date.

“UserCompostInputSettings” is an additional *Entity* storing the default settings for the compost input screen for each user, such as their waste characteristics (proportion & densities) and the volume of their waste container. We defined “UserCompostInputSettings” to have a many-to-one relationship with “User” to leave the option open for future iteration of the app that users may save multiple compost input settings in their profile. “UserCompostInputSettings” is updated each time a user changes the settings (volume or input slider) and submits waste to their compost.

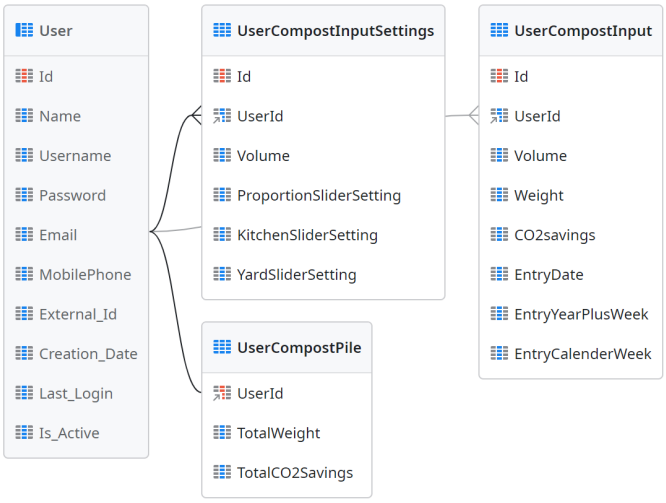


*Figure 21: Entity diagram for composting logic*

The concept of trees and the XP-System are represented with the help of three additional *Entities*: "UserXPProfile", "UserForest", and "UserCurrentTree" (Figure 22). All three have a one-to-one relationship with "User". The "UserXPProfile" stores information about the user's XP profile, including his/her total XP points, the current XP level, the streak duration (later explained in more detail), whether he/she is the weekly leader and if yes how much he/she composted during that week. Additionally, we store information about whether to show certain pop ups to the user, e.g., if he/she moves one XP level up. The "UserForest" simply stores the number of trees in the user's forest. "UserCurrentTree" is used to store the stage and progress of the user's current tree, which are needed to display and animate the tree on the main dashboard. The weight attribute of the current tree is used in the algorithm to calculate the new tree stage when making a composting entry. We will explain this later in more detail.

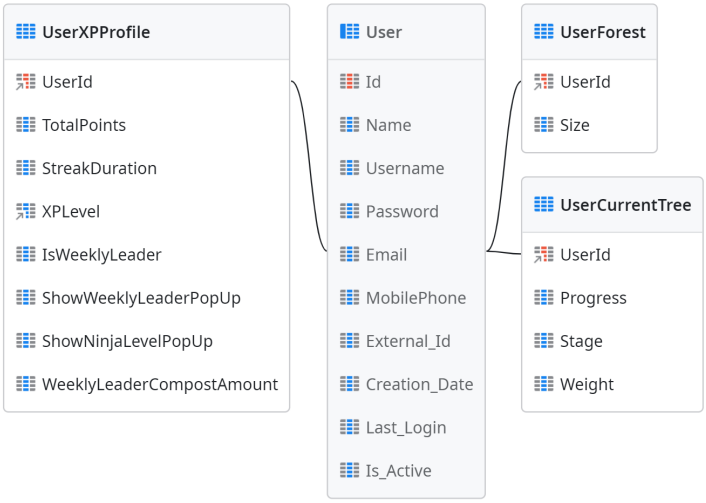


*Figure 22: Entity diagram XP and tree systems*

In addition to the "regular" *Entities* mentioned above we defined several static *Entities*:

- "CompostingMethod"
- "ExperienceLevel"
- "Gender"
- "TreeStages"
- "WasteDensities"
- "XPLevels"

Static *Entities* are *Entities* with predefined instances, called records, that cannot be changed during runtime. Static *Entities* are especially helpful when defining values like the minimum points and maximum points for the Compostuga XP levels that might have to be adjusted over time. These values are used in several places throughout the program. Defining them centrally in a static *Entity* allows those values to be easily and securely altered, without having to go through the entire code. For example, records in the *Entities* "TreeStages" and "XPLevels" might have to be extended or changed in the future as a result of testing or feedback.

## 7.2 Logic of Compostuga

In Chapters 4-5 we provided an overview of all *Screens* in the Compostuga app as well as a description of the underlying concepts behind the app's three main features. In the following

section we will provide a more technical explanation about how we implemented those *Screens* and features in *OutSystem*, with a focus on the underlying logic. As this report's length is limited, we will not be able to explain how we implemented every aspect and every detail. Instead, we will focus on the most important parts of the logic along our three main features: Input tracking, impact tracking, and gamification.

### 7.2.1 Input Tracking Implementation Logic

On the input *Screen* the user can interact with the app in mainly three ways. Firstly, he/she can enter a specific composting amount, either by using the calculator (1) or by inputting a weight directly (2) and then clicking the buttons (1) "Calculate" or (2) "Enter weight". After that, he/she can ultimately submit the previously entered amount to their compost by clicking the button "Submit" (3).

(1) Using the calculator and clicking "Calculate" triggers a simple *Action* that calculates the value of the local variable "Weight" with the following formula (Figure 23):

```
Round((Weight + Volume*(1-ProportionKitchenYard)*DensityYard + Volume*(ProportionKitchenYard)
*DensityKitchen),2)
```

*Figure 23: Formula - Value variable "Weight"*

This formula adds the sum of the share of yard and kitchen waste to whatever was previously stored in the variable "Weight" (by default 0) and rounds the result to two decimal places. The respective weight shares (for yard and kitchen waste) are calculated by multiplying the volume with the respective proportion, provided by the user through the proportion slider (a value between 0 and 1 determined by the UI element, whose position is set by the user) and the respective density. The two respective densities are calculated in a previous action as follows (using the example of the yard waste density) (Figure 24):

```
GetYardWasteDensityRange.List.Current.WasteDensities.MinDensity + (GetYardWasteDensityRange.List.
Current.WasteDensities.Range * (YardSliderSetting))
```

*Figure 24: Formula - Product of density range*

This formula sums the product of the density range of the yard waste and the yard slider setting (a value between 0 and 1 determined by the UI element, whose position is set by the user) with the density minimum. The range and minimum of the corresponding densities are previously fetched from the static *Entity* "WasteDensities".

(2) Directly entering a custom weight triggers an *Action* that simply assigns the inputted weight to the local variable "Weight".

(3) Most of the work of the input tracking happens when the user clicks the "Submit" button. This triggers the *Action* "SubmitOnClick" (Figure 25), which firstly validates the inputted weight. If the input is over 22 kg, a message prompts the user to double check. The *Action* then calls the server *Action* "UpdateCompostingProfile". After "UpdateCompostingProfile" is executed, the user XP point *Aggregate* is refreshed, which necessary for the input streak logic (not explained here). Finally, the user is redirected to the Main Dashboard.

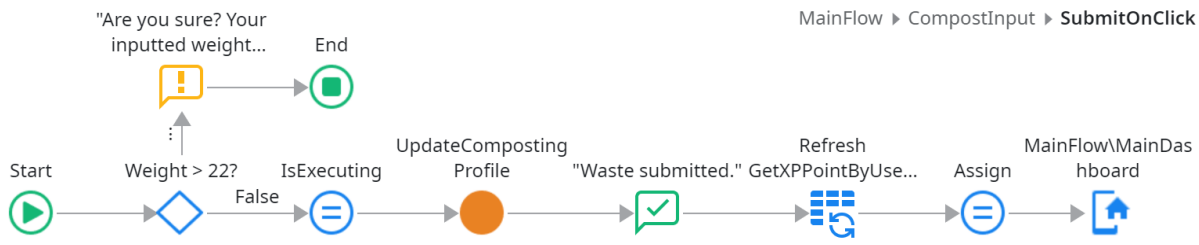


*Figure 25: SubmitOnClick Action*

The *Action* "UpdateCompostingProfile" (Figure 26) firstly updates the "UserCompostInputSettings" *Entity* if the input settings have changed (meaning the volume and/or the slider settings). This is followed by four server *Action* calls. "CreateUserCompostingInput" adds another row to the "UserCompostInput" *Entity*, with a

unique Id and the current "UserId". The $CO_2$ attribute is calculated by multiplying "Weight" with 2.80477, as explained in Subchapter **Fehler! Verweisquelle konnte nicht gefunden werden.**. Two additional important attributes, which are used for the input history graph, are "EntryYearPlusWeek" and "EntryCalenderWeek". "EntryYearPlusWeek" stores an integer, composed of the current year and current calendar week, i.e., 202245, for calendar week 45 of year 2022. By grouping, summing up, and sorting the inputs with the same "EntryYearPlusWeek", we get the weekly input history, visualized in the history graph of the impact report. "EntryCalenderWeek" additionally stores the current calendar week and year in text format (i.e., '45/22') used as the x-axis label in the history graph.

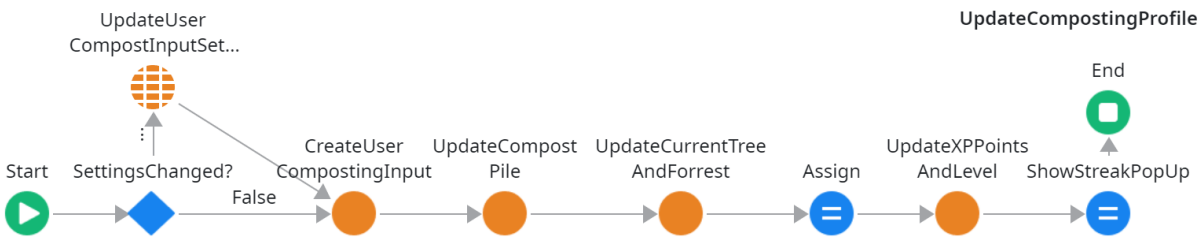


*Figure 26: UpdateCompostingProfile Action*

The *Actions* "UpdateCurrentTreeAndForrest" and "UpdateXPPointsAndLevel" will be explained in the next subchapter.

### 7.2.2 Impact Tracking Implementation Logic

For the impact tracking we must distinguish between the impact of Mudatuga as a company and each user's individual impact.

The former is rather a side product of the app and its database than a feature. As mentioned previously, we store each user's amount of composted food waste and consequent $CO_2$-eq savings in the *Entity* "UserCompostPile". Since these values are stored in the Compostuga database, Mudatuga can simply retrieve and aggregate this data using SQL queries. Since we also collect meta data about the user during the sign-up process and store it in the "AppUser"

entity, Mudatuga may cluster the composting data in different ways. They could, for instance, measure the amount of composted waste by city or by composting method. This could be a valuable insight for municipalities and other organizations.

*$CO_2$-eq and* equivalents

Each user can track his/her total individual $CO_2$-eq savings since he/she started tracking their waste with Compostuga. Firstly, users can track their total $CO_2$-eq savings and total weight of waste on the Main Dashboard. For this, the app simply fetches the corresponding database entry from "UserCompostPile" and displays it on the page. Secondly, they can track their $CO_2$-eq savings as six different equivalents on the Impact Report. The equivalents are calculated by dividing the user's total composted weight with a specific factor for the respective equivalent. In *OutSystems* the formula for EU household's daily electricity equivalent is for example calculated as follows (Figure 27):

```
Round(GetUserCompostPileByUserId.List.Current.UserCompostPile.TotalWeight/2.299247913,fractionalDigits:0)
```

*Figure 27: Formula - EU household's daily electricity equivalent*

Here, for the household daily electricity, 2.299247913 is the specific factor. The result is then simply displayed as a number below the respective equivalent's icon on the impact report.

*Tree and forest implementation logic*

The individual impact is additionally presented to the users through the trees and his/her forest, as one tree in the app represents $CO_2$-eq savings of 22.5 kg.

The tree and forest logic entails the algorithm that calculates the new state of the current tree and the forest size displayed on the main dashboard, after a user makes a composting input. The second aspect is the logic of the tree and forest animations, which intend to make progressing in the app pleasant and gratifying experience (this aspect can also be seen as part of the Gamification logic).

The algorithm that calculates the new state of the current tree and the new forest size is implemented in the "UpdateCurrentTreeAndForrest" *Action* (Figure 28). It is called by the "UpdateCompostingProfile" *Action* (Figure 26), which in turn runs after the user clicks on "Submit" on the Input Page.

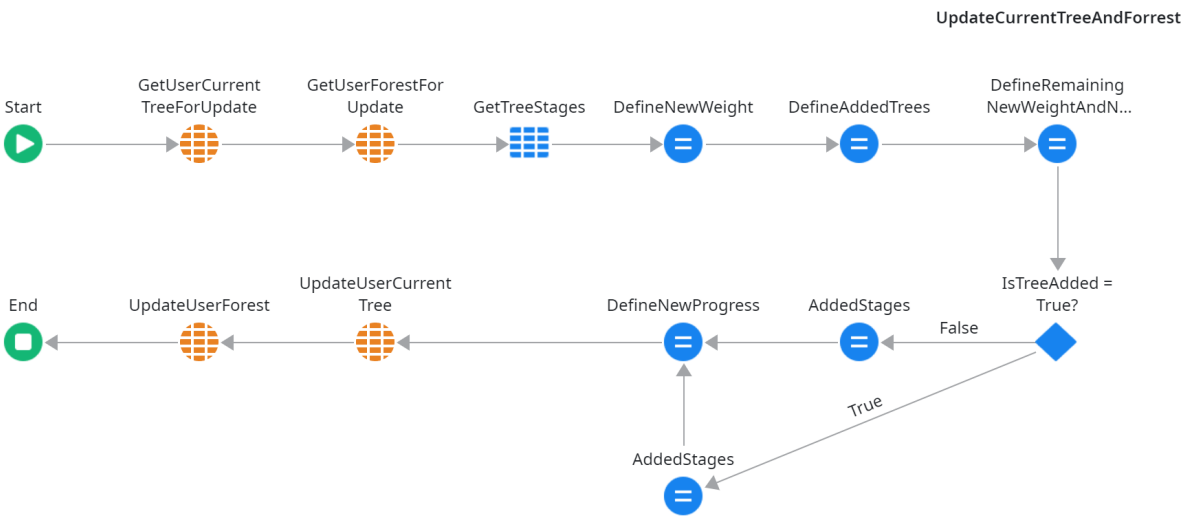


*Figure 28: UpdateCurrentTreeAndForrest Action*

"UpdateCurrentTreeAndForrest" has one input parameter "InputWeight" (the inputted weight) and two output parameters. The two output parameters are "AddedStages", containing the number of stages that were added as a result of that input, and "IsTreeAdded", convoying the information if a tree was added. These two output parameters are necessary for both the animation of the tree and forrest growth and the XP system.

The *Action* starts with three database requests, fetching the "UserCurrentTree" and "UserForrest" with the current "UserId" and the static *Entity* "TreeStages", which stores the different tree stages with their respective step sizes and upper weight limits. For example, "Stage4" has a step size of 9 kg and the upper limit 22.5 kg. The *Action* then calculates the new current tree weight ("NewWeight"), by adding the "InputWeight" and the "Weight" attribute of the "UserCurrentTree", which is the old weight of the current tree before the input.

With the new weight of the current tree, three values can be calculated successively: (1) The number of added trees (“NewTrees”), (2) the new tree stage (“NewStage”), (3) and the new progress (in %) of the current tree stage (“NewProgress”).

(1) The number of added trees (“NewTrees”) is calculated as follows: If “NewWeight” is greater or equal to the upper weight limit of tree stage 4, one tree is added, else zero trees are added. Note, that the inputted weight is limited to 22 kg (refer to Subchapter 7.2.1), so that with an upper limit of 22.5 kg, one input cannot result in more than one new tree (Figure 29).

```
If((NewWeight >= GetTreeStages.List[4].TreeStages.WeightUpperLimit), 1,0)
```

*Figure 29: Formula - Number of added trees*

(2) If a tree is added, the “NewWeight” would exceed the upper weight limit of stage 4. In that case, to calculate the new weight of the new current tree, the upper weight limit of stage 4 must first be subtracted from the “NewWeight”.

The “RemainingNewWeight” is therefore calculated as follows (Figure 30):

```
(NewWeight-(NewTrees * (GetTreeStages.List[4].TreeStages.WeightUpperLimit)))
```

*Figure 30: Formula - Remaining new weight*

With the help of “NewRemainingWeight” the “NewStage” can be determined using a nested if statement, which basically compares the “RemainingNewWeight” with the upper and lower limits of all tree stages and outputs the correct stage. Since this expression is too long and not really readable, we will leave it out here and instead add a screenshot to the Appendix 7.

The new progress of the new tree stage is determined in a similar fashion, with a nested if statement. Except that in this case the value for the new progress (in %) must also be calculated. Dividing the difference between the “RemainingNewWeight” and the lower limit of the correct

stage with the step size of the correct stage and multiplying it with 100 yields the new progress (in %). The following visualization (Figure 31) might give a better understanding:

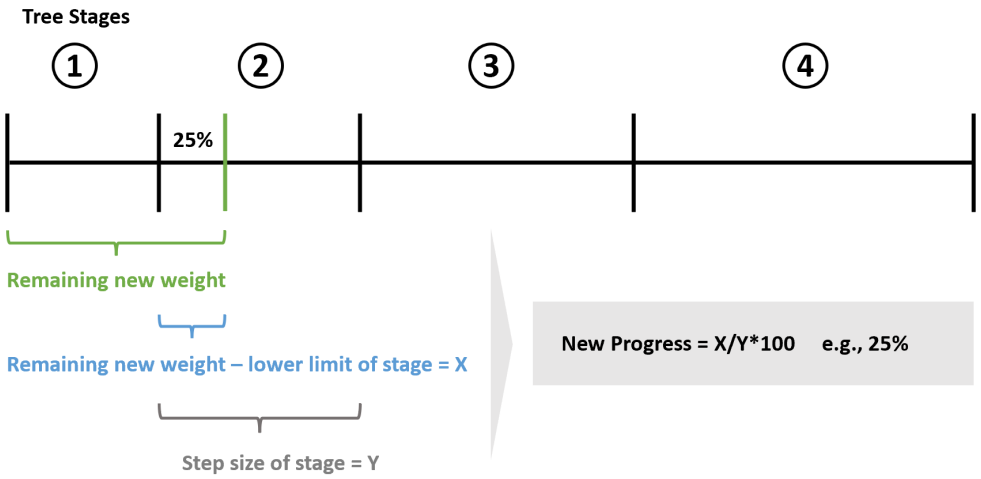


*Figure 31: New progress calculation*

As the entire expression is again too long and not really readable, a complete screenshot is added to the Appendix 8. For exemplary purposes, the part of the nested if statement for tree stage 2, looks as follows (Figure 32):

```
If(RemainingNewWeight >= (GetTreeStages.List[1].TreeStages.WeightUpperLimit) and RemainingNewWeight <
(GetTreeStages.List[2].TreeStages.WeightUpperLimit),(RemainingNewWeight-(GetTreeStages.List[1].TreeStages.
WeightUpperLimit))/(GetTreeStages.List[2].TreeStages.WeightStepSize)*100,
```

*Figure 32: Formula – New progress algorithm (tree stage 2)*

The two output parameters "IsTreeAdded" and "AddedStages" were also calculated but shall not be explained further here. The last step of the “UpdateCurrentTreeAndForrest” *Action* is then to update the respective database *Entities* with the newly calculated values.

We have now explained how the new state of the tree and forest are determined and updated after a user makes a composting input. However, this is only the first part of the overall tree and forest logic. To achieve a smoother user-experience this progress must be animated in the main dashboard. Since the animation logic is too extensive and would go beyond the scope of this report, we will not explain it further. For the sake of completeness, a screenshot of the “AnimateTreeForestAndPopUpsAfterFetch” *Action* is added in the Appendix 9. As the name

suggests, this action also contains the logic that triggers the corresponding popup windows that communicate the progress (e.g., gaining a new tree or new ninja level) to the user.

### 7.2.3 Gamification Implementation Logic

The Gamification logic essentially includes the XP system logic (although the tree and forest logic can also be seen as part of the Gamification).

*XP System implementation logic*

The XP System includes the XP points as well as the ninja level system. The underlying concept behind the XP points and ninja level system has been explained in Chapter 5.3. To summarize, the user has four ways to earn XP points:

- By reaching another tree stage [+125 XP]
- By gaining a new tree [+500 XP]
- By being on a streak (inputted multiple at least 2 weeks in a row) [+200 XP for each week]
- By having composted the most out of all users in a week [+400 XP]

In terms of the implementation, the first three ways are checked and calculated right after the user makes a composting input in the *Action* "UpdateXPPointsAndLevel" (Figure 33). Once again, this *Action* is called by the *Action* "UpdateCompostingProfile" (Figure 26), which in turn runs after the user clicks on "Submit" on the Input Page. "UpdateXPPointsAndLevel" has the two input parameters "IsTreeAdded" and "LevelAdded", which were the output parameters from "UpdateCurrentTreeAndForrest", as we have seen in the previous section. With these values we can easily calculate the XP points for gaining another tree and/or tree stage(s). The XP points for being on a streak are calculated in the "CheckAndUpdateStreak" *Action*, which is a bit more complicated. We shall not explain it further here but instead provide a screenshot of the *Action* in the Appendix 11.

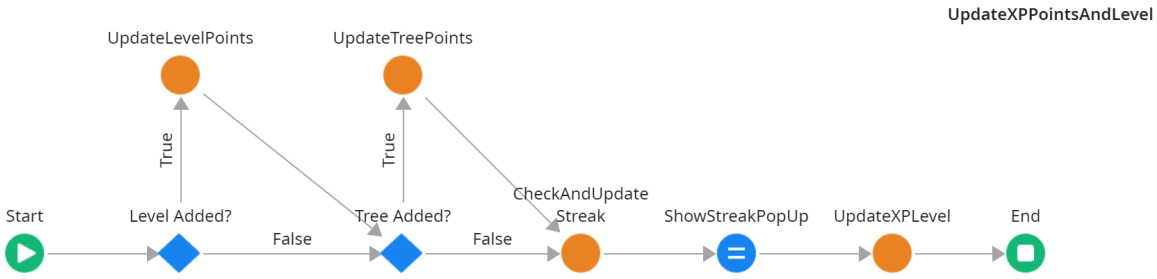


*Figure 33: UpdateXPPointsAndLevel*

Now that we have calculated all the XP points that the user might have gained, we need to determine if a new ninja level has been reached and update the database accordingly. This is done in the "UpdateXPLevel". The new XP level is calculated by comparing the total XP points with the point range of each XP level and then determining the correct one (Appendix 10). The point ranged of the XP levels are previously fetched from the static *Entity* "XPLevel". Finally, the users "UserXPProfile" is updated with the right XP level.

The weekly leader logic is independent from the input tracking. We therefore had to find another place in the program where we could define the *Action* "UpdateWeeklyLeader" (Figure 34). The solution was to run the *Action* inside a timer, which we timed to run every Sunday at 23:45. Notice that in this *Action* we had to call database queries with custom SQL queries. The reason for that is that the "UpdateWeeklyLeader" is called only once on the server and is independent from a user session. We therefore had to make a database call that updates many database entries at once, which was only possible using custom SQL queries. The first query is to reset the weekly leader from the previous week. We then determine the current weekly leader by fetching all "UserCompostInputs" of that week, grouping them by "UserId", summing up "Weight" to "WeightSum", and sorting by descending "WeightSum". The first entry of that *Aggregate* is then the weekly leader. After we determine the "UserId" of the weekly leader, we update his/her total XP points and calculate if a new XP level was reached. As the last step his/her "UserXPProfile" is then updated accordingly.

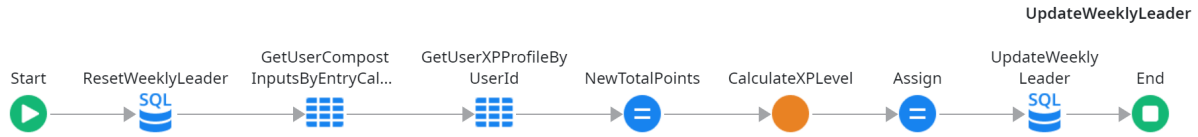


*Figure 34: UpdateWeeklyLeader Action*

Despite the length of the previous subchapters, there are many more aspects that we could not describe due to the limited length of the report, such as the implementation of the front-end (user facing interface). Nevertheless, have we now explained how we implemented the most important aspects of the Compostuga App. One key aspect of the implementation is however still missing, which is the deployment.

## 7.3 Deployment

During the development of an app, it must be continuously deployed and tested by the developers. However, during an external user testing, the app should not be updated or changed to ensure a consistent experience and not confuse the testers.

In order to enable simultaneous testing and development we worked with two separate environments. First, we developed the app on the “development” environment and later deployed the finished MVP on a separate “testing” environment. For a public rollout of the app in the future an additional third environment (“production”) may be added.

As of now the app was published mainly as a progressive web app (PWA), which is basically a website optimized for mobile devices. Additionally, to the PWA, we generated the app as an Android-package (.apk file) that can be installed natively on Android devices. A native iOS app was not generated due to Apple’s added complexity and security requirements for installing third party files. In the future, the app may also be published as an iOS app. The Android app has not been published in the Google Play store but was distributed with a download link to Mudatuga and testers.

# 8. User Testing – Method and Results

In the previous chapter, we talked about the technical implementation of "Compostuga". In this chapter, we will explain how we tested our application. We will start by talking about the testing mechanism of *OutSystems* and explaining different mobile application testing types. We will then introduce our testing method. In the end, we will present the results and feedback from the analysis of the testing feedback and list the improvements that we implemented in the app as a result.

In general, mobile application testing is a process where applications are tested for characteristics such as functionality, compatibility, usability, performance, and quality. Testing is performed by the developers of the mobile application as well as users that were not part of the development process.

## 8.1 Testing in OutSystems

*OutSystems* offers several tools and techniques for quality assurance. The first and most important technique is *OutSystems Test Framework*, which is composed of three frameworks to support software testing at different levels, namely at the unit, integration, and system levels. *Behavior-Driven Development (BDD)* is one of the frameworks that offers a no-code test environment to build API test cases and create units. *Unit Testing Framework* is the other framework that enables testers to define unit tests on the logic of the system without any dependency on the UI. The automated testing tool, *Ghost Inspector*, is integrated with the framework to support automated UI testing. The second technique in *OutSystems* is the *performance analyzer*, which captures real-time data and provides detailed reports during its usage growth to help performance monitor applications. The final technique used in *OutSystems* is *Automated UI Testing with Selenium*, in which UI test steps can be introduced

by recording user interaction with UI pages, using reusable scripts or manual scripting, while Selenium WebDriver enables writing complex test scenarios in common object-oriented languages such as Java and JavaScript (Khorram, Mottu, and Sunyé 2020).

## 8.2 Types of Mobile Application Testing

There are different mobile testing types that must be considered in every application testing plan to be sure the release of the application is user-friendly, useful, and has a chance of success. The first testing type we will explain is *functional testing.* This type of testing is targeted to ensure that every feature of the application works as planned. It focuses on testing the user flow within the application from the user's perspective, as well as each feature that the user flow comprises. The second important type of testing is *usability testing*, also known as user experience testing, where it is checked whether the application is user-friendly or not (Bose 2021). The objective here is to provide a user experience without any anomalies or bugs that is intuitive for a broad range of users. This type of testing is usually conducted by real users, not the development team, to ensure an external and unbiased perspective. The users are provided with tasks to complete on their applications, after which they are asked to fill out a survey. In the next section we will describe our roadmap for the testing phase of Compostuga.

## 8.3 Testing Method for Compostuga

We divided the roadmap for the testing phase of Compostuga into two rounds. The first round consisted of *guided tests* to get direct feedback from participants. In this round we asked friends and family members of the team to access and test the application while one of the team members was present and guiding the testers. The guided testing made use of the two main scenarios journeys previously introduced: Registering and onboarding as well as adding a composting input. Consequently, participants registered in the application to create their accounts as a first step, after which they were redirected to the main dashboard where they first

saw the tutorial pop-up and could start learning about the application for the first time. Next, they visited the other pages and tested several features of the application, such as the compost input and impact report page. The team member that was present observed the tester during their usage asked for feedback to understand where they had hard times or suggestions to improve the application. The whole testing phase took around 2 weeks to be completed.

After completing the first round successfully, we started with the second round of our testing phase. The second round consisted of *unguided tests* to get indirect feedback from a broader range of users. Here, students at the Nova School of Business and Economics and a group of customers of Mudatuga were selected to complete the testing. We collected the feedback from participants by asking them to complete a survey that included several questions about their experience using the application. The survey also included questions about the position of composting in their daily lives and if the application motivated them to start composting. The second round of testing took around 2 weeks to be completed by participants.

After collecting all the data from participants with the help of feedback from guided and unguided tests and surveys, we summarized, analyzed, and classified the data to identify the current problems in the application that need to be improved. We will go over these steps and present an analysis in the following chapter.

## 8.4 Feedback and Results

*Testing Round 1*

The general feedback from Round 1 was positive. Our testers found the app modern, aesthetic and generally intuitive to use. The most received suggestion for improvement was that we could add more explanations about composting methods and composting in general. As the app is intended for users who already know and practice composting, we discarded that feedback

for now. However, it confirmed our expectation that we would need to adapt the app in case we extend our target group. Another common feedback was that the onboarding pop ups were too text heavy and took too long to read. This sometimes discouraged the testers to read through the entire onboarding and instead led them to skip it, leaving them confused about some aspects of the app. Additionally, we received some technical suggestions like validating the mail address on the registration phase, and small improvements on interfaces to be sure that all texts and images are in the same style.

*Testing Round 2*

The survey we distributed to participants for our testing Round 2 included questions about their experience with the application, their knowledge of composting, and any additional feedback they thought would be useful for the future of our application. We received 13 answers in total. The reader can find the distribution of participants' answers to all questions in Appendix 4 and Appendix 7. In order to understand the data and get valuable insights from the feedback for the further development of the app, we conducted the following analysis.

In the first page of the survey, participants were asked if they were able to understand the different features and aspects of the application as well as the app's general idea by choosing one of the five options as seen on Appendix 2. Here, we can observe that on average for the total six questions asked around 70% of participants chose the "somewhat agree" or "strongly agree" option. The highest "strongly agree" option is chosen for both goal and compost input system of the application by participants. We hence concluded that the app does well in explaining what its general goal is and how to use the input feature. However, the survey also indicates that the app could be more intuitive to use in general, with about 25% of people selecting "strongly disagree" and "somewhat disagree". We added a hidden free text question to the survey that appears when participants choose one or more disagreeable options on the

first page to get more specific feedback. One of the answers we received in this part stated that the user's experience wasn't smooth due to the high amount of text and the lack of pictures or icons, which coincides with the feedback we got in Round 1.

On the second part of the survey, we asked participants four different questions, which can be seen in Appendix 3. Our objective here was to learn more about the participants and their background in composting. Surprisingly, we saw that more than half of the participants were composting in their daily lives and only around 2–3 people had no prior experience in composting at all. This was a good result because it meant that the people participating in the testing mostly matched with our target user group, which made the feedback even more valuable.

Another aspect and arguably the most important piece of feedback that we were looking for, was the participant's motivation. Compostuga is a mobile application that wants to help users to tracks their composting habits. It hence needs to be ensured that users become engaged in the application and have the motivation to continue to track their habits. The answers to the first questions, which can be seen in Appendix 6, show that the majority of participants were motivated by our application to start or continue composting, with only one person selecting "No" and two selecting "Maybe". For the second question, which asked if people would consider using the application, six selected "Yes", four selected "Maybe", and no one selected "No". Even though this is a very promising result it shows that there is still some room for improvement in making the app more engaging.

Before concluding the survey, we asked participants to share any additional feedback they had that wasn't covered by the survey questions. Here, we received answers related to everything from fixing bugs to offering new features for the application (see Appendix 6). One feedback suggested to add additional features that enable more interactions between the different users.

We decided not to develop it since we did not have enough time for it. But we are also very convinced that such features could add significant value to the app and included it in our future recommendation (see Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

There were also some bugs that testers faced. One common bug that participants reported was that after registering and logging into the application for the first time, they were already seeing some progress on the main dashboard. They were able to easily fix it by switching to another tab and returning it again to the dashboard page, but it nevertheless caused for some confusion. Other reported bugs included that the store tab did not work and that the inputted composting amount did not transfer. The reader will be informed in the following subchapter about the bug additional improvements we made to the application to address the bugs as well as complaints reported by participants.

### 8.4.1 Additional Features and Improvements

The first bug that we solved after completing the testing phase, was the initial progress bug. Now first-time users will see a progress bar set to zero on their main dashboards.

The fact that the testers could not access the store was due to the way we implemented the store tab. In the old version the store tab would have only worked on the native Android app, because it was implemented using a plugin that opened the native in-app browser. We changed the implementation so that users are now able to access the store inside the application on both PWAs and the native version.

We figured that the complaint about the weight not being transferred was not a bug but caused by the user not clicking “Submit” on the input page. We hence changed the button text of the calculator from “Add to compost” to “Calculate” to avoid the misconception that the weight has been submitted when it is only calculated and shown at the top.

Other minor improvements were made on the interface's side, such as reducing and overworking the text in the onboarding pop-ups, adding additional pictures in the input page tutorial, and displaying profile pictures of all users in the leaderboard. Increasing the size of the close button for all pop-ups in the application now makes it easier to click the button. Additionally, we implemented several features on the technical side of the application that we previously did not have time for, like solving the forgot password function and getting the streak logic to work.

Every piece of feedback we received from participants guided our team to plan the next step more accurately. At the end of this phase, we managed to implement the feedback and additional tasks on the roadmap that we had in mind since the beginning of the development phase. In the following chapter, we will conclude the project by discussing strategic recommendations for Mudatuga.

# 9. Conclusion

The presented thesis was primarily motivated to answer the two following questions:

1. What are Mudatuga's main objectives and how can they be achieved with an app while securing a good end-user experience?
2. How can an app be implemented within the given time frame and scope?

To address the questions, we began by gaining a comprehensive understanding of Mudatuga and the practice of composting. Subsequently, we refined the scope, objectives, and challenges for the development of the app. We agreed that the app, in its MVP form, should be a mobile composting habit tracker that incentivizes households to the continuous practice of composting through gamification and tracking of $CO_2$ emission reductions. Following this, we proceeded to define and specify all necessary features through benchmarking, conception, and design. These efforts formed the prerequisites for the implementation the app in *OutSystems*. After the completion of the first draft, user testing of the app was conducted and the resulting feedback was integrated into the app. Lastly, strategic recommendations were provided about further development possibilities of Compostuga and Mudatuga as a company.

The creation of the app can play a significant role for Mudatuga. With the app, the company is now able to increase its visibility and promote the practice of composting by enabling individuals to develop a habit. Besides, the app allows the company to collect data about user's composting behavior to measure and communicate the positive impact composting has on the environment (especially its impact on $CO_2$ emissions). This is of great interest regarding future funding and potential lobbying efforts of Mudatuga, that would help to anchor composting more deeply into society.

The app not only offers added value to the company, but also to its users. Users can benefit from the app by finally being motivated to uphold their composting habits thanks to a gamified experience and the tangibility of their individual impact. Those factors as well as an added sense of community through social features, have the potential to increase the enthusiasm for composting.

Moreover, the app also supports composting in general. Through the development of the app, a new platform was created to increase the promotion of composting and to encourage users to start composting and consequently making it a habit. These factors led to composting becoming more widespread, people learning more about it, and therefore resulting in a higher positive impact on $CO_2$ emissions.

It is now crucial for Mudatuga to focus on the next steps in order to fully capitalize on the potential of the MVP and realize its maximum value. First, the company should focus on achieving short-term quick wins, such as fixing final bugs, improving the interface based on feedback from the testing and deploying the app to the Apple Appstore and Google Play Store. In the long-term Mudatuga's focus should be on extending the app with social network features and an input validation. The app could then be monetized using a freemium model. In combination with solid promotion and lobbying strategies Mudatuga could take not only its environmental impact but also its business value to the next level.

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# Appendix

## *Appendix 1: XP Logic*

The overall XP Logic is based on a best practice example. It refers to a user, who uses the app in a frequent manner.

| Categories | Level | Ninja Name | Total Points<br>in XP | Time<br>in weeks | Tree Points<br>500 per tree | Tree Stage Points<br>125 points per level | Streak Points<br>First time 100 points<br>200 per streak | Leader Points<br>400 per leader |
|---|---|---|---|---|---|---|---|---|
| White Belt | 1 | Junior | 0 | 0 | / | / | / | / |
| | 2 | Genin | 325 | 1 | 0 | 125 | 200 | 400 |
| | 3 | Jonin | 650 | 2 | 0 | 250 | 400 | 400 |
| | 4 | Chunin | 1800 | 4 | 500 | 500 | 800 | 400 |
| Yellow Belt | 5 | Junior | 2450 | 6 | 500 | 750 | 1200 | 400 |
| | 6 | Genin | 3600 | 8 | 1000 | 1000 | 1600 | 400 |
| | 7 | Jonin | 4250 | 10 | 1000 | 1250 | 2000 | 400 |
| | 8 | Chunin | 5400 | 12 | 1500 | 1500 | 2400 | 400 |
| Orange Belt | 9 | Junior | 6375 | 15 | 1500 | 1875 | 3000 | 400 |
| | 10 | Genin | 7525 | 17 | 2000 | 2125 | 3400 | 400 |
| | 11 | Jonin | 8175 | 19 | 2000 | 2375 | 3800 | 400 |
| | 12 | Chunin | 9325 | 21 | 2500 | 2625 | 4200 | 400 |

### Categories

There are currently three leagues implemented (**bolt**) with the option of additional leagues in the long term:

- **White Belt**
- **Yellow Belt**
- **Orange Belt**
- Green Belt
- Blue Belt
- Purple Belt
- Red Belt
- Brown Belt
- Black Belt

### Total Points

The Total Points are measured in XP points. In our XP Logic, the total points are calculated as followed:

Example (White Belt Category, Level 4):

Total Points (1800) = Tree Points (500) + Tree Stage Points (500) + Streak Points (800)

→ Assuming the user already collected 500 Tree Points and 500 Level Points. In addition, we assume that the user composted every week and therefore collected Streak Points.

### Time

The fixed timetable to reach the next level was set based on our research. We therefore decided to achieve the first levels quickly (1 week), which extends to 2 and 3 weeks after the first few levels. The timeline (in weeks) was a crucial factor in calculating the overall XP points needed.

### Tree Points – 500XP

The Tree Points were assigned after the first 3/4 weeks, assuming it takes a user around three weeks to generate a tree. We then calculated with an additional tree in week 8, 12, 17, and 21.

### Tree Stage Points – 125XP

A user can earn 500XP Tree Points when completing one tree and additional 125XP per Tree Stage completed. Consequently, the achievement of a new tree and the timeline of the Tree Points as well as the Tree Stage Points are equivalent. The Tree Stage Points are calculated as followed:

Example (White Belt Category, Level 4):

Tree Stage Points (500) = Time in weeks (4) x 125XP

→ Assuming the user reached Level 4 after four weeks.

### Streak Points – 100XP / 200 XP

The user gets 100XP for composting in general. If the user decides to compost every week consecutively, she/he gets additional 100XP. This results in 200XP. The streak points are calculated as followed:

Example (White Belt Category, Level 4):

Streak Points (800) = Time in weeks (4) x 200XP

### Leader Points – 400XP

If a user has the highest composted amount in a week, he/she gets rewarded with 400XP. These points were not included in our calculations, as those points represent an individual case.

## *Appendix 2: User testing survey 1*

Please answer the following statements:

| | Strongly Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Strongly agree |
|---|---|---|---|---|---|
| I understood the compost input system (e.g. how to submit your compost of the week) | ○ | ○ | ○ | ○ | ○ |
| I understood the XP/gamification system (e.g. leaderboard, how to gain points) | ○ | ○ | ○ | ○ | ○ |
| I understood the tree/forest system (e.g. tree stages, how to earn a tree) | ○ | ○ | ○ | ○ | ○ |
| I understood the goal of the App. | ○ | ○ | ○ | ○ | ○ |
| I found the App intuitive to use. | ○ | ○ | ○ | ○ | ○ |
| I understood the positive environmental impact I would have by composting. | ○ | ○ | ○ | ○ | ○ |

← →

## *Appendix 3: User testing survey 2*

Do you compost?

- Yes
- Sometimes
- No

Does the app motivate you to start composting / compost more?

- Yes
- Maybe
- No

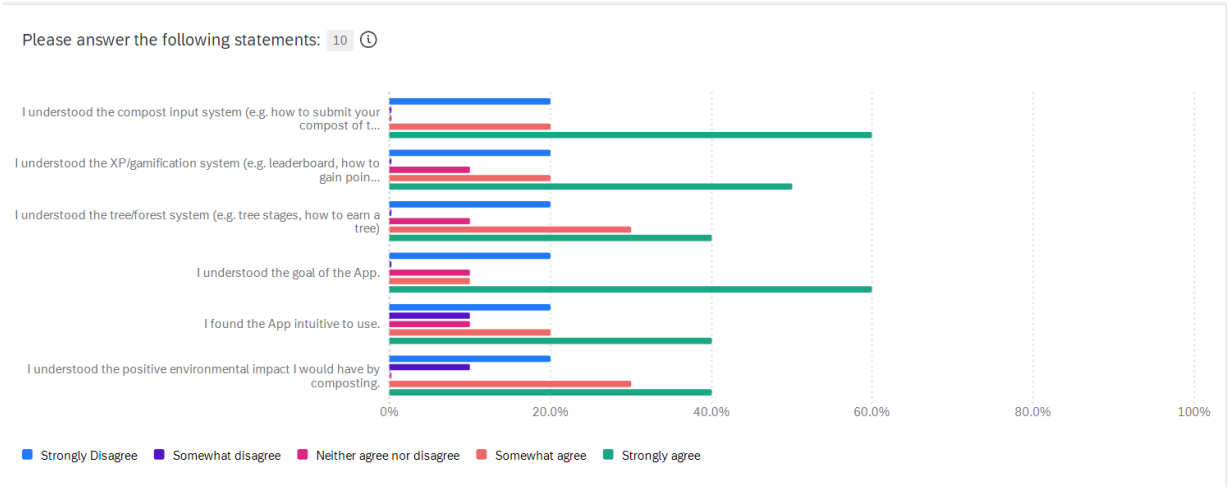
Would you consider using the app in the future?

- Yes
- Maybe
- No

Did you face any challenges (e.g. bugs, missing information etc.) while signing up / using the app?

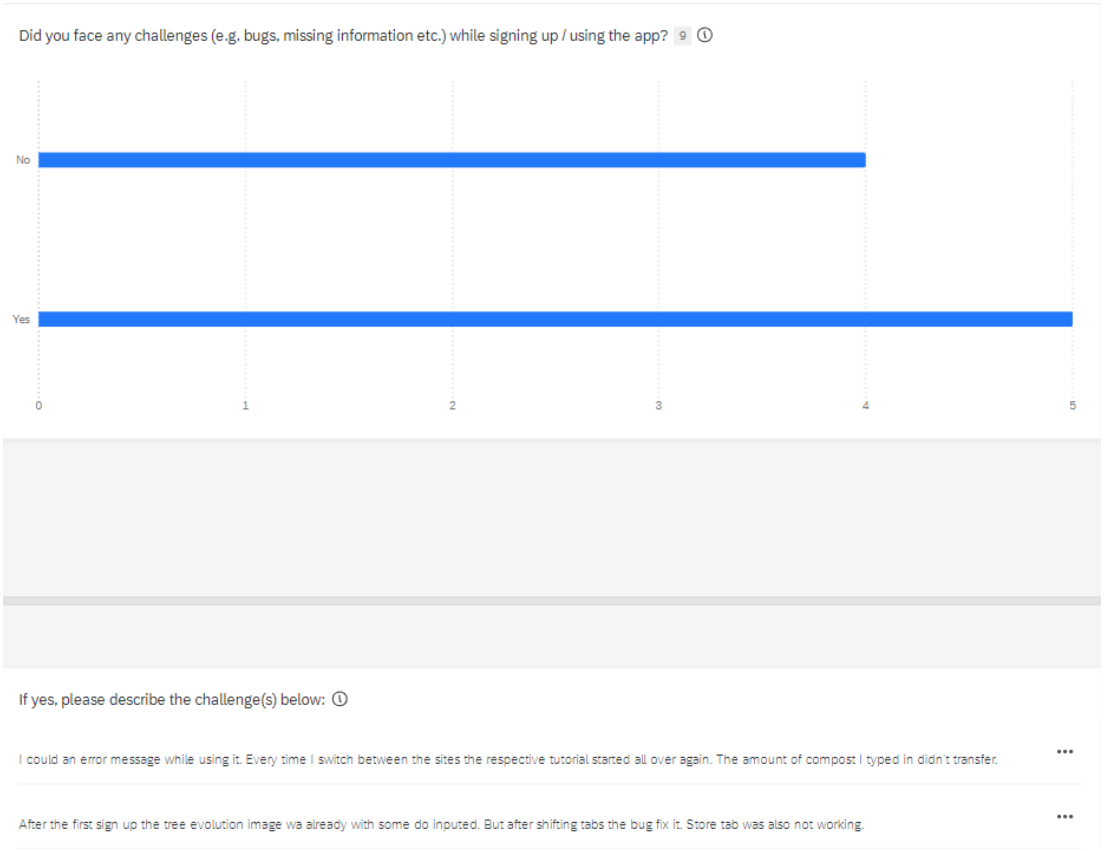
- Yes
- No

## *Appendix 4: User testing result 1*




## *Appendix 5: User testing results 2*

## *Appendix 6: User testing results 3*



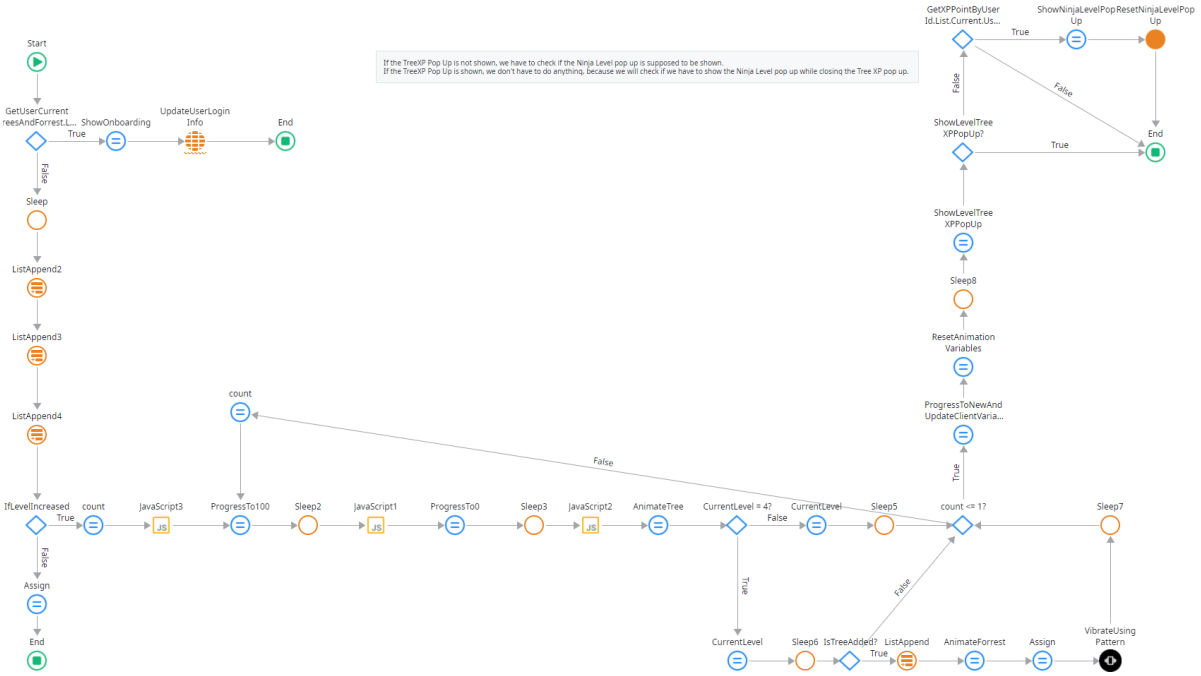

## *Appendix 7: New tree stage algorithm*

```
If(RemainingNewWeight<(GetTreeStages.List[1].TreeStages.WeightUpperLimit),
(GetTreeStages.List[1].TreeStages.Stage),
If(RemainingNewWeight >= (GetTreeStages.List[1].TreeStages.WeightUpperLimit)
and RemainingNewWeight < (GetTreeStages.List[2].TreeStages.WeightUpperLimit),
(GetTreeStages.List[2].TreeStages.Stage),
If(RemainingNewWeight >= (GetTreeStages.List[2].TreeStages.WeightUpperLimit)
and RemainingNewWeight <(GetTreeStages.List[3].TreeStages.WeightUpperLimit),
(GetTreeStages.List[3].TreeStages.Stage),
If(RemainingNewWeight >= (GetTreeStages.List[3].TreeStages.WeightUpperLimit)
and RemainingNewWeight < (GetTreeStages.List[4].TreeStages.WeightUpperLimit),
(GetTreeStages.List[4].TreeStages.Stage),-1))))
```

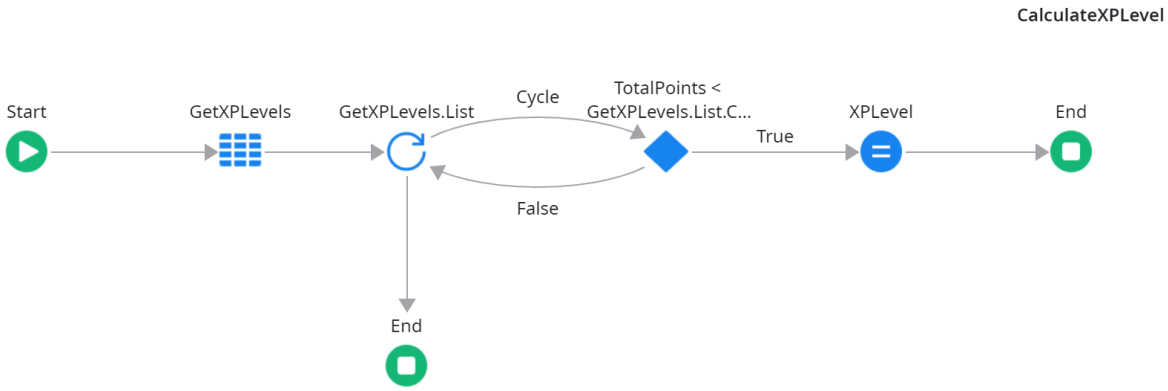
## *Appendix 8: New progress algorithm*

```
If(RemainingNewWeight<(GetTreeStages.List[1].TreeStages.WeightUpperLimit),RemainingNewWeight/(GetTreeStages.List
[1].TreeStages.WeightStepSize)*100,
If(RemainingNewWeight >= (GetTreeStages.List[1].TreeStages.WeightUpperLimit) and RemainingNewWeight <
(GetTreeStages.List[2].TreeStages.WeightUpperLimit),(RemainingNewWeight-(GetTreeStages.List[1].TreeStages.
WeightUpperLimit))/(GetTreeStages.List[2].TreeStages.WeightStepSize)*100,
If(RemainingNewWeight >= (GetTreeStages.List[2].TreeStages.WeightUpperLimit) and RemainingNewWeight <
(GetTreeStages.List[3].TreeStages.WeightUpperLimit),(RemainingNewWeight-(GetTreeStages.List[2].TreeStages.
WeightUpperLimit))/(GetTreeStages.List[3].TreeStages.WeightStepSize)*100,
If(RemainingNewWeight >= (GetTreeStages.List[3].TreeStages.WeightUpperLimit) and RemainingNewWeight <
(GetTreeStages.List[4].TreeStages.WeightUpperLimit),(RemainingNewWeight-(GetTreeStages.List[3].TreeStages.
WeightUpperLimit))/(GetTreeStages.List[4].TreeStages.WeightStepSize)*100, If(RemainingNewWeight >= (GetTreeStages.
List[4].TreeStages.WeightUpperLimit),-1,-1)))))
```

## *Appendix 9: Tree animation / Main dashboard Action*



## *Appendix 10: CalculateXPLevel Action*




## *Appendix 11: CheckAndUpdateStreak Action*