Engaging Data Visualization with Saxion’s Data Skyline

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Abstract

The aim of this project is to improve the data skyline, a visual installation at Saxion Hogeschool, by visualizing relevant data in an engaging way. The new interactive visualizations create an experience that users would like to return to. Waste separation and collection is the topic of the new view of the data skyline. This topic was chosen because it is relevant for all students, employees and passersby of Saxion. They encounter the need to separate waste at home and soon at Saxion too. This project creates a view that shows a creature living in the data skyline. Users can keep the creature alive by scanning the barcodes on their waste, which helps them to dispose of their waste correctly. Besides, a daily question on a variety of topics is presented to spark curiosity in users. User evaluations were conducted throughout the design process to assess the installation's effectiveness. The summative evaluations showed that most participants experienced a willingness to return. The final design meets the goals and can be adapted for use in other contexts where the topic of sustainability in relation to waste separation and collection is of importance.

Acknowledgement

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Chapter 1 – Introduction

This project aims to update the data skyline, a physical dashboard at Saxion Hogeschool. The data skyline was designed by students, 100%FAT and the Smart Cities research group [1]. Saxion has two skylines, one in Enschede and one in Deventer. This project will focus on Enschede due to its proximity to the University of Twente and the time constraints. In this report, the terms data skyline and skyline will refer to the data skyline in Enschede. This skyline displays various widgets of information related to the city of Enschede and the research group of Smart Cities and Ambient Intelligence, showing, for example, the weather data and parking space availability throughout the city.

Figure 1: Photo of the data skyline in Enschede [1].

The skyline is an installation designed to be interacted with frequently. However, it does not receive much attention from students, employees and passersby of Saxion. People do not seem to return to the skyline nor interact with it on a regular basis. The client, the Ambient Intelligence research group, would like the skyline to be updated with new and relevant data sources and visualizations that encourage users to interact with the skyline. The data skyline should become relevant for students, employees and passersby of Saxion and should function as an interactive centerpiece.

This project revives the skyline by adding a new view focused entirely on waste collection and separation. Here, the users feed their waste to the creature by scanning the barcode of their products. In return, the skyline provides data on how to sort said waste into the proper waste bin, since many people sort their waste incorrectly [2]. Additionally, Saxion recently started separating waste in one of their canteens and want to expand this[3]. Furthermore, the installation keeps statistics on the products that were scanned and on the creature. It also provides information on waste separation and collection that might not be general knowledge. The view is set up in a playful way to create an engaging experience, that can be repeated.

To create an installation that encourages users to return, the following research questions were addressed:
Research question: How can the visualizations of the data skyline be improved to make the skyline repeatedly engaging for students, employees and passersby of Saxion?
Sub-question 1: What data is relevant for all students, employees and passersby of Saxion?
Sub-question 2: How can data be visualized in a way that is attractive to students, employees and passersby of Saxion?
Sub-question 3: How can the data skyline engage students, employees and passersby of Saxion in a way that invites users to return to the skyline?

The research process was executed by following the Creative Technology Design Process [4]. The prototypes were assessed by using user evaluations.
The project was limited by the availability of data, the timeline of the project, the availability of participants for the evaluations, the expertise of the researcher, and the physical constraints of the skyline.

In this report, the development of the new view will be discussed. The project followed the methodology of the Design Process for Creative Technology [4]. Chapter 2 will cover the background research that forms the foundation of the project. An expert interview and a literature review were conducted to gain insight into the stakeholder requirements and the state of the art. Chapter 3 will focus on the ideation phase and the specification of the requirements for the project. The ideation phase was a dance between the wishes of the client, the opportunities of the project and the restrictions of the situation. Methods like mockups and ideation sessions that led to the idea will be discussed and the final idea and its requirements will be formulated. Chapter 4 will show the execution of the project and describe the development of the different elements for the new view. During this realization phase, practical choices were made in the creation of the prototype and functional tests were performed to create a prototype that could be used to evaluate with users. Then, chapter 5 will discuss both the formative and the summative user evaluations. These evaluations tested whether the prototype fulfilled the non-functional requirements that were set up in the specification phase of the process. Chapters 2, 3, 4, and 5 show the iterative process in nonchronological order. The Design Process was followed twice in its entirety, discounting loops and jumps within and between phases of this iterative process. Lastly, chapter 6 and 7 will focus on the discussion and the conclusion respectively.

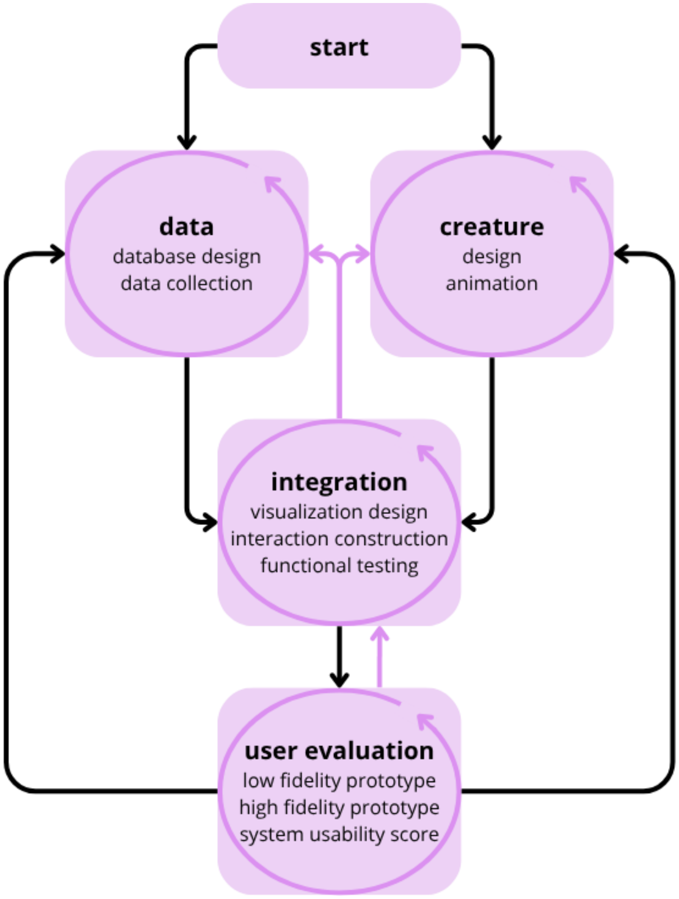

Figure 2: The process diagram of the project.

Chapter 2 – Background Research

2.1 Context

2.1.1 The Stakeholders

There are multiple stakeholders in addition to the student executing this project and the University of Twente supervisor.

The client

The client of the project is a researcher and lecturer of Saxion Hogeschool. Saxion has a Data+AI lab that is coordinated by the research groups Ambient Intelligence and Smart Cities [5]. The client would like the data skyline to be a centerpiece of the capabilities of the Data+AI lab and to shed a positive light on the lab and Saxion. Next to that, the client would like the skyline to present data that contributes to the sustainability awareness of users.

The users

The users of the data skyline are the students, employees and passersby of Saxion Hogeschool Enschede. At the moment, there are not many people who actively use the data skyline. The skyline is mainly visited by passersby as they have not seen it before. After the implementation of the updated skyline, more students and employees will repeatedly visit the skyline. The users would like to be entertained by and engaged with the data skyline.

The non-users

Individuals that do not make use of the installation are also considered to be stakeholders. If someone wishes not to engage with the skyline, they should not be disturbed by it. The installation should therefore be noticeable and appealing to visit, while also being present in such a way that it does not negatively impact the active non-users, such as a receptionist who does not want to constantly hear loud noises emanating from the skyline.

2.2 Waste separation and collection

Data is needed to fill the data skyline with new visualizations. This data should be in line with the focus of the research group Smart Cities, improving quality of life [6]. Since Saxion signed the Sustainable Development Goals [7] in 2018, the focus should also be on one or more of those goals. Waste separation and collection is relevant to Sustainable Development Goals 11 and 12. Waste separation and collection is also a topic that is relevant to everyone, regardless of background. There is also a lot of data available on waste that could be visualized. For example, there is a dataset that contains the amount of categorized waste per city in the Netherlands [8] and there is information on how to sort waste in specific cities [9], [10]. News around the topic is also available [11].

2.3 Capturing attention

The data skyline should be attractive for the users, not only to start interacting but also to keep interacting with it. The academic literature that covers the factors that cause interaction and repeated interaction was reviewed[12].

2.3.1 Attention catching

There are multiple attractors that can attract users to screen installation. To start, the phenomenon that describes people being attracted to installations where other people are interacting is called the Honeypot Effect [13], [14], [15], [16]. Next, when people notice that they can interact with the installation it also invites them to interact [13], [17], [18], [19]. The key is to let people know that they can interact without them having to interpret instructions. Lastly, the screens should be in a place and position where they can be spotted easily [15], [18], [20], [21], [22].

2.3.2 Attention keeping

There are two ways to keep the attention of users, prolonging attention and causing the user to return. Since the data skyline should not keep people from doing their jobs and studies, it should not prolong the interaction. Users return because of two distinct factors. The first factor is place [15], [18], [20], [22], [23]. If an installation is in an accessible place, people are more likely to interact with it repeatedly than if it were in an inaccessible place. The second factor is updated data [15], [20], [22], [23], [24], [25]. If the data on the screen changes regularly, the users will have something new to see and will return.

2.3.3 Discouraging factors

Factors that discourage users from interacting with screen installations are also discussed in literature. People might feel uncomfortable or be in company that does not expect or approve of interacting with the installation [16], [21]. Additionally, people might expect the visualization to show information that they do not want to see [22], [26]. Lastly, people might want to be polite and avoid being in the way of others by not taking the time to interact with the installation [14].

Chapter 3 – Ideation

During the ideation phase, ideas were generated and background information was incorporated. In the beginning of the ideation phase, there were many options regarding data and technologies. Along the way, as more and more background information was gathered, the topic became clearer, and a solution could be chosen.

3.1 Data Sourcing

The search for a suitable topic started with searching the internet for (live) databases in the category of smart cities data. Many data sources were found on various topics. There was a live feed of the river “de IJssel” in Deventer [27] and live water level data to go along with it [28]. Another live camera feed of a building site close to Saxion was found [29]. Datasets on wind, air quality, rain and weather were also available through weather stations [30]. There was also data found on the quantities of waste that cities produced [8]. Another topic that sparked interest was the amount of pollen in the air [31], [32]. Although many of these topics had potential, the majority was not of relevance to the students, employees, and passersby of Saxion. Some of the data sources did not have enough data to base a skyline on, for example the river “de IJssel” only had water level and the live feed. In order not to overload the user with too much information one topic should be chosen. The topic of waste separation and collection is a broad enough topic to be able to create many visualizations. It is also relevant to the students, employees, and passersby of Saxion, due to them coming into contact with waste separation at home and possibly at Saxion in the future. Furthermore, it follows two Sustainable Development Goals, 11 Sustainable Cities and Communities and 12 Responsible Consumption and Production.

3.2 The ideation session

When it was clear which data was available and of interest, an ideation session was held. Its attendees were three researchers from the research group Ambient Intelligence and the research group Smart Cities. After a brief introduction on the project and the available data, a warmup was done to get everyone in a creative mindset. The warmup was adapted from one found on the internet called “teken maar raak” [33]. It involved five pieces of paper on which the participants drew one squiggle. Then, the paper was passed to the person sitting on the right in the circle. This person would try to make a drawing with the squiggle. After the warming up, the ideation session moved to ideating ideas for the project

3.2.1 Crazy eights

Crazy eights [34] is the first ideation technique that was done in the session. It involves everyone getting eight blank sections on paper. The source described folding one paper into eights, but it was decided that two papers folded into fours would give the participant more room to express themselves. A timer of eight minutes was then set, during which the participants had to fill their eight sections with their ideas. Communication was allowed during this process, but the participants understood their task and did not feel the need to communicate. As the alarm of the timer sounded, everyone lay down their pens and the round of discussion started. Taking turns, everyone explained their ideas to the group. Whenever an addition or an important remark was made, this was written down on a sticky note and placed on the idea it was referencing.

3.2.2 Round robin

After the crazy eights ideas were all explained and nobody had anything to add, the next phase of the ideation session started. The process of round robin was explained. Everyone received a piece of paper to write one or two ideas on. The group waited until everyone had written down an idea they liked or an idea they wanted to be elaborated. Then, the papers were passed to the neighbor to the left. This person would read the contents of the paper and then write any elaboration or comment that they thought of. This would go on until the papers were back at the original owner. Then, the group discussed the results of the round robin. For this method, sticky notes were also available.

Before the start of the ideation session, some ideas were written down to be used during round robin in case the group lacked a bit of inspiration. These ideas were not used, since crazy eights left people with enough ideas. Most of the premade ideas came up naturally in the session. The others were discussed like the crazy eights and round robin.

3.3 Processing the ideas

3.3.1 SWOT analysis

After the ideation session with the research group members of Saxion, the ideas were extracted from the records of the session and listed. Then a SWOT analysis was done on every idea in the list. This was done to get an idea of the strengths and weaknesses of the ideas. It was also interesting to see the overlapping threats between the ideas. The opportunities section was not very structured, it had entries ranging from possibilities with the hardware of the idea to combinations that could be made with other ideas. The result of the Swot analysis was a table across five pages with every idea that was generated and their strengths, weaknesses, opportunities, and threats.

3.3.2 Idea prioritization

The requirements for the ideas were generated to later be used as a tool to choose a viable idea for the project. The requirements were adapted to fit the goals of this project. The final requirement for the idea can be found in Table 1.

Table 1: The idea prioritization table.

Must	**Should**	**Could**	**Won't**
Be interactive Be repeatable Be able to facilitate single user Be related to data	Be intuitive Fit within the current space Be informative Be understandable Include ways to see historical data Have clear data encoding Be relevant to the users Be related to the SDGs	Facilitate multiple users at once Be open ended, allow continuation Have extra, sturdy sensors/actuators Have live data Change daily Create a coherent experience Use data that the user has direct influence on Relate data to reality Have competitive elements Be understood by Dutch users Start conversations Create contact between users Show improvement /progress	Require more than 10 minutes per use Be singular use Contain more than two sentences per section Stimulate people to be wasteful Purposefully create a negative atmosphere Present something unwanted as wanted Damage the image of Saxion

3.4 Chosen concept

The chosen concept combines multiple elements of the ideas found in the ideation phase. The topic waste separation and collection has been chosen as the focus of the project. The goal is to create a creature that lives in the data skyline and interacts with the user. An added sensor, a barcode scanner, is needed to allow for interaction with the skyline. When an item is scanned, the skyline will process the information and react to the input. Statistics on the health of the creature and previous user interactions will be shown. Besides that, the skyline will show (interactive) visualizations related to the topic. As a bonus, the two skylines of Deventer and Enschede could be coupled by a poll. Everyday there will be a question of the day. The user can then answer the question and see what other students, employees and passersby answered at either location. The questions will be multiple choice and do not have a set topic. A rough mock-up was made to visualize the idea.

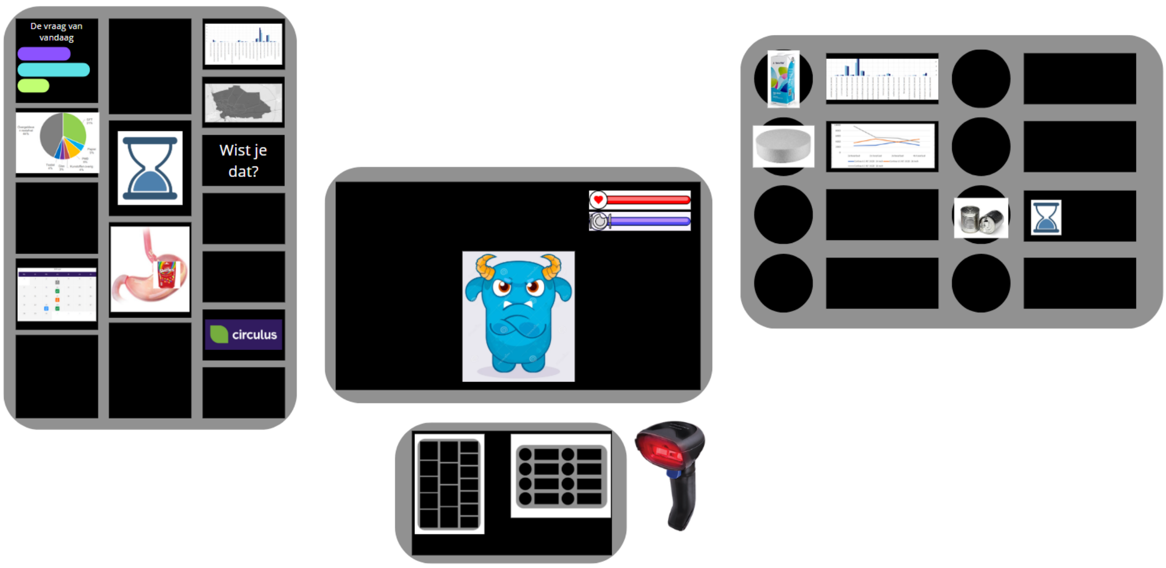

Figure 3: The rough mock-up of completed idea.

3.4.1 Situational sketch

Frank is a student at Saxion Hogeschool. He attends physical classes four days a week. While going to class and during his breaks, he often walks past the data skyline that is located in the entrance hall of Saxion's Epy Drost building. A few months ago, the skyline updated. Since then, there is a mode that has a little creature living in it. The creature likes to have Frank scan the packages of the food he has brought. Today, Frank has a pack of Skittles and a bottle of Fanta in his backpack. He scans the pack of skittles and sees that the packaging is supposed to go into the plastic waste bin. He also sees that the little creature eats his virtualized packaging. On one of the screens next to the creature, its stomach is shown. The skittles that Frank just scanned are shown on top of all the other waste that was scanned today. Next, Frank scans the Fanta with the built-in barcode scanner. The skyline shows that the bottle should be turned in at a store that takes “statiegeld” bottles. The little creature also eats this virtualized item and gets it in its stomach. Next to the creature, the rest of the screens are filled with visualizations of other data related to waste. Every time he visits the creature, he notices another visualization he has not paid attention to yet. It has become a routine to check on the little creature. Frank sometimes plays with him when he is a little early for class or when he and his friend are taking a walk between classes. Some days, when the question of the day appeals to him, Frank answers the question of the day and looks at what others answered.

3.4.2 Challenges

The chosen concept has a few challenges that have to be considered in the project. First the data will have to be visualized in an understandable and interactive manner. This will have to be examined with the use of user testing. That brings a second challenge, creating a user test that gives accurate and reliable results. Since the working prototype of the skyline will not be available early on in the project, user testing with paper prototypes or mock-ups is required.
A more hands-on challenge is the animation of the creature. Creating a two-dimensional animation of a self-designed creature is a quite ambitious goal for someone without animation or character design experience.
A public dataset that contains information on package material has not been found before the creation of this idea. However, such a dataset is vital for the project. Therefore, the dataset might have to be created manually with packaged food products that are commonly found on people. Furthermore, products that are not packaged in with barcodes also produce waste. This includes fruit or baked goods. Creating an interface similar to the supermarket interface where the user selects the item might be a solution. However, this might confuse the user if implemented poorly or be out of scope of the project.
It will also be challenging to create visualizations with live data. Not only the visualizations that are based on external data, but also the visualizations that are based on the data that is gathered by the skyline. The creature should be able to smoothly react to input without lagging due to data writing or retrieving.

3.4.3 Focus

Since the project is relatively big it might be wise to have a base plan and an ambitious plan. The creature and its interaction are central to the project. The creature should be designed and animated properly and the barcode scanner should work. The user testing that should prove the concept, the formative user testing, is also vital for the project. Some of the side visualizations should work with external live data. If the plan should be condensed, it would be acceptable for the visualizations not to be connected to each other in the background. It would also be acceptable if the skyline would not have products without barcodes in the system.

3.4.4 Functional and nonfunctional requirements

Table 2: The functional requirements for the project.

Functional Requirements	
Must	• The installation must allow for interactivity. • The installation must be able to facilitate a single user. • The installation must be able to be used whenever users want during the opening hours of the building. • The visualizations and elements of the installation must be related to the data. • The visualizations must be about the waste separation and collection of the city the skyline is in. • The system must react to live user input.
Should	• The installation should occupy the same area as it does now. • The installation should include ways to show historical data. • The system should operate with no maintenance.
Could	• The installation could facilitate multiple users simultaneously. • The installation could have other sturdy sensors and/or actuators. • The installation could have live data. • The installation could prevent tampering and misuse. • The visualizations could change regularly. • The system could use data that the user can directly influence.
Won't	• The installation will not require more than 15 minutes per use. • The visualizations will not contain more than two sentences each. • The system will not have large databases that slow down the system.

Table 3: The non-functional requirements for the project.

Non-Functional Requirements	
Must	• The installation must convey the intended message to the user. • The experience must be able to be repeated.
Should	• The interaction with the installation should be intuitive or easy to understand to the users. • The system should protect user privacy. • The installation should create one coherent experience. • The installation should be available to all users. • The visualizations should be related to the Sustainable Development Goals. • The information that the data communicates should be informative. • The information that the data communicates should be relevant to the users. • The visualizations should be understandable to the users. • The visualizations should have clear data encoding.
Could	• The installation could create contact between users. • The installation could serve as a conversation starter. • The installation could be impactful to the users. • The system could be open ended or allow continuation. • The experience could teach people and stimulate a change in behavior.
Won't	• The installation or its use will not cause or encourage harm to the users, physically or mentally. • The installation will not purposefully create a negative atmosphere. • The installation will not damage the image of Saxion. • The experience will not stimulate people to be wasteful. • The visualizations will not present unwanted reactions as wanted.

These functional and non-functional requirements were set up to guide the project to the intended outcome. The requirements of the project were discussed at length to bring them in line with the expectations of the client. With this set of functional and non-functional requirements, the idea that was constructed in the ideation phase could be revisited.

The requirements were also adjusted and sorted based on their feasibility within the timeframe and with the resources of the project. This was done with the help of the MoSCoW method[35]. The most important requirements received the label “must”, as the project would not succeed without these. Next, the requirements that are not vital to the project but do play a big role received the label “should”. The third category in the method is “could”. Requirements with this label have low priority and can be implemented within the ambitious plan of the project if time allows. The last category with the label “won’t” consists of requirements that are important to actively avoid during the project.

Lastly, the requirements underwent minor adjustments during the progression of the project. New insights arose during the other phases of the project that changed the plan and therefore the requirements slightly. These changes were ongoingly communicated with the client and the supervisor to keep the project on track.

3.4.5 Specific description

The crystallized idea after the rethinking comes down to the finished prototype being an interactive installation focusing on the waste collection and separation within the city it is located, Enschede. It will be added to the existing installation as a mode that can be selected on the touch screen. It will tie the physical world to the digital environment on the skyline by allowing users to scan the barcodes of their waste creating possessions. The skyline will then display a friendly creature that responds to the input and several visualizations that reflect on the collected data. The skyline will also give tips and (lesser known) facts on waste collection and separation which are intended to educate and entertain the user.

The hardware of the installation will mostly remain unchanged from the initial version. The four screens will be used for the new view. The hardware is extended by a handheld barcode scanner, which enables the scanning of products by the user. This scanner will send the data of the barcode to the system via a USB-port.

The software will undergo the most changes. More precisely, a whole new environment will be added to the skyline as a new mode. This will require a set of websites that can be run on the skyline and a database that can save and give access to the relevant data.

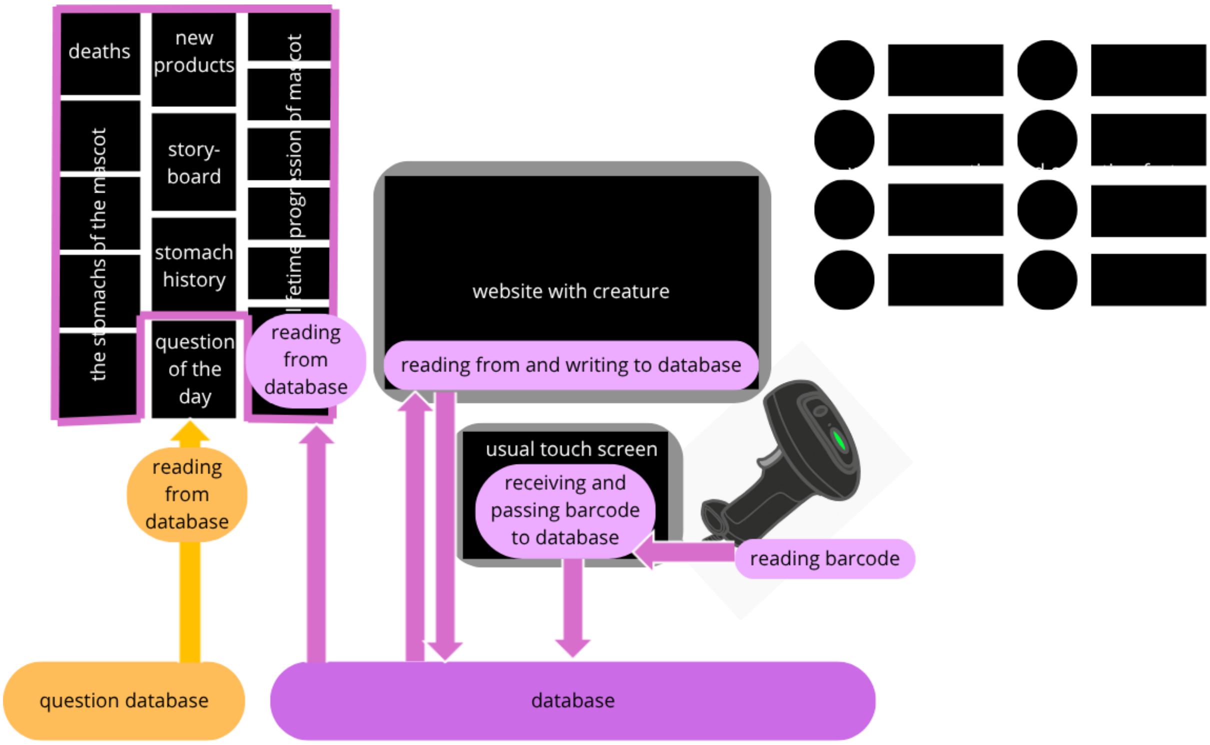

Figure 4: A visual representation of data communication and website positioning.

In the communication between the websites and the databases is visualized in figure 4. The user can use the scanner to scan their product which will send the data of the barcode to the website of the touch screen. This will then communicate the barcode to the database. The website of the creature will then act on the data and produce its own data for the database. The websites on the left screen can all fetch the data they need from the database.

The question of the day possesses its own database. This data is also visible on the "energy" mode and users can answer the question there too.

Chapter 4 – Realization

The project was developed during the realization phase. This included writing code, designing the creature, designing the database, and creating visualizations.

4.1 The creature

The creature is the centerpiece of the installation. It had to be designed, drawn, animated, and integrated into the system. The first step in this process was to decide on a design and animation software to use. OpenToonz[36], Adobe Animation [37] and Blender [38] were three good contenders after a bit of exploration. They are all capable of supporting the design and animation process. OpenToonz is a free software that has a lot of tutorials and is easy to use for beginners. Adobe Animation requires a paid license and is not as straightforward as OpenToonz. However, there is some experience with Adobe Illustrator in the skillset of the student which might compensate for the complexity of Adobe Animation. Nevertheless, the student that implements the project has much more experience with Blender in its 3D environment through Creative Technology. This resulted in the free Blender software being chosen for creating the creature. Even though the 2D environment works significantly differently than the 3D environment and Blender is not easy for beginners, it seemed to be the best option for the project.

4.1.1 Design

After choosing the design software, the creature had to be designed. The creature should be considered cute and likable to the users [39]. It also had to be not too complex, since there was no experience in 2D designing and animating. In order to achieve this, the creature was given a round body without a clear head shape and a humanlike eye. The creature was given a pair of legs but no arms since it does not have a clear use for them. The creature should not resemble a living creature. Therefore, the color of the creature could not be neutral like white, brown, beige, orange, gray, or black. Red seemed too aggressive, while pink and blue seemed to gender the creature. Yellow was excluded, since it would require a lot of detailing for it to look well rounded. The last two options were a shade of green or a shade of purple. Green was quickly crossed out since it made the creature look too much like another copyrighted character. This left purple, which was also a fitting color for the waste theme, since the main colors for the waste theme are orange for plastic, green for organic, blue for paper, and gray for rest.

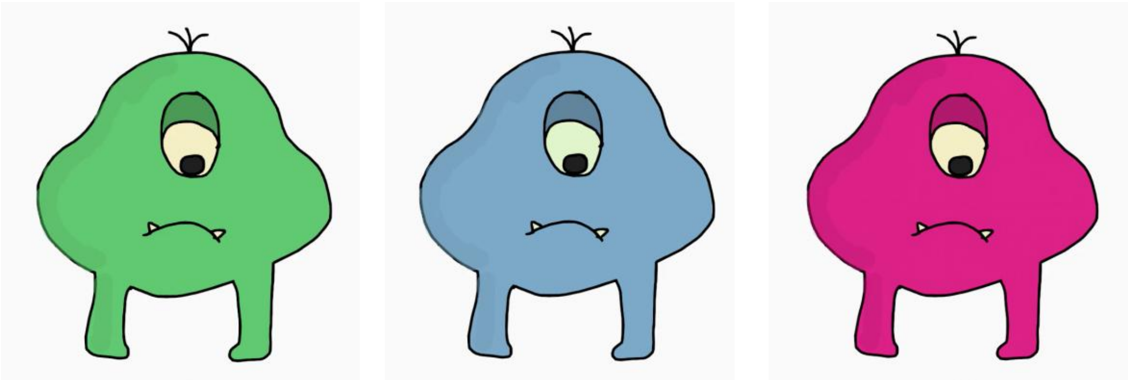

Figure 5: The first digital design in three different colors.

The first online drawings were done in an unstructured way since the software was quite new and undiscovered. The process included a lot of alternating between YouTube tutorials and trial and error. Eventually the process became easier since more features of the software were utilized properly. Features such as stabilizing the camera and removing the background were discoveries that made the effort a lot easier. The result of the design process was a lot smoother than the first iterations and can be seen in figure 5.

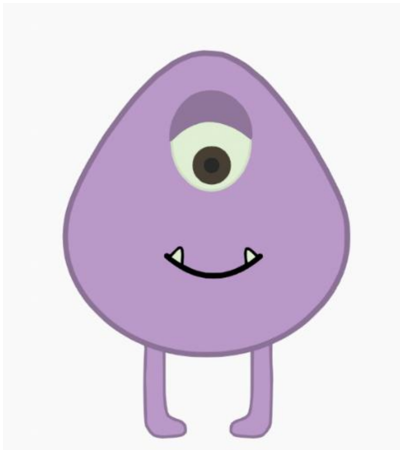

Figure 6: The finished design of the creature.

4.1.2 Animation

During the process of designing the creature, small tests were done to learn how to animate. Insights into a proper structure of the file were made because of these little tests, making the transition from designing to animating smoother. The first few animations were simple like the creature looking to left and right (see appendix B).

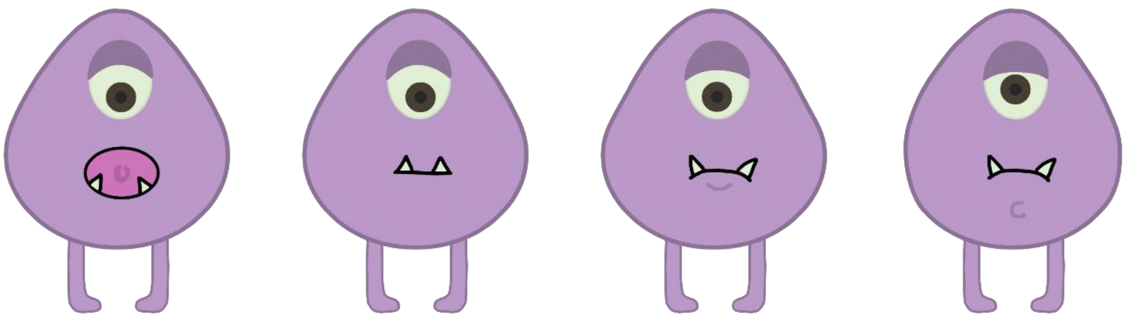

Figure 7: Four frames of the creature eating.

The most important animations were done early on. This included the eating animation and a happy wiggling animation (see figure 7 and appendix B). Since the animations should be smooth and make the creature seem real, it was important to start and end each animation with the same frame. By doing so, all animations could be played in any order and the creature would not glitch or jump between states.

Later, when it became clear that the creature needed more liveliness, it was animated to walk and to be hungry (see appendix B and figure 8). It also had to be able to show a starved creature and the arrival of a new creature (see appendix B).

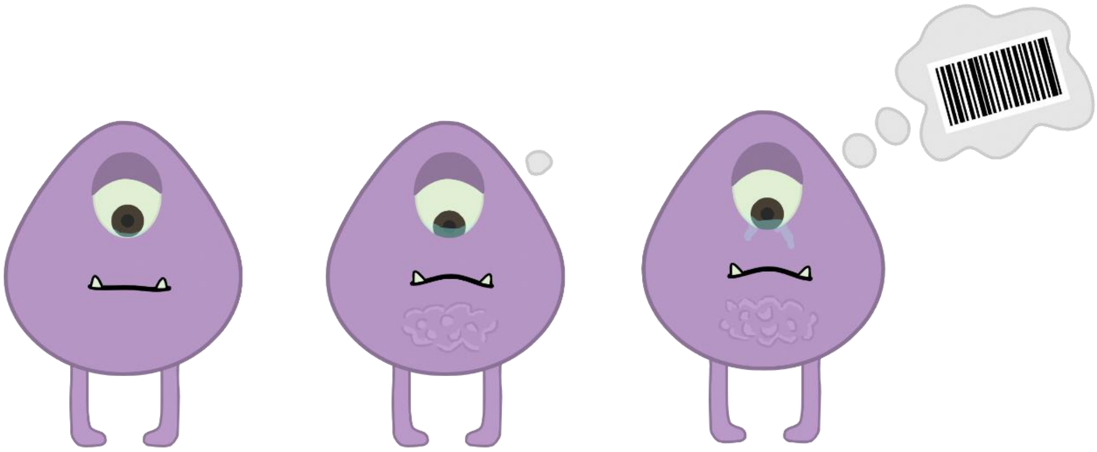

Figure 8: Three frames of the creature being hungry.

4.1.3 Integration with system

The middle screen was reserved for the creature. The creature needs to respond appropriately to the input of the user. Since the input of the user is collected at another screen, the creature listens to the database for updates from the user. The creature has statistics like lifetime and hunger, which it updates and bases its reactions on. When the creature is not interacted with, it will randomly choose a neutral animation to play to catch the attention of people. The creature is displayed on the screen with a hunger bar and a food bowl. Above the food bowl, a shredder shreds the logo of the kind of waste that the user has scanned. In figure 9, a screenshot can be seen right after a plastic cookie wrapper was scanned. The hunger bar of the creature decreases over time during the opening hours of the building it is located in (Epy Drost).

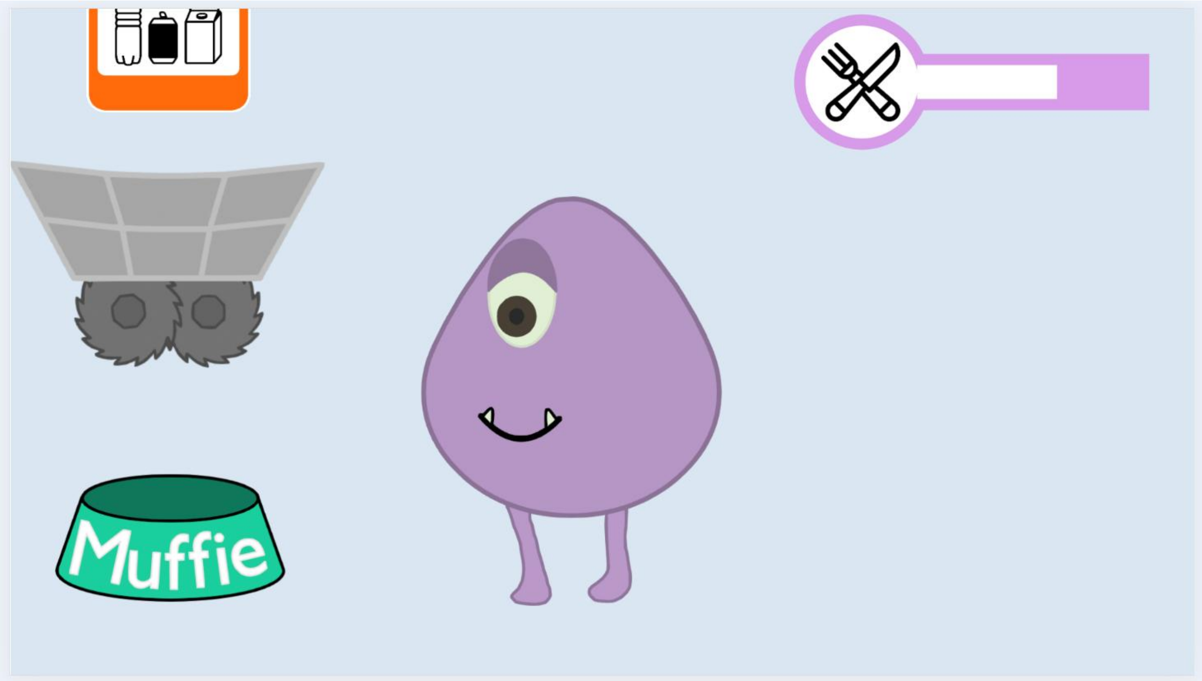

Figure 9: The creature walking to its bowl with the plastic logo about to be shredded.

The website is a simple HTML file that runs a JavaScript code that creates a canvas. This canvas was chosen as the method of displaying the animations since has a few built-in methods that make adding and manipulating images and shapes easier. Another option for the website was a game-engine like Phaser [40], which is specifically made for games. However, since the creature is basically just a few images being manipulated and changed on some numerical input, a canvas was suitable enough in this case.

4.2 The database

The main database of the project is responsible for providing the data to the visualisations and to the creature. It also serves as a storage for the statistics of the creature, so that it does not reset every time the mode is changed.

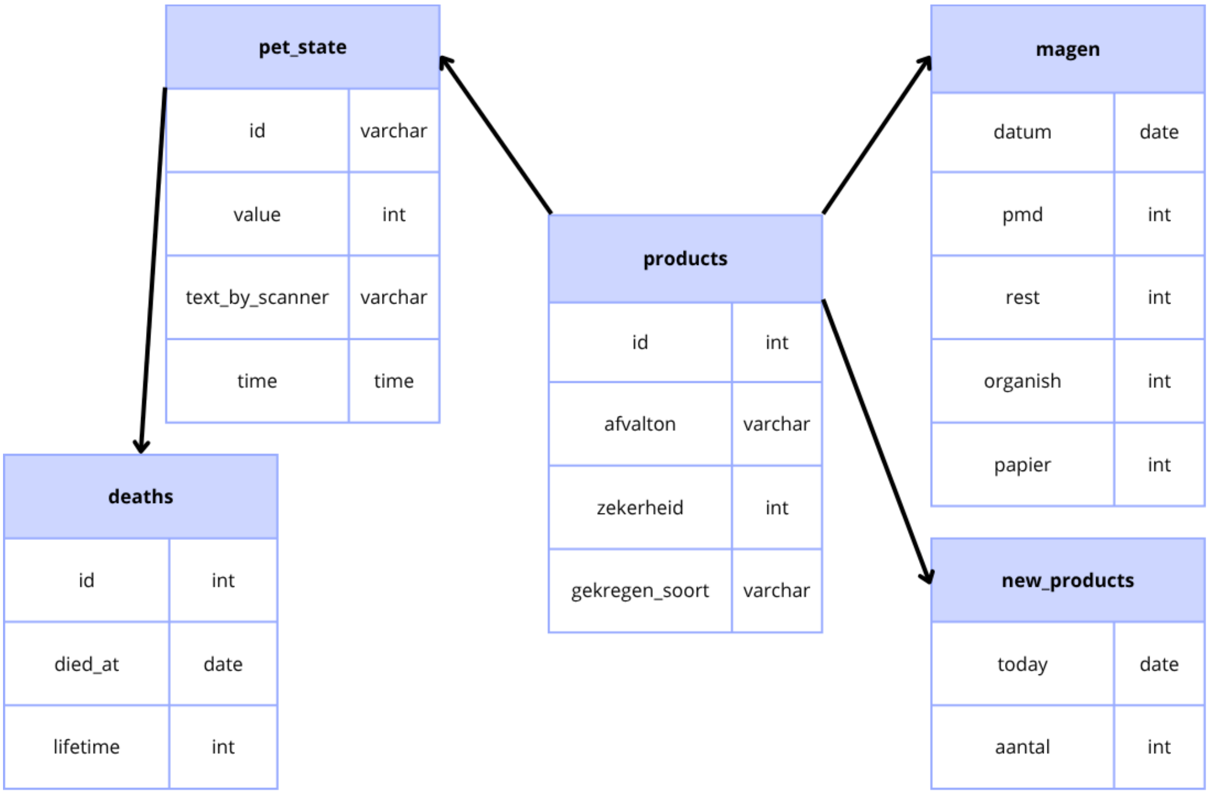

Figure 10: The snowflake schema of the main database.

The products table consists of products that are sold near Saxion in Enschede. It is the facts table of the database. At first, online databases were researched and tried. A lot of databases with barcodes did not contain data on waste. The one that did occasionally contain data on waste was not structured very well due to it being open source. This database was from Open Food Facts [41] and was quite big. Attempts at filtering the data to make smaller database were futile as most items were wrongly or insufficiently labelled. For this database to be near complete, it would take up a lot of storage and therefore a lot of fetching time. That is why the choice was made to create a new database with products found at Saxion. All products that were in the Spar at Saxion and at the cafeteria were scanned and added to the products table that is used now. This was done by hand since databases were not affordable or available. Therefore, this table has more reliable and accurate data, however it is nowhere near encompassing every product that students, employees, or passersby could carry with them.

To solve the issue of the database being incomplete, it had to be able to update. However, the data should keep its reliability. Two columns were added to the table zekerheid (certainty level) and gekregen_soort (received kind). If the certainty level is above 5, the type of afvalton is certain and not questioned. However, if the certainty level is under this value, the creature will ask the user in which bin it should go. The user can then scan the correct bin shown on the screen. If the scanned type is the same as the received kind, the certainty level gains an increment. However, if the two types differ, the certainty is set to 0. This means that it will take multiple of the same answers in a row before the database assumes that the type is correct.

When an entirely new product is scanned, it is added to the products table with zekerheid set to 0. In this case, the first dimension table of products, the table of new_products, will also increase the value of the date of today. This value can then be read by the appropriate screen that visualises it.

When it is known what type the product is, the second dimension table, magen, gets updated. There are four values that afvalton can take pmd, papier, organisch, and rest. The value corresponding with the correct type gets updated when the type is known. These values can then be read by the appropriate screens that visualize them.

The table of pet_state is the third dimension table. It is used for the value like hunger and lifetime and for saving the scanned barcode so that the creature can reach it. It is therefore very small and not used like a normal database table. It has the subdimension table of deaths. The table of deaths keep track of the moment of death and the lifetime of dead creatures. When the hunger of the creature drops to 0, it dies. The current lifetime gets transferred to the database of deaths and the date of the death gets added too. This can then be read by the appropriate screen that visualizes it.

4.3 The question of the day

The question of the day is mainly located on the other view of the skyline. Its purpose is to raise interest in the data skyline in its entirety. It shows a new question every day about various topics. The topics can be among others about the topics of the skyline, pop culture, the environment, language, personal habits or weather. All the questions are multiple choice that can be answered on the energy mode. In the waste collection and separation mode the question and the shuffled bar graphs of the answers can be seen (see figure 11). This is done to raise curiosity in the user about what the answers could be.

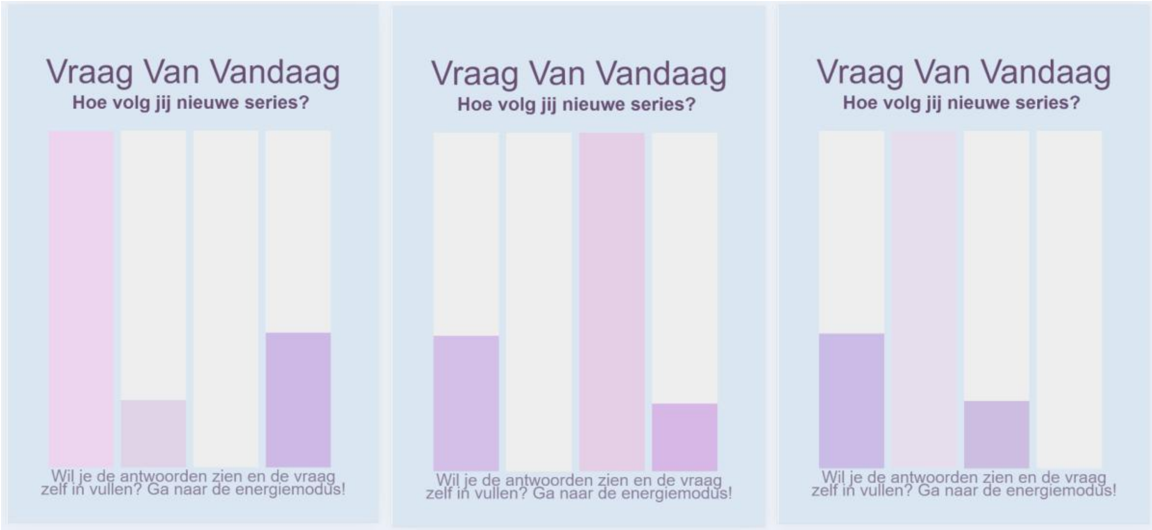

Figure 11: The screen of the question of the day in an interval of ten seconds.

Since most of the question of the day is handled in the other view, it has its own database. Which is stuctured as seen in figure 12. In this database the qotd_answers table serves as the facts table. The questions, choices and conc_answers serve as the dimention tables.

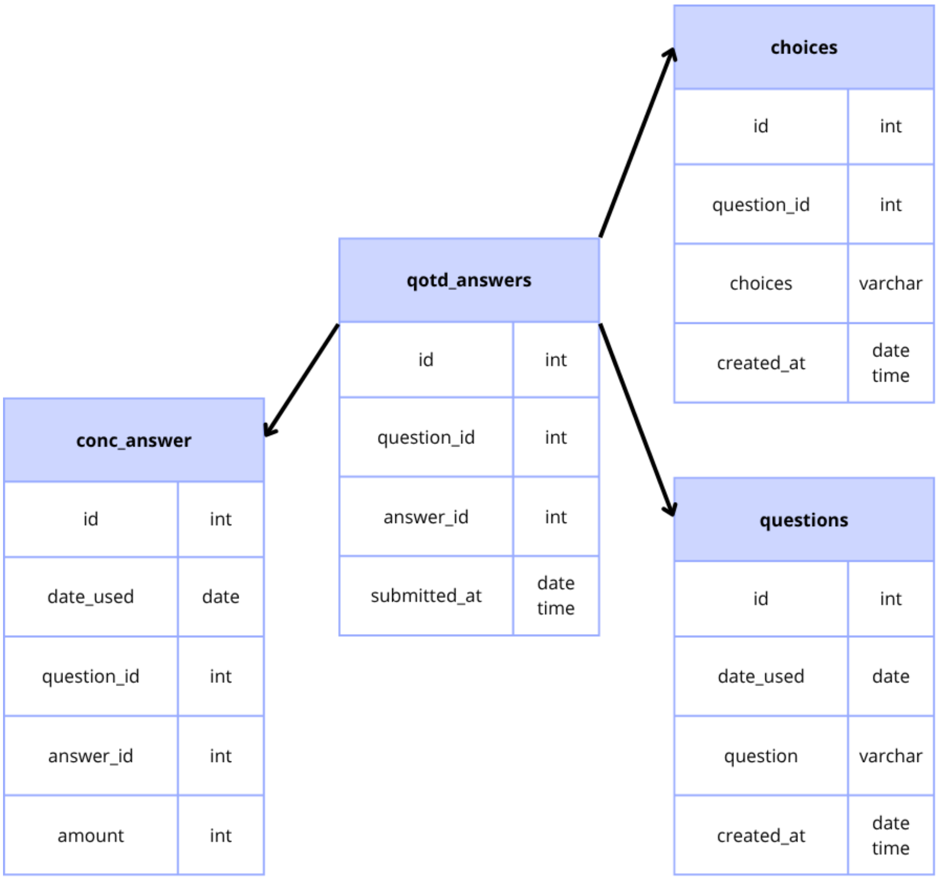

Figure 12: The screen of the question of the day database star schema.

4.4 Storyboard

Due to the scanner being overlooked in the first evaluations, it seemed necessary to highlight the scanner. Since people only focused on the screen, a logical conclusion is to dedicate one of the screens to a storyboard showing the use of the scanner. The screen that is chosen is on eye level for most people to highlight its importance to the installation and it is designed to be easily understood. It was peer tested and improved to be as clear as possible. A little animation was also added to the screen in order to increase the chance to catch the attention of the user. The stomach was animated to indicate the hunger of the creature. The product was animated to indicate the importance of the barcode. The scanning beam of the barcode scanner was animated to highlight the action of scanning. The uvula was animated to emphasize that the creature opened its mouth. The snapshots of the storyboard can be seen in figure 1 and appendix B.

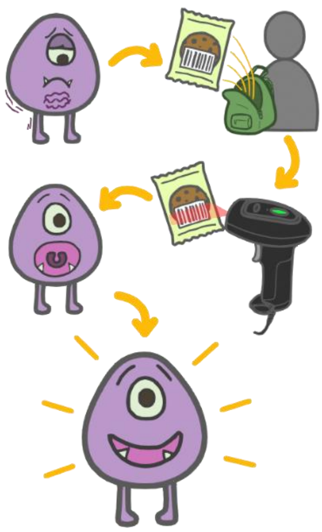

Figure 13: An important frame of the storyboard.

4.5 Data visualizations

The left screen of the installation shows several data visualizations. It has the four stomachs of the creature, the number of deaths, a bar graph of what the creature ate last week, and the number of new products the creature has eaten today.

4.5.1 The stomachs

The stomachs show an intuitive visualization of the number of items that the creature has eaten. It automatically updates when the creature eats. The creature has four stomachs, one for each kind of waste. Every day the stomachs reset at midnight. The stomachs can be seen in figure 14. As seen in this figure, the organic stomach is empty. It will probably often present itself like this since many organic items do not have their own barcodes. This is also mentioned as a disclaimer under the organic stomach on the data skyline.

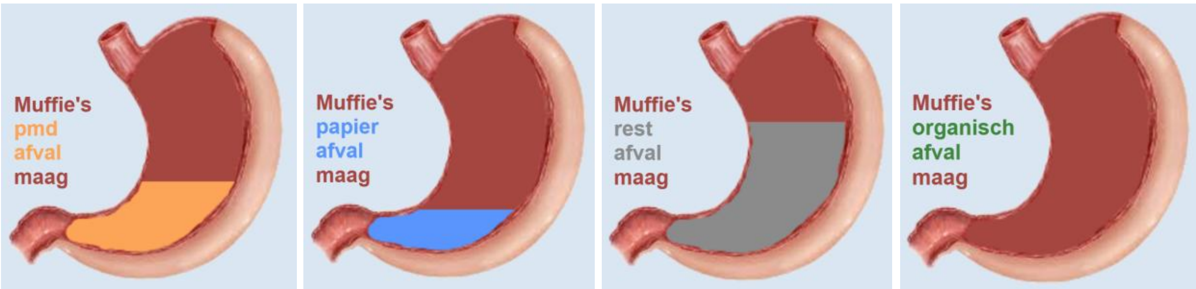

Figure 14: the four screens of the four stomachs.

4.5.2 The deaths

The deaths screen shows the tombstones of the creatures that died in the last week. It is designed to give a shock to the users and make them want to take care of the creature that is alive now. During the first user evaluation, the screen was received with many emotions. Therefore, the screen is kept as a controversial conversation starter. On the screen the tombstones are accompanied by the date they died and their lifetime (see figure 15). The creatures are programmed to be unable to die on the weekend.

Figure 15: The screen of the deaths.

4.5.3 Scanned items last week

The screen that shows the historic stomach data was added to visualize the changing amounts of waste throughout the week. It can also be linked to the deaths if there are days on which less waste is scanned. Here the recurring color theme is also used.

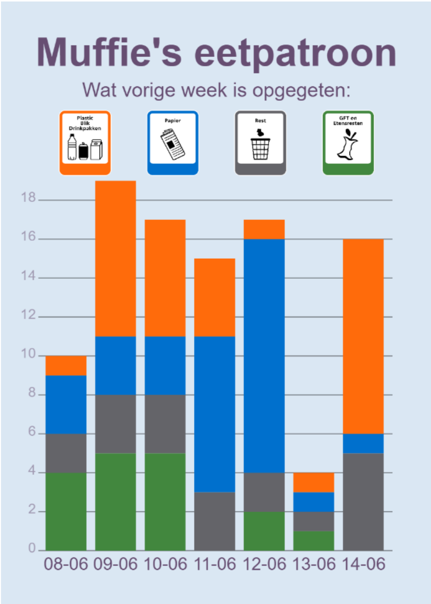

Figure 16: The screen of the historic stomach data.

4.5.4 New products

The new products screen shows how many new products have been scanned today. The thought behind this was to provide an incentive to scan products. It shows how many new products were scanned today, yesterday, and on the day most products were found. The dot of today can pass the high-score, when that happens the new high-score will be set and used the following days.

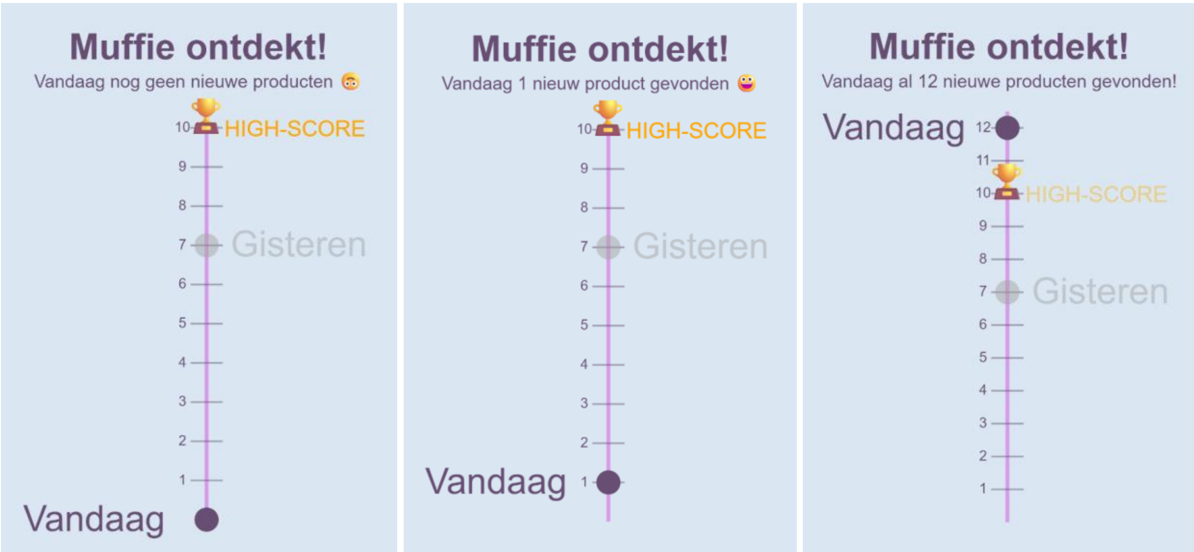

Figure 17: The screen of the new products with different data for today.

4.6 Facts on waste separation

The right screen of the installation is reserved for waste separation and collection facts. The facts were collected with the intent to entertain and inform the user. They are focused on the waste collector of Enschede, Twente Milieu [42]. The color coding scheme is also used here and the logos of the Dutch government [43] are used. The screen has 18 facts to display and cycles through them. The cycling happens randomly so the same fact is never on the screen twice. In figure 18 and 19 it can be seen that there are multiple facts. In the two figures a few facts are visible at both instances in the same or different places.

Figure 18: The right screen of the installation showing waste separation facts.

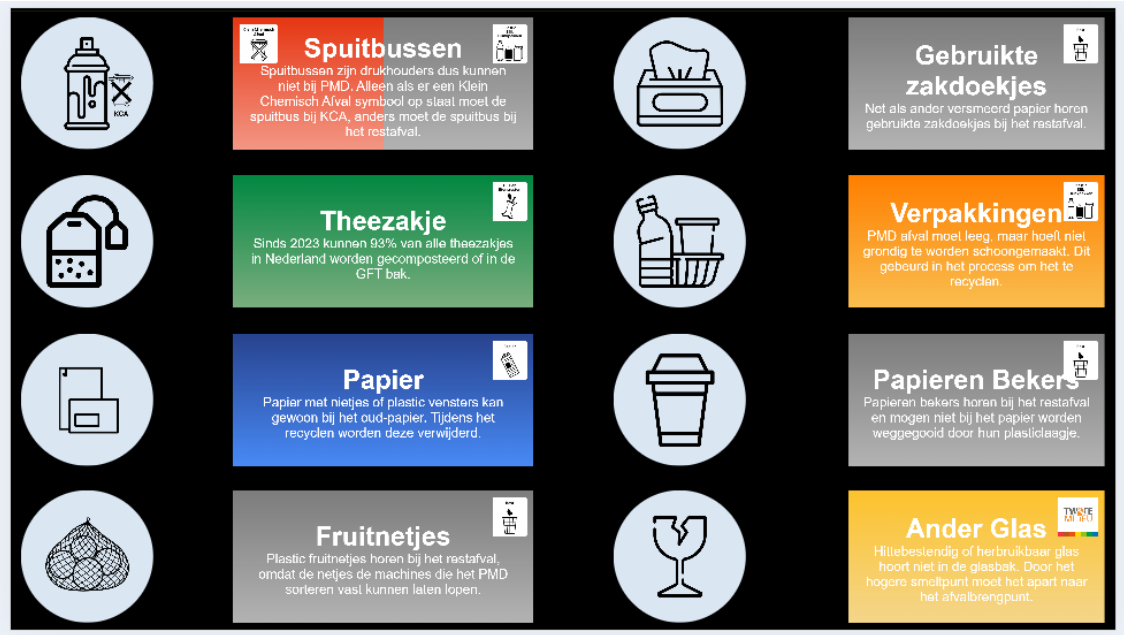

Figure 19: The right screen of the installation at a later moment.

4.7 Waste bins next to the installation

As mentioned, the installation did not change drastically. Two changes were made. The first being the barcode scanner being added to the side of the touch screen. The second change is the addition of the four waste bins (see figure 20). This choice was made to give the students an opportunity to act on the information that is received during the experience. Only the paper bin will be collected separately in the foreseeable future. However, it might give a nudge to policy makers to speed up the process to separate waste at Saxion.

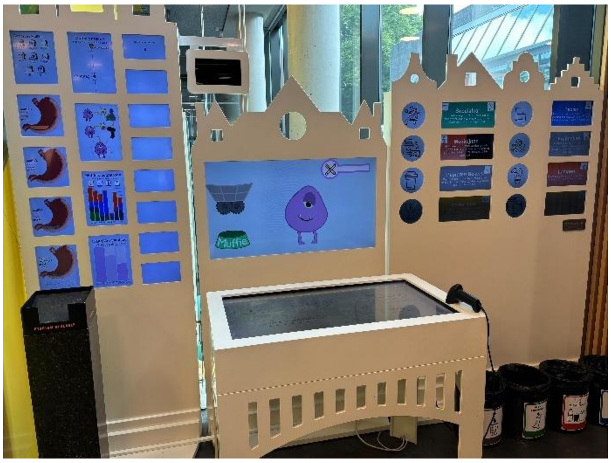

Figure 20: A photo of the data skyline with the waste view.

Chapter 5 – User evaluations

5.1 Formative evaluations

Two evaluation phases were executed. The first evaluation phase served the purpose of steering the project in the right direction. Therefore, the first specification and realization phase were rushed to have a prototype to test the idea rather than the prototype itself. The results of this evaluation have been included in the second phase of the ideation, specification, and realization.

5.1.1 Setup

Since the first evaluation was early in the project, the first prototype to be evaluated was a mid-fidelity prototype. The prototype consisted of a setup similar to the real skyline. The setup was located in a quiet office in the same building as the skyline. The screens of the skyline were simulated with two external screens, one laptop screen and one iPad screen. The system showed the original setup when the evaluation started. Only the extra buttons for the two extra views differed from the skyline downstairs. Participants were asked to attend individually, so their actions and reactions to the prototype could be effectively monitored.

Figure 21: A photo of the setup during the first evaluation phase.

5.1.2 Participants

There were sixteen potential users that participated in the first phase evaluations. Of those participants nine identified as male and five as female, two participants did not wish to share this information. Eleven participants were students, of which eight currently attend Saxion. Five participants were researchers/teachers.

5.1.3 Procedure

The prototype was adapted after the first half of participants to enhance the results wielded from the evaluation. The procedure of the evaluation remained the same.

The participant was welcomed and subjected to an introduction. After the introduction the consent form was explained and offered next to the information brochure. After that, the evaluation could start. The participant was instructed to intuitively interact with the installation and try to think out loud. Observations were written down by one of the researchers. During the evaluation the other researcher guided the participant if they asked for help. After the participant felt they were done, they were asked questions about the installation. Lastly, they were asked to fill in some demographic questions. The questions on the installation and demographics can be found in appendix C.

5.1.4 Results

The observations and the answers to the questions were analyzed to come to the following points of improvement.

Midway adjustments

A few issues with the installation were found during evaluation with the first eight participants that were adapted for the second eight. Five of these changes were implemented. The first significant change was the naming of the creature. The first eight participants were not empathizing with the creature, so for the next evaluations the creature had its name, “Muffie”, placed in the upper right corner of the screen. This also brought forth the second change. The name of the creature was added to the visualizations on the left-hand screen, since not enough of the first eight users see the correlation between the information of the creature on the left-hand side screen and the creature.

The third change added the labels of the different waste categories to the facts on waste. In that way not only the color would indicate the type of waste, and the color code might become clearer.

The other two changes pertained to the question of the day. The question of the day was different for the second part of the group due to them participating on the second day. The last change was an alteration to the little flap of the question of the day. The first version (see figure 22) was not intuitive to use. Most users did not lift the flap without being instructed to. The improved version includes a handle that makes the affordance of the flap more apparent to the user.

Figure 22: The original flap for the answers (left) and the improved flap (right).

Final adjustments

Many points of attention were highlighted after the first phase of evaluations. The first issue that almost every participant ran into was the ambiguity around the barcode scanner. Many participants did not notice the scanner or know what to do with it. The storyboard was developed to tackle this issue.

The four different kinds of waste were also not very clear in the first iteration. The second iteration created a bit more understanding. For further development more screens shall be using the color scheme and there will be bins with the same colors next to the installation.

The users enjoyed the facts about waste separation. Some people already knew a few of the facts and seemed proud of themselves. More facts are added to the screen to make the facts less static and keep them interesting.

Another note was that the creature was a bit static. A few participants expressed the wish for more interaction with the creature. Due to time constraints this was not implemented. However, some participants also wanted the creature to show more movement. More animations were added to give the creature a lifelike appearance.

The question of the day was not interesting enough for many participants. People expressed their desire for questions that were less professional and more provocative. Next to that, it was observed that the answers were difficult to locate.

5.2 Summative evaluations

The second evaluation phase focused on testing the usability of the prototype and checking whether the goal of the project was reached. The results of this evaluation were part of the foundation of the future works chapter.

5.2.1 Setup

The real data skyline was used for the second evaluation. The system showed the original setup when the evaluation started. Only the extra buttons were added to the touch screen. Participants were asked to attend in groups of twos and threes, so the evaluation would be close to a normal use scenario.

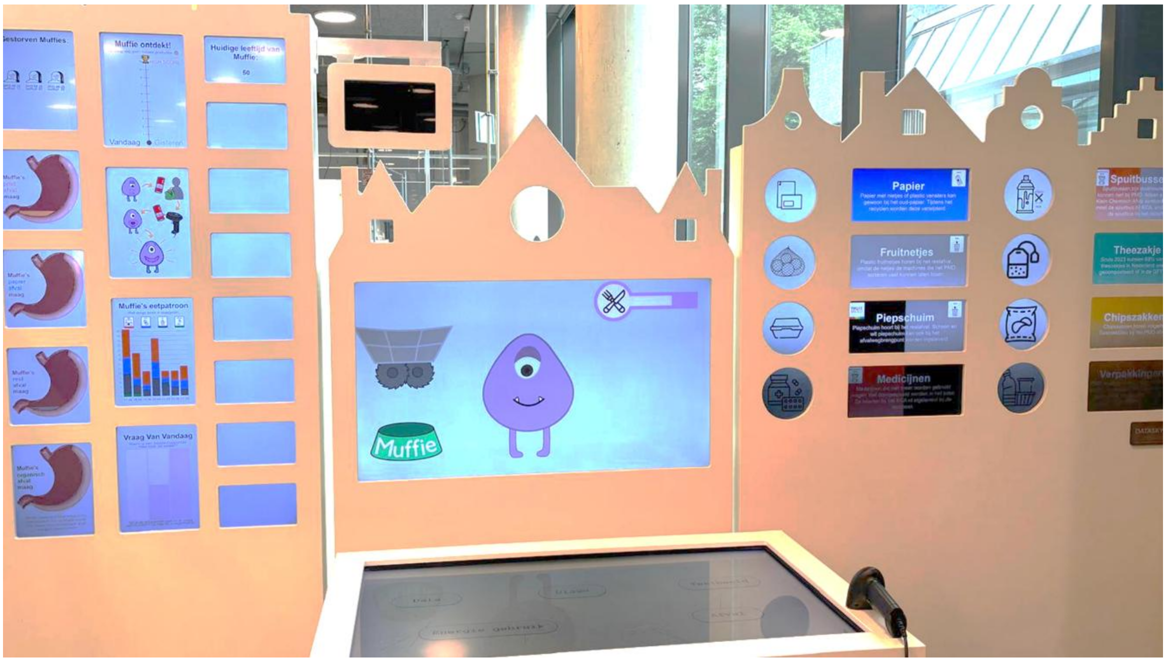

Figure 23: A photo of the setup during the second evaluation phase.

5.2.2 Participants

Twenty people attended the second evaluation phase. Ten of these participants identified as male and the other ten identified as female. Of these people sixteen were students of which eight currently attend Saxion. Three participants were researchers/teachers, the last participant was the partner of one of these researchers.

There were four pairs, three trios and three individuals that participated in the second evaluation phase. All groups consisted of people that had personal or professional relationships, ensuring they were familiar with one another and not strangers.

5.2.3 Procedure

The participants were welcomed and subjected to an introduction. After the introduction the consent form was explained and offered next to the information brochure. After that, the evaluation could start. The participants were instructed to interact with the view that was named “afval”. They were also asked to think out loud. Observations were written down by one of the researchers. During the evaluation the other researcher was available for questions but remained distant. After the participants felt they were done, they were asked to each fill in questions about the installation. These questions included the System Usability Score questionnaire [44] that was translated to Dutch [45]. Lastly, they were asked to fill in some demographic questions. The questions on the installation and demographics can be found in appendix D.

5.2.4 Results

The second phase of evaluations brought forth many valuable insights. Since the evaluation tested multiple aspects, individual topics can be discussed.

Emotional engagement

Some participants showed a strong emotional response to the creature “Muffie”. Many described Muffie as cute and pitiful. Many people enjoyed telling Muffie what type of waste they had scanned and were proud when Muffie correctly identified waste. The high score feature also triggered competitive behavior in a few participants, motivating them to find and scan more items.
A few students compared Muffie to “Pou” [46], a virtual pet game that lets the user take care of a rounded triangle shaped being. This comparison heightened the connection between the participant and Muffie.

Creature liveliness

The improved animations made the creature appear livelier and caused participants to see it more as a pet. However, there were some confusions on the ageing of Muffie. People thought that the age was expressed in years and that Muffie was therefore very old. Many participants expected to be able to see the creature growing or ageing. Adding to that, a few participants mentioned that Muffie should deteriorate as the hunger bar gets smaller to show its hunger.

Clarity of the visualizations

The visualizations were understood by most of the participants. People understood that the deaths of Muffie would increase if the creature were to die. Some people even compared the deaths to the data of Muffie's intake this week.
It was understood by all groups that the stomachs of Muffie showed the number of products that Muffie had eaten that day. The color coding for the different types of waste was also clear to all participants. The visualization on new products scanned, was also understood by most participants.
Not everyone noticed that the stomachs were showing live data and were therefore changing when items were scanned. The difference one item made was not noticeable enough.

The storyboard

Some people noticed the barcode scanner before the storyboard. A few of those people knew immediately what to do with the barcode scanner. The rest, except two participants, understood the function of the barcode scanner after seeing the storyboard. The two participants that did not understand were the oldest participants and older than fifty.

The facts

The waste facts were generally well received. Some participants found the changing of the facts distracting. However, the changing of the facts also grabbed attention and caused engagement. Slowing the change rate slightly might be beneficial. The number of facts kept the attention of the participants longer than during the last evaluation phase. A lot of participants were captivated by the facts for longer than two minutes. Many people mentioned that they learned new facts, which means they served their purpose. However, it would be beneficial if the facts were changed periodically since the facts will not show anything new to the users at next visits.

Repeatability

Out of the participants, twelve stated they would return to the skyline, specifically for the waste view. Five said they would return only if they happened to be nearby for other reasons. Three people stated they would not return; one reasoned they do not carry items with barcodes while the other two gave no reason.
In response to the question of the day, twelve people said they would come back for it. Six participants would return if they were already in the area. Lastly, two would not return, one mentioning a lack of time.
It is important to note that the participants that did not want to return for the creature, did want to return for the question, and vice versa. This suggests that the combination of the creature and the question of the day broadens the appeal to the skyline.

System Usability Score

The average System Usability Score (SUS) [44] was 76, indicating a generally positive usability. The average SUS score found in a multidisciplinary study was 69 [47], meaning that the system has a significantly higher than average usability score. Only one participant scored under 55. This score came from the participant that was aged older than sixty. This person did not understand the technology nor the purpose of the installation. Figure 24 shows the boxplot of the SUS results.

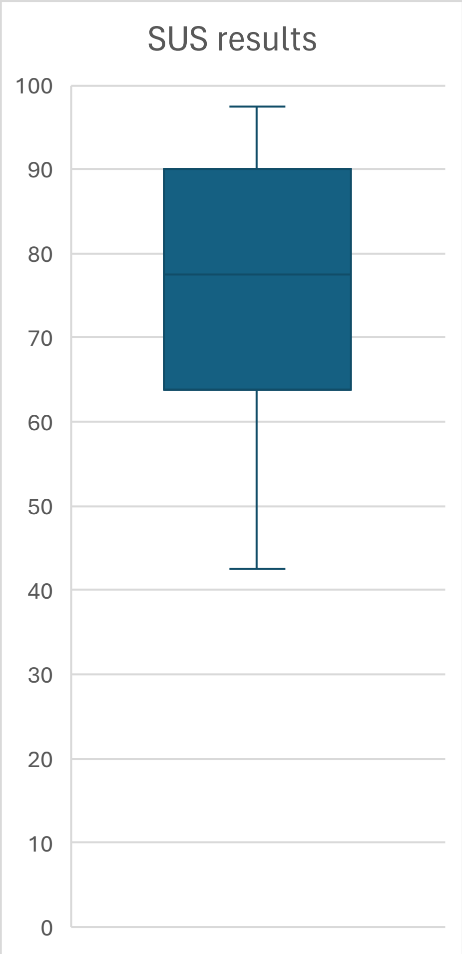

Figure 24: The calculated scores of the SUS questionnaire.

Chapter 6 – Discussion & Future Work

The view on waste separation and collection is designed to encourage users to repeated engagement with the installation. The implemented features successfully motivated users to return to the installation after their first use. However, it was not tested if they would return after their next interactions. So, it does not really test if it is repeatedly engaging rather than if the users would want to return after the first interaction. Long term usage was not measured.

There were some limitations present during the user evaluations. The sample of participants was not fully representative of the actual user base. Next to the students of Saxion, a few students from the University of Twente and from Hogeschool Viaa participated. These students do not typically come into contact with the skyline. Furthermore, many of the staff that participated were from the research groups Smart Cities and Ambient Intelligence. This may have created a bias due to their interest in the data skyline. Additionally, many people that were asked to participate in the study declined. The opinions and experiences of these types of people are therefore not included in the study, even though they are part of the target group.

Of course, the procedure of the user evaluation is not exactly representative of realistic use. People don't usually have whole bags of waste with barcodes with them. Next to that, they may have the motivation to interact without explicit instruction. Therefore, the observed behavior does not fully represent the natural behavior of users.

The data skyline looks almost identical to what it was before the addition of the waste view was made. Therefore, many people might not notice the update of the skyline and walk past the installation without giving it much thought. The skyline could benefit from some improvement that shows that other data is available. The creature could be displayed in one of the screens of the data view or the views could alternate when left idle for too long. The creature could also serve as a mascot for the building and be visible on multiple screens throughout it. The connection between the user and the installation might be strengthened if the creature acted as a mascot.

Furthermore, more animations and interactions could be added to make the creature livelier. The animations could show the aging of the creature so that the lifetime gets more tangible. The new interactions could be independent of waste. Then, the installation would also allow people to interact with the creature when they do not carry waste. This could also add to the connection between the user and the installation. An example of an interaction is that the question of the day could also be asked by the creature instead of being linked to the other view.

The lifetime was experienced as quite vague. Next to aging animations, another solution was developed. This solution involves upgrades when goals for the lifetime of the creature are reached, but it is only partially implemented. This solution should be finished and be tested to see if it adds to attracting users.

A substantial limitation of the view now is that the data might get outdated. The processes and ways that waste is separated and collected are constantly changing. Currently the installation has no way of compensating for that. The facts that are given are preprogrammed and the database has no algorithm that checks past entries on validity. Adding an automated system to validate or update information in the database would help maintain accuracy and relevance over time, however this was not realistic within the scope of the project.

There is also the technical limitation of cybersecurity. The current code was not developed with cyber security in mind due to limited experience. The databases are accessed with an unprotected key that can be easily found by anyone with the link of the website. This should be adapted to be more secure when the view is installed permanently.

Lastly, the new view has been designed for and proven effective at Saxion in Enschede. It works there and it could be adapted to work in different settings and locations. With more development and evaluation, it could serve as a repeatable, informative experience in other public or private settings. A version of the view could offer insights wherever waste is generated.

Chapter 7 – Conclusion

This research aimed to create an interactive experience with the data skyline that is repeatable for the users. Based on the user evaluation that was conducted, it can be concluded that this project reached its goal. It results in an interactive experience that users are interested in repeating.

The research questions were formulated as follows:
Research question: How can the visualizations of the data skyline be improved to make the skyline repeatedly engaging for students, employees and passersby of Saxion?
Sub-question 1: What data is relevant for all students, employees and passersby of Saxion?
Sub-question 2: How can data be visualized in a way that is attractive to students, employees and passersby of Saxion?
Sub-question 3: How can the data skyline engage students, employees and passersby of Saxion in a way that invites users to return to the skyline?

The client wished to use the skyline in a more engaging and meaningful way. The topic of waste separation and collection was chosen as it is important to the users. Many of the students, employees and passersby live close to Saxion, meaning that most of them come into contact with waste separation and collection in Enschede.

The used data relating to this topic consists of the barcodes of products and the waste bin that should be used to dispose of said product. This data has been collected from products sold by the shop and the cafeteria in Saxion

The creature was made to create a connection between user and installation and therefore engage users to return to the skyline. Next to this the question of the day was implemented into the skyline. Both of these implementations have effects on people that make them want to return, whether it is curiosity or the desire to care for the creature. The user evaluations showed that the majority of users would like to return to the installation, if they are in the area.

The applied methodology of this project resulted in an outcome that aligned the initial goals and expectations. The data skyline now has a new view available that aids in attracting users to the installation. This view can now be adapted to function in the Saxion building in Deventer. The view might play a bigger educational role when Saxion starts to separate waste.

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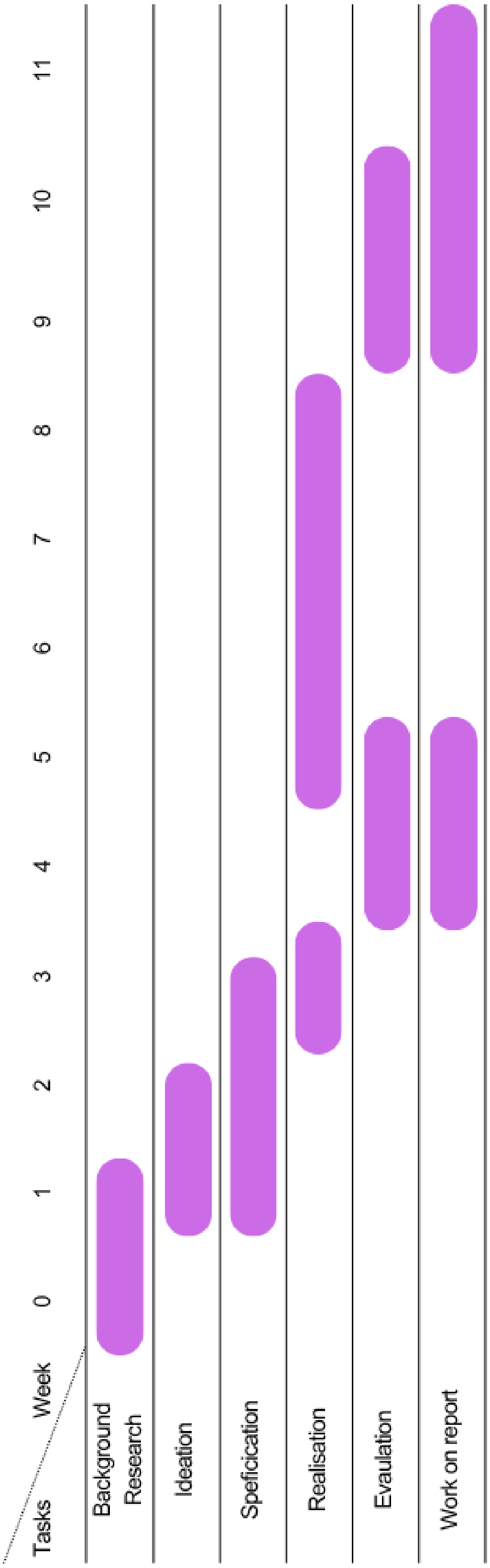
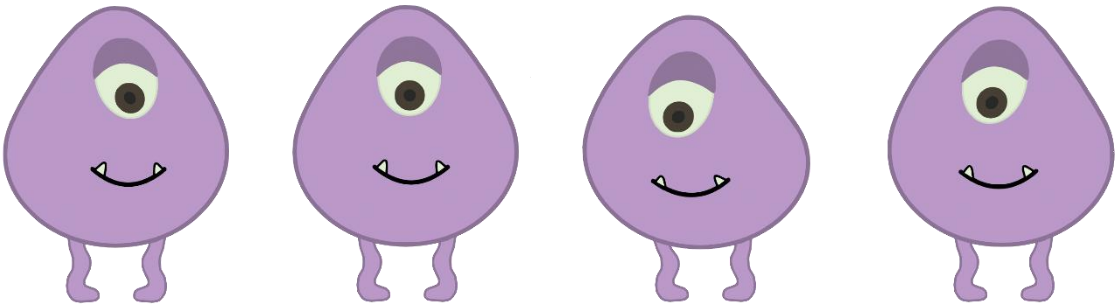
Appendix

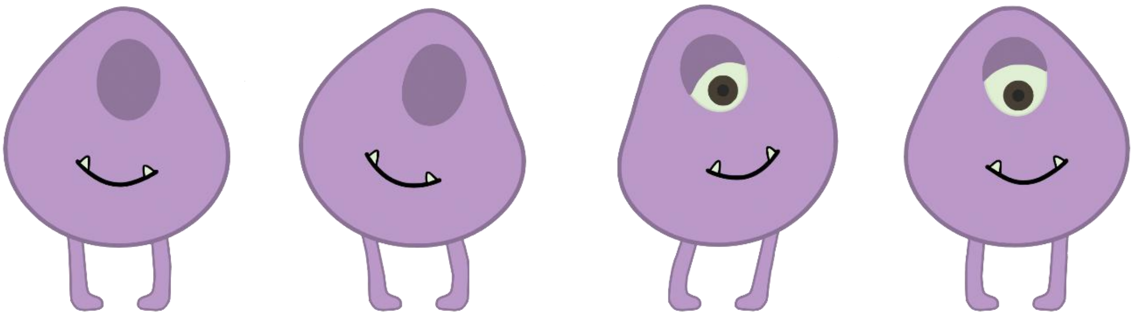
Appendix A: The rough timeline for module 12 after ideation and background research in module 11



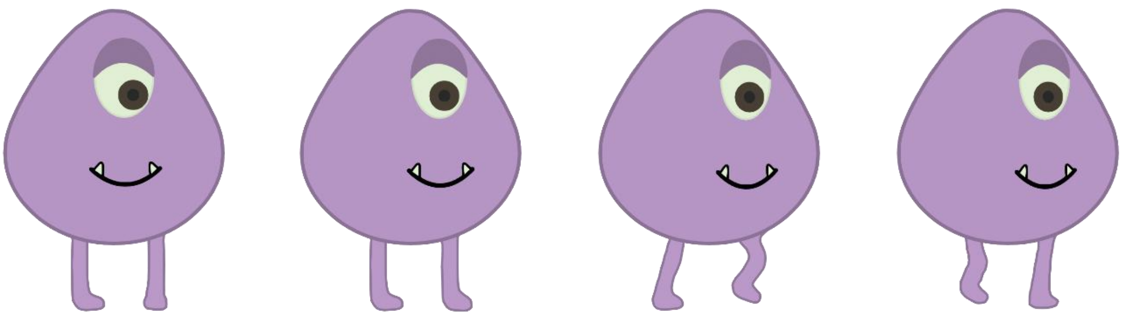
Appendix B: Snapshots of the animations



Four frames of the creature looking left and right.

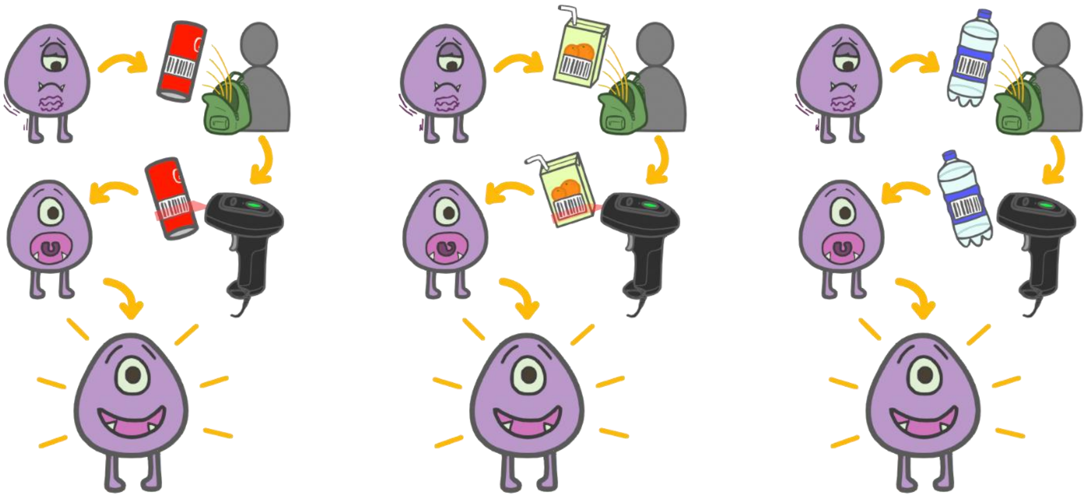


Four frames of the creature wiggling.



Four frames of the creature turning and walking right.

A frame of the dead creature and two frames of the new creature being delivered.



Three important frames of the storyboard.

Appendix C: Formative user evaluation questions

Vragen voor vraag van vandaag

Ben je benieuwd welke vraag morgen op de skyline komt?

- Ja
- Nee
- Een beetje

Plek voor uitleg

Jouw antwoord

(ja) Zou jij terugkomen om de vraag van morgen te bekijken?

- Ja
- Nee
- Misschien

Plek voor uitleg

Jouw antwoord

(nee) Wil je weten welke vraag morgen op de skyline komt?

- Ja
- Nee
- Een beetje

Plek voor uitleg

Jouw antwoord

Wij vragen je om nog een aantal vragen in te vullen.

Kies het standpunt dat het beste bij jou past: *

- ◯ Ik weet altijd hoe ik afval moet scheiden
- ◯ Ik kijk altijd op het label van het product dat ik weg wil gooien zodat ik weet hoe ik het moet scheiden, als het er niet staat dan gok ik
- ◯ Ik zoek vaak op hoe ik afval moet scheiden als ik het niet op de verpakking kan vinden
- ◯ Ik probeer te scheiden zoals ik denk dat het moet, als ik twijfel gok ik
- ◯ Ik scheid wat ik zeker weet, als ik twijfel is het restafval
- ◯ Ik gooi al mijn afval bij het restafval
- ◯ Anders: ______

Kan jij je inleven in het wezentje/schepsel? *

	1	2	3	4	5	
Helemaal niet	◯	◯	◯	◯	◯	Helemaal wel

Leg uit: *

Jouw antwoord

Geeft het wezentje/schepsel jou het gevoel dat je er vaker voor wil gaan zorgen? *

	1	2	3	4	5	
Helemaal niet	◯	◯	◯	◯	◯	Helemaal wel

Leg uit: *

Jouw antwoord

Vond je de weetjes over afval interessant? *

	1	2	3	4	5	
Nee, erg oninteressant	◯	◯	◯	◯	◯	Ja, erg interessant

Leg uit: *

Jouw antwoord

Wat vond leuk aan de data skyline/ het wezen? *

Jouw antwoord

Kun je vertellen wat je mist wat het wezen of de ervaring zou verbeteren? *

Jouw antwoord

Nu komen er wat algemene vragen over jou.

Ben je student, docent of ander personeel van Saxion? *

- ◯ Student
- ◯ Docent
- ◯ Ander personeel
- ◯ Anders: ______

Waar woon je? *

- ◯ Gemeente Enschede
- ◯ Gemeente Hengelo
- ◯ Gemeente Losser
- ◯ Gemeente Dinkelland
- ◯ Gemeente Haaksbergen
- ◯ Anders: ______

Waar kom je vandaag *

- ◯ Dezelfde gemeente als waar ik nu woon
- ◯ Een ander land
- ◯ Anders: ______

Heb jij de data skyline al gezien of gebruikt? *

- ◯ Ja, ik kijk er vaker naar en gebruik de informatie ook
- ◯ Ja, ik kijk er soms naar, bijvoorbeeld als ik even niks te doen heb
- ◯ Ja, ik heb het zien staan, ik het wel eens bekeken
- ◯ Ja, ik heb het zien staan, maar ik heb het nooit van dichtbij bekeken
- ◯ Nee, ik heb de skyline nog nooit gezien
- ◯ Anders: ______

Kun je een reden geven waarom dit zo is? *

Jouw antwoord

Appendix D: Summative user evaluation questions

Eindvragen afval modus

Vul deze vragen in, nadat je de afval modus hebt gebruikt.

Ik denk dat ik dit systeem vaak zou willen gebruiken. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik vond het systeem onnodig ingewikkeld. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik vond het systeem gemakkelijk te gebruiken. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik denk dat ik de hulp van een expert nodig heb om dit systeem te kunnen gebruiken. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik vond de verschillende functies van dit systeem goed geïntegreerd. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik denk dat er te veel tegenstrijdigheden in dit systeem zaten. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik kan me voorstellen dat de meeste mensen heel snel leren om dit systeem te gebruiken. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik vond het systeem heel lastig om te gebruiken. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik voelde me zelfverzekerd tijdens het gebruik van het systeem. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Ik moest veel dingen leren voordat ik met het systeem aan de slag kon gaan. *

	1	2	3	4	5	
Geheel mee oneens	○	○	○	○	○	Geheel mee eens

Eindvragen over de afval modus - 2

Kies het standpunt dat het beste bij jou past: *

- ◯ Ik weet altijd hoe ik afval moet scheiden
- ◯ Ik kijk altijd op het label van het product dat ik weg wil gooien, zodat ik weet hoe ik het moet scheiden, als het er niet staat dan gok ik
- ◯ Ik zoek vaak op hoe ik afval moet scheiden, als ik het niet op de verpakking kan vinden
- ◯ Ik probeer te scheiden zoals ik denk dat het moet, als ik twijfel gok ik
- ◯ Ik scheid wat ik zeker weet, als ik twijfel is het restafval
- ◯ Ik gooi al mijn afval bij het restafval
- ◯ Anders:

Kan jij je inleven in Muffie? *

	1	2	3	4	5	
Helemaal niet	◯	◯	◯	◯	◯	Helemaal wel

Leg uit: *

Jouw antwoord

Geeft Muffie jou het gevoel dat je er vaker voor wil gaan zorgen? *

	1	2	3	4	5	
Helemaal niet	◯	◯	◯	◯	◯	Helemaal wel

Leg uit: *

Jouw antwoord

Vond je de weetjes over afval interessant? *

	1	2	3	4	5	
Nee, erg oninteressant	◯	◯	◯	◯	◯	Ja, erg interessant

Leg uit: *

Jouw antwoord

Zou je terugkomen naar de dataskyline voor de afvalmodus? *

- ◯ Ja
- ◯ Misschien
- ◯ Nee

Leg uit: *

Jouw antwoord

Wat vond je leuk aan de afvalmodus? *

Jouw antwoord

Kun je vertellen wat je mist aan de afvalmodus of wat de ervaring zou verbeteren? *

Jouw antwoord

Tenslotte nog wat vragen over jou

Hoe identificeer jij jezelf? *

- ◯ Man
- ◯ Vrouw
- ◯ Zeg ik liever niet
- ◯ Anders:

Hoe oud ben je?

- ◯ 16-22
- ◯ 23-30
- ◯ 31-40
- ◯ 41-50
- ◯ 51-60
- ◯ 60+

Ben je student, docent of ander personeel van Saxion? *

- ◯ Student
- ◯ Docent
- ◯ Ander personeel
- ◯ Anders:

Waar woon je? *

- ◯ Gemeente Enschede
- ◯ Gemeente Hengelo
- ◯ Gemeente Losser
- ◯ Gemeente Dinkelland
- ◯ Gemeente Haaksbergen
- ◯ Anders:

Waar kom je vandaan? *

- ◯ Dezelfde gemeente als waar ik nu woon
- ◯ Een ander land
- ◯ Anders:

Heb jij de data skyline al gezien of gebruikt? *

- ◯ Ja, ik kijk er vaak naar en gebruik de informatie ook
- ◯ Ja, ik kijk er soms naar, bijvoorbeeld als ik even niks te doen heb
- ◯ Ja, ik heb het zien staan, ik het wel eens bekeken
- ◯ Ja, ik heb het zien staan, maar ik heb het nooit van dichtbij bekeken
- ◯ Nee, ik heb de skyline nog nooit gezien
- ◯ Anders:

Kun je een reden geven waarom dit zo is? *

Jouw antwoord