Interactive feedback in museums

Creative Technology, University of Twente

Graduation project Bachelor thesis

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Abstract

Museums in the Netherlands are experiencing increased expenses and a decline in visitor numbers. To address these challenges, it is crucial for museums to understand how visitors experience their exhibits. However, existing feedback collection methods often fall short in measuring diverse visitor experiences. This research seeks to address this issue by introducing an innovative and interactive approach at museum Oyfo, aimed at enhancing the quality of feedback. The proposed solution involves integrating an AI-based image generation feature within an interactive feedback collection system.

Drawing upon the principles of the Creative Technology Design process, this study explores the ideation, specification, realization, and evaluation phases. Through this design process a new method is developed that improves the quality of feedback by combining visitors' sketches depicting their favourite aspects of the museum with their responses to experience-related questions, the system generates unique images. These images are then assembled into a picture mosaic, providing a visual representation of the overall visitor experience.

Through evaluation, the effectiveness of the system in motivating visitors to provide feedback is confirmed. Additionally, areas for improvement are identified and discussed. This research serves as an initial step towards the development of user-centric museum experiences, aiming to provide museums with valuable insights to enhance visitor satisfaction and engagement.

Acknowledgements

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1. Introduction

1.1 Introduction

Museums worldwide are facing a challenging environment with rising costs and decreasing visitor numbers. According to the Dutch museum institution called the "Museumvereniging" [1], museums in the Netherlands have experienced a significant decline in visitors over the past few years. This trend is concerning because museums rely on visitor revenue to remain financially sustainable. To address this issue, museums need to focus on improving the visitor experience. Research has shown that visitors' museum experiences can be influenced by various factors, including sociocultural, cognitive, psychological, and environmental conditions [2]. To remain competitive and attract visitors, museums must offer an experience that satisfies their visitors. Johnston and Kong [3] argue that improving the visitor experience can have several benefits for museums, such as increasing visitor satisfaction and loyalty, building trust and emotional connections, and gaining a competitive advantage.

Obtaining insight into how visitors experience a museum can be beneficial. This insight allows museums to analyse factors that either disappoint or please visitors. Determining these crucial factors supports museums in making informed decisions about improvements. After implementing these improvements, museums can benefit from updated insights into the effects of these changes. In summary, museums should gain an understanding of the visitor experience to make informed decisions about improvements and properly evaluate their effectiveness.

Despite the vital importance of the visitor experience, most commonly used feedback collection methods have inherent limitations. According to Saunders, Lewis and Thornhill [4], questionnaires conducted through the web, mobile, or SMS as self-report methods exhibit extremely low response rates, often below 10%. Nevertheless, they remain one of the most prevalent methods for obtaining feedback. Requesting visitors to dedicate additional time for providing feedback can be perceived as tedious or insignificant. Saunders, Lewis and Thornhill [4] further elaborate on this point by noting that non-respondents, who refuse to participate, may have various reasons for their unwillingness. These reasons may stem from holding strong opinions, either positive or negative, regarding their experience. Consequently, survey results can become skewed due to the specific groups of individuals who are willing to engage in self-reporting about their visit.

This research aims to design, test, and evaluate a new feedback collection method. The study will be conducted in collaboration with Techniekmuseum Oyfo [5], located in Hengelo. Oyfo is a technical museum that is aimed towards families with children, school classes, and adults interested in technical installations. Currently, Oyfo uses two methods to evaluate their visitor experience. The first method involves the use of "museum inspecteurs"

[6], translated from Dutch to museum inspectors. This initiative allows children under the age of 12 in the Netherlands to become museum inspectors, encouraging them to visit museums and provide ratings and evaluations of their experiences. The feedback collected is stored, and Museum.nl [6] ranks all the museums in the Netherlands based on the experiences they offer to children. A higher ranking on this list enhances a museum's visibility on websites that recommend museums. The second method involves voluntary reviews written on platforms like TripAdvisor. However, these reviews can also be subject to similar biases as mentioned before. Oyfo aims to expand its feedback collection scope and improve the quality of feedback.

To design, test, and evaluate a method that improves the quality of feedback provided by museum visitors with diverse backgrounds, four main factors need to be considered. The first factor is the level of visitor engagement. Visitors should have motivation beyond simply leaving feedback. They should derive additional benefits, such as experiencing fun and engaging elements that serve as incentives for providing feedback. The second factor is integration. Visitors should perceive the feedback collection method as an integral part of the exhibition, feeling compelled to complete the method to achieve a sense of fulfilment in their exhibition experience. In other words, it should feel like the final experience of the museum exhibition. The third factor involves the storage, processing, and presentation of the collected data. If the method successfully obtains higher quality feedback, the data should be made accessible to Oyfo. This accessibility ensures that the feedback becomes usable for the museum and enables the evaluation of visitors' experiences. The fourth and final main factor pertains to the evaluation of the method's effectiveness. To gain a proper understanding of whether this solution enhances the quality of feedback at Oyfo, participants should be included in evaluating the validity of the feedback and assessing their willingness in providing it.

1.2 Research Questions (RQs)

To summarize the previous section of the introduction, the main research question is formalized, and in order to provide a more detailed answer to this main research question, several sub-research questions have been defined and formulated. This leads to the following main research question (Main-RQ):

Main-RQ: *In what manner can the quality of feedback be improved at museum Oyfo, given by visitors with diverse backgrounds?*

To answer this main-RQ, the following sub-research questions (sub-RQs) have been formulated:

Sub-RQ1: *How can the current questionnaire regarding the visitor experience be reformed into a more immersive method?*

Sub-RQ2: *How can the collection method be integrated into the currently offered experience at Oyfo?*

Sub-RQ3: *How can the collected feedback be made accessible for Oyfo?*

Sub-RQ4: *How do participants evaluate this mode of feedback?*

1.3 Structure of the report

The rest of this bachelor thesis report follows the following structure in order to obtain an answer to these above mentioned research questions:

Chapter 2: Background

This chapter will scope out the existing works regarding the research and this can be used to provide requirements and inspiration for this project.

Chapter 3: Methodology

This chapter will explain the different methods and techniques that will be used to obtain an answer to the research questions.

Chapter 4: Ideation

This chapter will analyse the stakeholders and their needs, it will then explain the different concepts that have been created to solve the research questions and it will select the most appropriate one.

Chapter 5: Specification

This chapter will define the specific details and requirements of the selected concept. The goal of this chapter is to provide a clear understanding of how the system should function and look.

Chapter 6: Realisation

This chapter will explain the realisation of the system, including the choices made and their justifications.

Chapter 7: Evaluation

This chapter will evaluate the effectiveness of the system, it will start with the test procedure and will finish with providing the results.

Chapter 8: Discussion & Future work

This chapter will discuss the findings of chapter 7 and suggest improvements for future work or research.

Chapter 9: Conclusion

This chapter will use the discussion from chapter 8 to answer the research questions and to conclude this research.

2. Background

To provide guidelines in which the manner in which the quality of feedback for visitors with a diverse background can be improved, background research has been conducted. This chapter defines the current problem by researching relevant background information and possible solutions by researching the state of the art. This chapter is divided into three sections: Literature research, state of the art and conclusion. The first section, the literature research, will investigate which factors contribute to how a visitor perceives a museum and it discusses the relevance of the providing a good experience, it will analyse current methods that can be used to collect information about the visitor's experience, and it will provide an overview of different modalities of questionnaires. The second section, the state of the art, will look at similar methods or research that use alternative methods to engage their users or to obtain feedback. The conclusion from this section can be used to provide research and design guidelines.

2.1 Background research

We have researched different aspects that can contribute to measuring the visitor experience in a museum. The background research will research the elements needed to perform develop a new method of collecting feedback in museums.

2.1.1 The visitor experience

Museums are dependent on their visitors and their experience within the museum. Preko et al. [7] state that offering a high-quality experience that enhances visitor satisfaction is essential for preserving and sustaining the long-standing growth of museums. Chan [8] emphasizes the significance of understanding visitors' personal context and mindful state in creating maximum enjoyment and appreciation. Zomerdijk [9] and Posnignon [10] both support the idea that measuring visitor experience directly influences satisfaction, loyalty, and the overall success of a museum by attracting more visitors. Furthermore, Camarero and Garrido [11] highlights the importance of embracing new formulas and technologies to enhance the social diffusion of a museum's activities and collections. This significance is further emphasized by Goulding's statement [2] that museums face growing pressure to become competitive and self-reliant. In conclusion, as museums operate in an increasingly competitive environment, the visitor's experience within the museum plays a critical role. Therefore, it is essential for museums to measure how visitors perceive their offered experience in order to effectively assess and make improvements.

Factors that contribute to a visitor's experience can be different for each museum, but there are three general factors that influence how a visitor experiences a museum: the physical setting, the quality of services provided, and the level of engagement. Ponsignon [10] states

that the layout of the museum and the types of exhibits directly impact the visitor's experience. Additionally, factors such as ambiance, lighting, and aesthetics of the museum space can influence visitor attitudes and behaviours. Zomerdijk [9] and Johnston and Kong [3] support the significance of the physical setting, highlighting that visitors construct their experiences, which are influenced by the museum's physical environment.

The second factor contributing to the visitor experience is the quality of services provided by the museum. Chan [8] states that a museum experience is a socio-psychological encounter that provides sensory, emotional, cognitive, behavioural, and relational values. Ponsignon [10] expands on this by emphasizing that staff members play a crucial role in building personal relationships with visitors, thereby enhancing the overall experience. Johnston [3] supports this factor by stating that visitor value is created through the service received, the experience itself, and the resulting outcomes. Zomerdijk [9] further validates this factor, as a positive correlation exists between commercial friendship between service providers and visitors, visitor satisfaction, loyalty, and word-of-mouth recommendations.

The third and final factor is the level of interactivity in a museum. Goulding [2] states that interactivity between visitors and exhibits is an important aspect for the construction of the visitor experience. Chan [8] expands on the importance of interactivity, stating that visitors describe their experiences based on cognitive and affective aspects, including the level of involvement, engagement, and variation of stimuli. Zomerdijk [9] offers another perspective, indicating that experiences are also shaped by the level of interactivity among fellow visitors.

The factors mentioned in this section can be categorized into three distinct aspects. The first aspect pertains to the physical setting of the exhibition, as the ambiance of the museum directly influences the visitor's experience. Secondly, the quality of services provided by the museum is crucial, with staff members playing a key role in building visitor relationships and satisfying their needs. The third aspect focuses on the level of interactivity, which involves engaging visitors with the museum and facilitating interactions among them, resulting in increased enjoyment and an overall improved visitor experience. It is important to note that these factors are overlapping and mutually supporting elements. Furthermore, it is worth emphasizing that the overall exhibition and presentation of the museum also play a significant role in shaping the visitor's experience.

2.1.2 How can a museum improve the visitor experience?

With the determination of the factors that contribute to the visitor’s experience, the next step is to look at which steps a museum can take to improve this visitor experience. Goulding [2] highlights the social nature of museums, emphasizing the need for designs that maximize engagement and allow visitors to creatively and intelligently piece together the historical

narratives. Visitors should feel comfortable, and clear and easy-to-follow maps should be provided to avoid confusion.

To further improve the offered experience Johnston and Kong [3] suggest that a mindset change is critical, the important factors to change are: visitor, staff and cost-efficiency. This perspective is further supported by Camarero and Garrido [11], who state that to innovate, and thus change the visitor experience, a museum should innovate in the core service (temporary exhibitions, educational programs, friends programs, etc.) and in the supplementary services provided (displays and screens, virtual visits, or publication through the web). Johnston and Kong [3] present an eight-staged improvement "roadmap" that can be used to enhance the visitor experience. These steps include: (1) Instigation and objective setting, (2) Coordinate and oversee the changes, (3) Undertake visitor research, (4) Define the experience, (5) Undertake action research, (6) Prioritise Areas for development, (7) Develop and pilot the changes, (8) Change the support systems.

In conclusion, a museum should innovate and improve on the services provided and can follow a 8 staged improvement "roadmap". The improvement of the visitor experience comes from the top level and the overall mindset should be changed to enable a museum to improve their visitor's experience.

2.1.3 Feedback collection methods in museums

Methods that assess how visitors experience museums can be categorized into two types: self-report methods and observation methods. Self-report methods involve asking visitors to evaluate their own perception of the museum. Jiminez et al. [12] state that self-report methods, such as surveys, interviews, and questionnaires, are useful for measuring attitudes, behavioural intentions, beliefs, and retrospective reports of behaviours. These methods can be further classified into qualitative and quantitative approaches. Chan [8] suggests that qualitative approaches are better suited for measuring the museum experience as they provide a deeper understanding of complex behaviours. Ponto [13] supports the use of self-report methods, highlighting that survey research can help describe and explore variables and constructs of interest. However, Ponto [13] also acknowledges that self-report methods may suffer from biases and other sources of error. The effectiveness of self-report methods is further questioned by Caruelle [14], who argues that emotions are initially experienced physiologically (e.g., heart rate acceleration, sweat secretion), and only later do individuals become aware of their emotions. This implies that visitors may not always be aware of their emotions, making self-report methods potentially unreliable for capturing their experience.

The second type of feedback collection method is the observation method. Goudling [2] emphasizes the importance of non-intrusive observation, where visitors are not manipulated

or stimulated in a way that could influence their feedback. It is worth noting that Goudling's work was published in 2000, and technological advancements for non-intrusive observation have since emerged. Jiminez et al. [12] provides a list of methods that use new technologies that can observe the level of engagement in a visitor. The list consists of 7 methods and these methods have been expanded and analysed on their applicability in a museum through the use of external sources in table 1:

Method	**Explanation**	**Applicability in a museum**
Electrodermal activity (EDA)	Electrodermal activity (EDA) is a psychophysiological indicator of emotional arousal. When an emotionally arousing stimulus is experienced, eccrine sweat glands produce sweat, which is an efficient conductor of current. As a result, the electrical properties of the skin change. Caruelle, et al. [14]	Visitors can wear a device to measure EDA over time and location, enabling certain interactions without disturbing them.
Heart rate	The heart rate is a strong indicator of the psychophysiological state of a visitor. Sarkar and Barat [15]	Visitors can wear a device to measure heart rate over time and location, allowing certain interactions without causing disturbance.
Electroencephalography (EEG)	EEG can be used to measure brain activity, this will be done through electrical currents. It can identify user engagement considering the baseline versus the EEG data while performing a task. Jiminez et al. [12]	Non-intrusive implementation is challenging as it requires precise placement of multiple sensors on the visitor's head
Pupillometry	The change in the diameter of the pupil can be measured to monitor cognitive and affective processes. Köles [16]	It can be implemented in a VR installation with a stable head position, enabling simultaneous display and measurement.

Posture analysis	Posture is a natural element that can be observed and interpreted to catch non-verbal communication. Posture analysis is most often performed on a chair with pressure sensors. Jiminez et al. [12]	Non-intrusive method for determining user engagement when visitors are seated, commonly performed using chairs with pressure sensors. However standing postures could also be measured, this would be less intrusive
Respiratory rate	The measurement of the respiratory rate can obtain an insight into the emotional response of a visitor, which can be retraced to the user engagement. Jiminez et al. [12]	Current measurement methods require physical attachments like breathing masks or belts, making implementation challenging in a museum setting.
Facial expressions	The measuring of facial expression analyses the facial muscle movements to determine the internal emotional reaction. This reaction could be a strong indication of certain social signals that show the visitor's focus, intention, attention, motivation and emotion. Jiminez et al. [12]	A camera can be installed to continuously capture data on visitor engagement. Emotions should be stored, and visitors must provide consent for analysis.

Table 1: Non-intrusive user engagement measurement methods

To summarize, the self-report methods are less intrusive and have more respect for autonomy, as the visitor can choose whether or not they want to partake in the method. Self-report methods do suffer from certain levels of biases and can have other unseen errors. The observation methods are more reliable, as the psychophysiological levels of a visitor rarely lie. Nevertheless, observation methods should be integrated in a way that does not disturb the

visitor and their experience. Informed consent is also necessary before any non-intrusive observation methods.

2.1.4 Modalities of questionnaires

There are many different designs of questionnaires, figure 1 shows the modalities of questionnaires according to Saunders, Lewis and Thornhill [4]. The choice of the design for questionnaire is dependent on four main different factors:

1. Time available to complete the data collection.
2. Financial implications of data collection and entry.
3. Availability of research assistants and field workers to assist.
4. Cloud based survey design, data collection and analysis software.

The current modalities of questionnaires do not cover the needs for a questionnaire that motivates people to fill in the questionnaire. This lack of a suitable modality allows for the suggestion of a new modality, “the interactive questionnaire”.

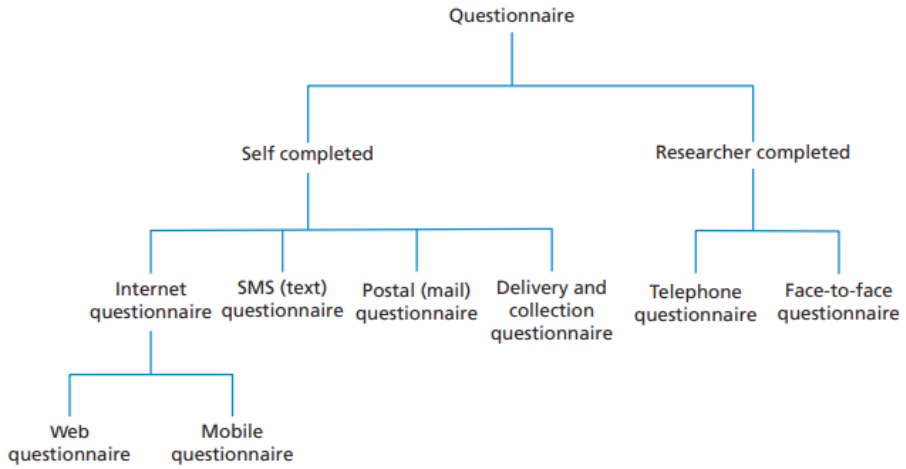


Figure 1: Modalities of surveys, from Saunders, Lewis and Thornhill [4]

2.2 State of the art

There are some examples that improve the quality of feedback through the use of engaging or motivating elements, these examples have been analysed on their elements that could be applicable in the design process of this method.

2.2.1 Starbucks

Starbucks is an American company and is considered to be the largest coffeehouse chain and one of the most recognizable brands in the world [17]. Despite serving coffee to an enormous number of customers each day, the company initially struggled to retrieve customer feedback about their services and products. To gain better insight into the customer experience,

Starbucks randomly invites approximately 1 in 20 customers in the United Kingdom to participate in the My Starbucks Experience survey [18]. This involves the selected customer filling out a survey in exchange for a discount on their next order.

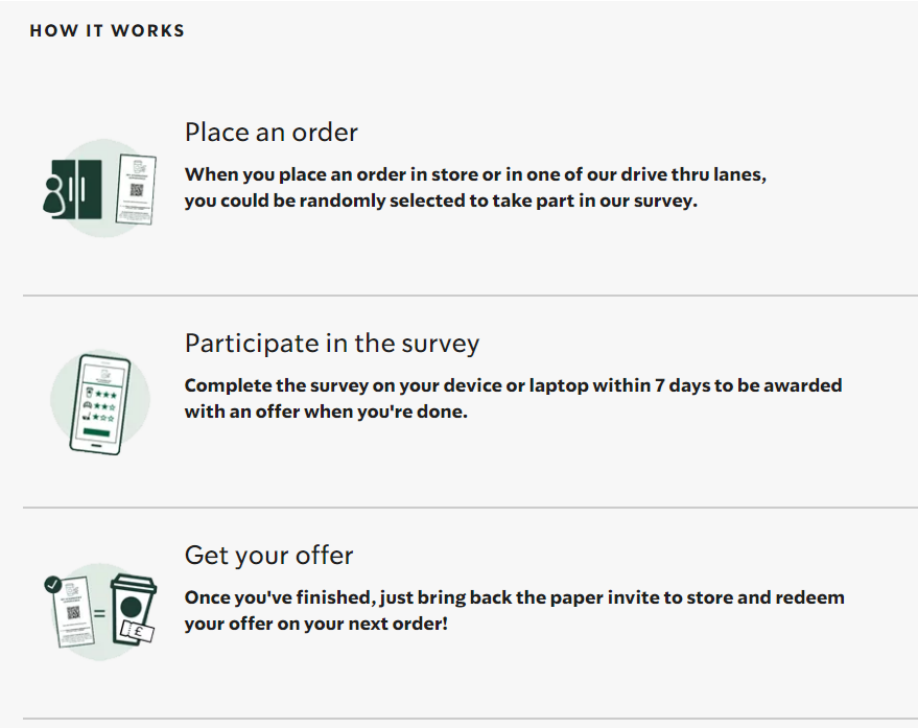


Figure 2: Starbucks survey reward [16]

The applicability of this method to the project is questionable since it relies on extrinsic motivation (discount) [19] to encourage an individual to leave feedback. Although the randomness in participant selection is ideal for obtaining a large pool of respondents due to the company's vast scale, implementing this system in a relatively small museum like Oyfo without significant funds to promote visitor feedback would be difficult. One potential approach to the Starbucks method is to expand beyond Oyfo and implement this system in all museums in the Netherlands. This would allow visitors to receive a discount on their next museum visit while providing feedback on their current museum experience.

2.2.2 HappyOrNot

HappyOrNot [20] is a visitor feedback solution that is used in different industries, like museums, airports or hospitals. HappyOrNot consists of a physical feedback terminal that allow the users to rate their emotional satisfaction with the ease of pressing one of the four buttons with the corresponding emotion, as shown in figure 3. HappyOrNot provides their visitors with real-time data analytics that can help them to obtain an insight into the emotional state of the respondents over time and location. This system removes the unwillingness of people to spend time to leave feedback, as it takes less than a second to leave feedback.

Figure 3: The HappyOrNot terminal [20]

HappyOrNot can be a valuable inspiration source for the design of a museum feedback collection method, as it is quick at collecting immediate feedback from a wide range of visitors. By implementing certain elements of HappyOrNot in combination with other feedback collection methods, the newly designed method can remove the problem of visitors not wanting to spend time providing feedback.

2.2.3 Gamification in Surveys

Harms et al. [21] describe the process of designing and evaluating a gamified online survey tool. They highlight that traditional surveys can be perceived as boring, leading to low response rates, and suggest that gamification can enhance survey engagement. In their research, various game mechanics, such as points, badges, and leader boards, were implemented to incentivize participants to complete the survey. The results demonstrated a higher response rate and increased survey completion when using the gamified approach. Two examples of gamified survey questions are shown in Figure 4:

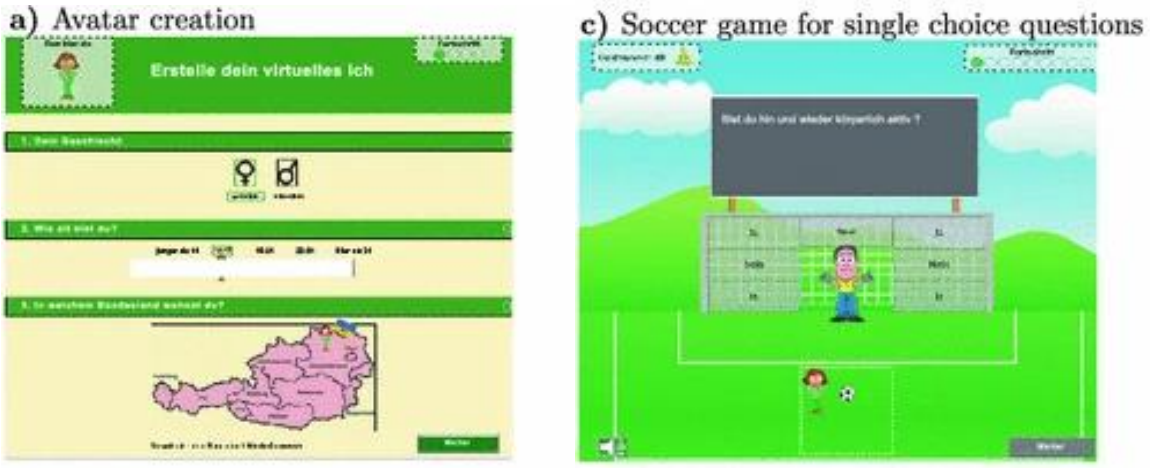


Figure 4: Gamified survey [21]

This research serves as a valuable starting point for the reformulation of survey questions. It indicates that gamification is an effective strategy for improving survey participation and completion. However, it is important to acknowledge that the effectiveness of this method may vary depending on the target group. For instance, individuals without a preference for sports might find sports-related elements in the gamified approach less effective. Nonetheless, a similar method can be applied to reformulate the questions that the museum intends to ask its visitors.

2.2.4 Museum Inspecteurs

Another approach at collecting visitor feedback in a museum has been created by Museum Inspecteurs [6]. This is an Dutch initiative that aims to engage children between the ages of 7 and 12 with museums in a fun and interactive way. This initiative promotes cultural education and encourages children to visit museums. It offers a digital game where children assume the role of museum inspectors and tackle challenges related to various artworks and exhibitions. By participating in Museum Inspecteurs, children not only learn about art and culture but also develop critical thinking, problem-solving, and social skills.

The Museum Inspecteurs program holds promise as an effective approach to promoting cultural education and engaging children in museums. It provides valuable learning experiences while fostering an enjoyable and interactive environment. Figure 5 presents an overview of the process, showcasing the steps in Dutch:

Figure 5: "Museum Inspecteurs" [6]

The steps involve creating an account and adding a profile for children, visiting museums, conducting inspections after the visit, and even creating artworks to fill up their own "child museum".

By engaging children through Museum Inspecteurs, museums can gain valuable insights into how children perceive their museum visits. This feedback can help museums identify areas for improvement and make necessary changes to enhance the overall visitor experience. Moreover, Museum Inspecteurs fosters visitor engagement and participation, creating a sense of community as visitors actively participate in the evaluation process.

2.3 Discussion & Conclusion

The objective of this chapter was to provide a comprehensive overview of existing research on the visitor's experience and the measurement of this experience. Additionally, the aim was to explore various research and methods that could be applicable for improving the quality of feedback obtained.

The research indicates that offering a better visitor experience leads to higher satisfaction and increased visitor loyalty. The factors contributing to this experience can be categorized into three sections: the physical setting, the service provided, and the level of visitor engagement. For a museum to improve on these factors, a shift in mindset is necessary. Determining which factor to prioritize for improvement can be challenging, but valuable insights can be gained from visitor information. Therefore, it is crucial to implement methods for collecting this information to inform decision-making processes

Two types of feedback collection methods exist. The first type is self-report methods, which rely on visitors voluntarily dedicating their time to provide feedback through surveys, interviews, or questionnaires. While self-report methods can be efficient, they are contingent on the response rate and may provide skewed information. The second type is observation methods, which can be more reliable as they are less prone to biases. However, the level of

intrusiveness of observation methods affects their effectiveness. Tracking factors such as posture or facial expressions is easier and less disruptive compared to measuring pupillometry.

Within the state of the art, interesting approaches at improving the quality of feedback have been suggested. However, the common theme in the state of the art is the usage of gamification [22] elements, these elements can be implemented to encourage the visitor to leave their feedback. These elements can be incorporated to motivate visitors to provide feedback, through a gamified story that triggers a sense of satisfaction or through quick and accessible feedback mechanisms.

To elevate the visitor experience, a new method for collecting user feedback should be designed, focusing on the three factors of the visitor experience. Two options for collecting feedback are available. The first option is to employ a well-designed self-report method that motivates visitors to provide feedback, thus increasing the response rate and improving the quality of feedback. The second option is to utilize an observation method that efficiently collects data without interrupting the visitor's experience. To further enhance the response rate of feedback, gamification elements can be incorporated, and interactions with the system should be quick, intuitive, and accessible.

3. Methods & Techniques

After analysing the background information shown in Chapter 2, this chapter will discuss the next steps that will be taken to design this new method of feedback collection. The design process of this project will follow one main design process, which will be supported by alternative design techniques. The main design process that will provide guidelines for the project is the Creative Technology Design process, made by Mader and Eggink [23]. This method has been selected, as the to-be designed feedback collection method will have the user experience in the centre, to attract as many respondents as possible and this design process allows for iteration around the user needs. The design process of Creative Technology is illustrated in figure 6. It consist of four phases; Ideation, Specification, Realisation and finally the Evaluation phase. Each phase has a start and an end with a set of requirements, each of the phases will be explained and the methods that result in the best solution will be discussed in the following sections of this chapter.

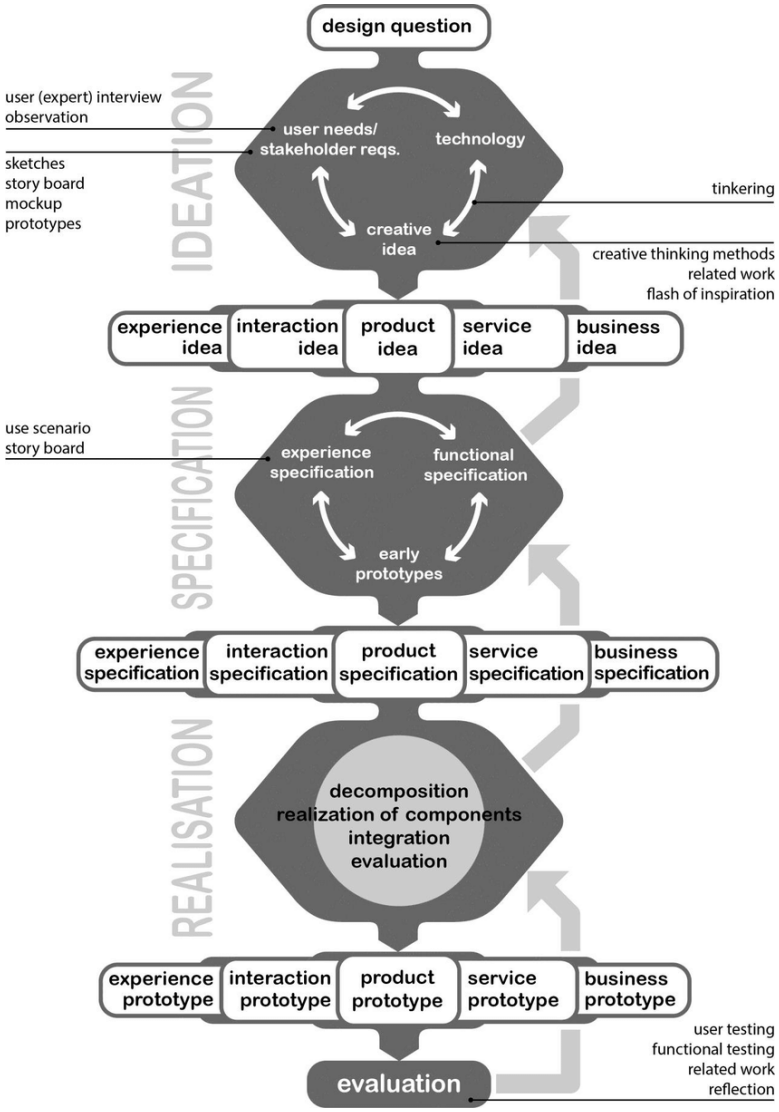


Figure 6: Creative Technology design process [23]

3.1 Ideation Phase

The ideation phase is the first step within the Creative Technology Design Process. In this phase, the problem will be defined, the user and stakeholder needs will be analysed and these will be used as base on which concepts will be created. This phase is aimed at creativity and there are many different ways of generating ideas, the aim is to use a converging motion to concept as many ideas as possible. This phase typically starts with a design question or a problem statement, in this project the design question will be the main research question and it is as follows: "*In what manner can the quality of feedback be improved at museum Oyfo, given by visitors with a diverse background?*" From this question there are three different starting points from which the iterative process can start: the user needs/stakeholder analysis, a creative idea and specific usage of technologies. From one of these starting points, the design process starts with an iterative process which can move in any direction. The ideation phase is characterized by divergent thinking and broad exploration of ideas. To conceptualize, different methods that define the requirements and design concepts will be discussed in this chapter.

3.1.1 Possible stakeholder conversations

To obtain an overview of the requirements of this project, interviews with different museums will be conducted. These interviews will be set up through emailing 15 different museums located throughout the Netherlands with the following questions:

1. *Is [Museum name] currently gathering any kind of visitor feedback? (This could be as broad as having a survey at the end to tracking actual visitors)*
2. *Are you known with other methods of collecting this sort of data? (for example, camera tracking)*
3. *In what sort of visitor data would [Museum name] actually be interested? (could be passive data or active data)*
4. *Is there a possibility to discuss these questions more elaborate in an interview?*

The goals of these interviews can be categorized into three different objectives, the first is to obtain an insight into the methods that are currently being used to give the museums an insight into their visitor's experience, which in turn an insight into the relevancy of designing a new method of feedback collection. The second objective is to set any additional requirements for this project, and what a method should measure. The third and final objective was to ask the experts whether they had any ideas about a new method that can be used as a stepping point for possible concepts.

The interviews that originated from the responses on these emails will be conducted either through a videocall or a face-to-face interview. The interviews will be conducted in a semi-structured manner, this method allows for the museums to properly explain their answers and they can drift to new, possibly unknown, factors that have not yet been considered yet.

The main points obtained through these interviews will be listed and analysed to provide a starting point for the creation of the requirements, that will be used to verify certain concepts. The feedback saved will not contain any personal information and they cannot be traced back to the respondents.

3.1.2 Interview with University professor

An interview with a professor from the University of Twente will be conducted, this professor is an expert regarding building physical consoles that have been designed for interaction with an user. The goal of this interview is to obtain an insight into the possibilities and limitations of creating a physical installation that can measure the visitor experience. This interview will happen face-to-face and it will be conducted in a semi-structured manner. The topics that will be discussed are the following:

1. Engaging factors of physical consoles.
2. Interaction between the console and the user.
3. An estimation of the cost and time needed to create a physical console.
4. Physical attributes, like material and electronics.
5. Any additional suggestions or warnings.

This interview will help the diverging process, as new ideas could be discussed. There will be no data stored from this interview, only ideas will be used to further ideate concepts.

3.1.3 Prioritize requirements

To obtain a comprehensive overview of the necessary requirements and prioritize them accordingly, a priority list will be established using the MoSCoW method [24]. The MoSCoW method is a prioritization technique that aids in understanding and managing priorities. The acronym MoSCoW stands for Must have, Should have, Could have, and Will not have this time. Requirements will be created and evaluated based on their priority in alignment with Oyfo's needs and the requirements. The resulting prioritized list of requirements will serve as the basis for evaluating the designed concepts.

3.1.4 Concept creation

The prioritized list of requirements will be used to design multiple concepts. These concepts will be created using the Cambridge concept design process [25]. This process allows for the starting point of the needs (MoSCoW list) and allows for creative thinking to

design and evaluate different concepts. With the support of this design process and the CreaTe design cycle [23], a final concept will be chosen.

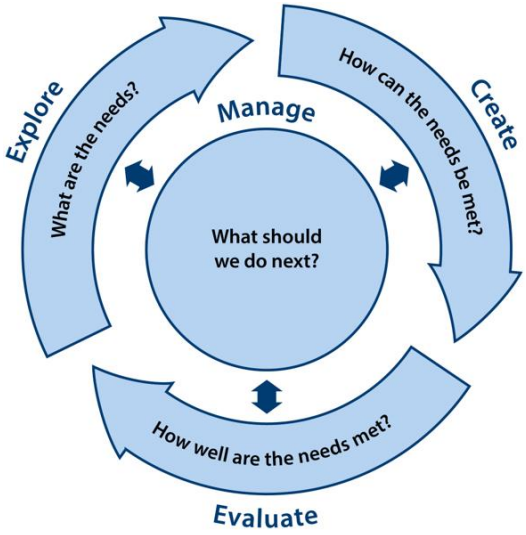


Figure 7: Cambridge concept design process [25]

3.2 Specification Phase

The specification phase is the second step within the Creative technology Design Process. This phase ensures that the final design of the feedback collection method functions in a desired way and that it meets the earlier determined requirements. This phase starts with the earlier generated product idea and turns it into a concrete plan, this will be done by defining how certain requirements will be met. Interaction methods and other functionalities will be discussed and evaluated. This evaluation will be conducted with the use of a short feedback loop, with input from the designer and stakeholders. This involvement should help to identify certain issues with the functionality or the user experience. At the end of this phase there will be a detailed plan for how the new feedback collection method will be designed, how it will be integrated into the museum and how the collected data will be stored and processed.

3.2.1 Flowchart

To obtain a proper insight and understanding of the design of the final concept, a flowchart will be created, this flowchart allows for an overview of which components are connected with each other. Furthermore, it provides an insight into the interactions and the connection between components.

3.3 Realisation Phase

The realisation phase represents the third step within the Creative Technology Design Process. This phase is dedicated to developing the prototype, taking the ideas generated during the ideation phase and specified in the specification phase, and bringing them to life

through implementation and testing. The activities in this phase include prototyping, testing, and iterating on the design choices. The ultimate objective of the realisation phase is to create a physical installation that can be deployed in Oyfo for the purpose of evaluating its effectiveness.

3.3.1 Expert interviews

The feedback collection method will involve a combination of software developed in Unity and hardware manufactured at the University of Twente. To ensure the quality and effectiveness of each component, expert interviews will be conducted. These interviews will follow a semi-structured format, where the experts will be presented with the design plan or specific elements and asked to evaluate its feasibility and suitability. The insights gathered from these interviews will serve as the primary guiding factors during the implementation phase. The feedback obtained from the experts will inform and shape the realization of the feedback collection method.

3.4 Evaluation Phase

The evaluation phase is the fourth and final step in the Creative Technology Design process. Its objective is to assess the effectiveness of the designed solution in meeting all the requirements. Additionally, it aims to provide insight into which elements work well and which need improvement, serving as a starting point for future work. This phase involves gathering feedback from users and analysing the collected data to draw conclusions about the solution's effectiveness. In the context of this project, the physical solution will be implemented at Oyfo, enabling users to provide feedback on their experience and interaction with the solution.

3.4.1 Data analysis

To obtain an insight into whether the collected information provides Oyfo with a comprehensive understanding of their visitors' experience, the obtained data will be analysed. The analysis will assess whether the data provides an informed perspective on the three factors of visitor experience: physical setting, service provided, and level of engagement.

3.4.2 Interviews with visitors

To obtain insight into the effectiveness of the feedback collection method, participants who have interacted with the system will be invited to participate in brief interviews regarding their experience. These interviews aim to gather participants' perspectives on the feedback collection method. The interview questions will cover the following topics:

1. *Interactions*
2. *Attracting or repelling elements*
3. *Functionalities*
4. *Comparison with a survey*

5. *Willingness to participate*

The interviews will be conducted in a structured face-to-face format, enabling prompt feedback and increasing the likelihood of participants sharing their feedback The collected data will be anonymized, and participants will provide informed consent prior to the interviews. The interview results will be analysed to evaluate if the requirements have been met and assess participants' engagement with providing feedback. This analysis will provide a comprehensive evaluation of the method's effectiveness.

4. Ideation

This chapter will cover the ideation phase, in this phase the goal is to design many different ideas in a diverging manner. Each of these designed concepts will be tested against the requirements that will be set up at the start of this chapter. This chapter will start with an overview of the requirements and it will cover the concepts created and the concept selected. The starting point of the ideation phase is the design question: *How can a new system be designed, that allows to increase the quality of feedback at museum Oyfo?* From this question, 5 different technologies will be chosen and a concept will be developed for each technology. These concepts will be presented to the stakeholders, and the most fitting solution will become the final concept.

4.1 Preliminary requirements

The requirements obtained from the technological museum Oyfo and from the background research are formulated in a MoSCoW listed table, each requirement will be given a number R1 – R10.

MoSCoW	Explanation	Nr
Must	As a museum, I **must** be able to safely and anonymously store visitor feedback to respect their privacy.	R1
	As a museum, I **must** obtain a relevant insight how the participants experience the museum.	R2
Should	As a museum, I **should** be able to implement this new method within our budget constraints to ensure financial responsibility.	R3
	As a user, I **should** not be disrupted by the feedback collection method during my museum experience to maintain a state of flow and engagement.	R4
	As a museum I **should** be able to obtain a relevant insight into the three factors of the visitor experience, physical setting, service provided and the level of engagement.	R5
	As a museum, I **must** have secure access to the collected feedback to ensure privacy protection for participants.	R6
	As a user, I **should** be able to use the feedback collection method, regardless of my demographics, to ensure inclusivity.	R7
	As a user, I **should** be engaged to leave feedback through fun elements to increase the likelihood of participation.	R8

Could	As a museum, I **could** customize the implementation of this method to align with the museum's aesthetics in order to integrate it into the experience.	R9
	As a user, I **could** experience gamification elements that encourage me to complete the feedback process and increase my engagement.	R10

Table 2: MoSCoW listed preliminary requirements

4.2 Idea Generation

The different ideas have been developed with the objective of addressing the challenge of effectively measuring the visitor experience in a museum. Starting from this initial problem, we utilized the Cambridge concept design process [25], which involves iterative exploration, creation, and evaluation. Through this process, five different technologies were identified as potential mediums for solutions to the problem. From these technologies, the most suitable solution was selected and further refined. In this section, each of the different technologies will be briefly explained and the concepts that come from them.

4.2.1 The AR-Survey

The first concept was to use the engaging elements of Augmented Reality (AR) to engage visitors of a museum to leave feedback. This idea could be implemented in two different manners: The first idea was to use AR to show a gamified list of questions that should be answered, for example if the participant has to choose between two options. The AR application could showcase each of these options and the participant could walk around it to obtain a better insight in the choice that they were faced with. An example of how this could work is given in figure 8: This method could approach any survey question and convert it into a 3D-world where the participant had to choose which option they liked the best. The downside of this manner is that it is very time intensive to create one question, however it is the most engaging manner of using a AR-survey.

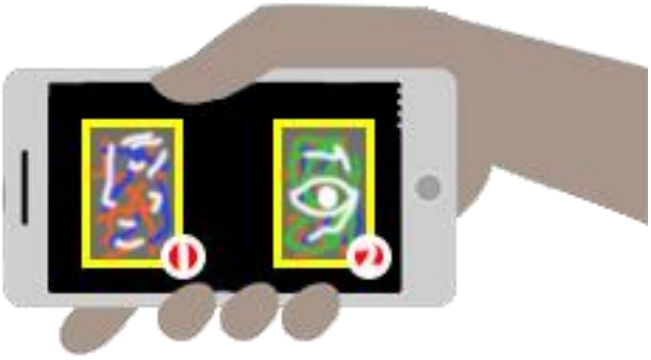


Figure 8 : Possible usage of the AR-survey

The second approach involves a more direct implementation of the AR application, where the questions remain in written form but are displayed within an AR textbox. Additional engaging elements would be incorporated around the question boxes, enhancing the overall survey experience. This approach offers greater adaptability, as it does not require the creation of individual 3D models for each question, however it is less engaging.

4.2.2 Haptic feedback wearable

Another concept that was developed involves the use of a haptic wearable. This wearable would consist of a wristband equipped with haptic technology, a GPS tracker, and three buttons on top. Each button would have an emoticon corresponding to happy, neutral, or displeased. The purpose of this wearable is to provide a tactile feedback experience.

When a participant approaches a new installation, the wearable would detect the proximity and trigger a vibration. This would prompt the participant to press the button that corresponds to their emotion towards the installation. The feedback collected from the wearable would then be sent to a database, which can process the data and generate a map of emotions. This map would provide the museum with insights into which installations are liked the most and which ones are the least pleasing. Figure 9 provides an example of the haptic feedback band. The downside to this concept is that it provides very linear feedback without any possibility deeper questioning of the visitors.

Figure 9: Example of haptic feedback collection band

4.2.3 Museum supporting application

The third concept involves integrating the feedback collection method into an application that provides information about the installations to the visitor. This application would be accessible to the visitor while they are present at each installation, offering additional details and insights. By clicking on specific aspects of an installation, the visitor can access more in-depth information. The application would track and record the amount of additional information

accessed by the visitor, providing visibility into which parts of an installation require the most supplementary information.

Additionally, the application could include quick questions about other aspects of the museum. By spreading the questions throughout the visitor's entire museum experience, it can engage them to provide feedback. This approach ensures that the feedback collection is not limited to a single survey or interaction, but rather integrated into the overall museum visit. A downside regarding this method is that the development requires either very much time regarding the integration of all museum installations or it requires an already existing application which could be altered.

4.2.4 Emotional tracking

Another approach to measuring the visitor's experience is to utilize cameras installed at the installations to track the emotional state of the visitors. This method involves tracking only the emotions of individuals present at the installation and transmitting this data to the system, without storing any video footage. The collected emotional data would provide the museum with a map illustrating the distribution of different emotions across each installation. This information can be valuable in understanding the emotional responses triggered by specific installations.

However, it's important to note that implementing this system would require participants to provide informed consent. The presence of cameras and the awareness of being tracked may influence participants' awareness of their emotions, potentially leading to skewed results. It's crucial to consider the potential impact of the tracking system on the authenticity of the emotions expressed by visitors.

4.2.5 The feedback console

The feedback console is a physical arcade-like console that has a monitor, 4 buttons with emotions illustrated on it, and a recorder attached to it. The monitor shows a gamified story of the questionnaire which Oyfo wants to have answered, these gamified questions will ask the participant to either press the button that they find corresponding with their emotion regarding the question or they can press the recording button to answer possible open questions. This physical installation would be placed at the end of the exhibition and it should be styled to fit the environment of Oyfo. These interaction methods allow the museum to obtain relevant feedback regarding different topics and it allows the visitor to have an fun and easy interaction. A possible example of such a physical console is given in figure 10.

Figure 10: The feedback console

4.3 Concept evaluation

The five different concepts have been shown to Oyfo in an interview, the goal of this interview was to obtain an improved insight into the requirements, the preferences and to obtain a certain level of verification. The concepts will be plotted against the requirements in table 3, this table in combination with the feedback from Oyfo have been used to conclude to the final concept. For clarity purposes the table has been colour coded according to the answer. The requirements will be repeated with the linked abbreviation:

R1: As a museum, I **must** be able to safely and anonymously store visitor feedback to respect their privacy.

R2: As a museum, I **must** obtain a relevant insight how the participants experience the museum.

R3: As a museum, I **should** be able to implement this new method within our budget constraints to ensure financial responsibility.

R4: As a user, I **should** not be disrupted by the feedback collection method during my museum experience to maintain a state of flow and engagement.

R5: As a museum I **should** be able to obtain a relevant insight into the three factors of the visitor experience, physical setting, service provided and the level of engagement.

R6: As a museum, I **must** have secure access to the collected feedback to ensure privacy protection for participants.

R7: As a user, I **should** be able to use the feedback collection method, regardless of my demographics, to ensure inclusivity.

R8: As a user, I **should** be engaged to leave feedback through fun elements to increase the likelihood of participation.

R9: As a museum, I **could** customize the implementation of this method to align with the museum's aesthetics in order to integrate it into the experience.

R10: As a user, I **could** experience gamification elements that encourage me to complete the feedback process and increase my engagement.

Requirement	AR-survey	Wearable	Application	Emotion tracking	Physical feedback console
R1	Yes	Yes	Yes	Yes	Yes
R2	Yes	No	Yes	No	Yes
R3	Yes	No	Yes	No	Maybe
R4	No	Maybe	No	Yes	Yes
R5	Yes	No	Yes	No	Yes
R6	Yes	Yes	Yes	Yes	Yes
R7	Maybe	Yes	Maybe	Yes	Yes
R8	Yes	Maybe	Maybe	No	Yes
R9	Yes	Yes	Yes	Yes	Maybe
R10	Yes	No	Yes	No	Yes

Table 3: Requirements vs Concepts

From the plotting of the requirements against the different concepts, the two best solution appears to be the AR-survey and the Physical feedback console. These two concepts have been further analysed and discussed, Oyfo has a preference for the physical feedback console, as this keeps the offered experience intact and thus it will contain a lower risk of disturbing the visitors. The selection of the physical feedback console is further supported by the fact that Oyfo is a museum with a lot of physical interactivity, this can make the implementation and integration of this concept into the experience more straightforward.

4.3 Second iteration on concept

With the selection of the physical feedback console as the final concept, several interesting challenges need to be considered. The first challenge involves determining an interaction method for open-ended questions that is accessible, enjoyable, and interactive while also respecting the privacy of the visitors. Another challenge is developing a gamified

story for the console that appeals to visitors of different age groups, incorporating various themes within the Oyfo experience. Creating such a story may prove to be a challenging task.

Based on the chosen concept, a second iteration on the different interactions has been conducted. The system aims to provide a fun and engaging interaction method for both open-ended and closed questions. To align with the high level of interactivity and creativity at museum Oyfo, the chosen interaction method is drawing. Participants will be asked to draw their favourite part of the museum and answer a few questions about their experience. These questions consist of both open-ended and multiple-choice formats. The open-ended questions will be directly translated into prompts, while the multiple-choice questions will be converted into predefined prompts. The drawn image and the participant's responses will then be combined and sent to an image conversion software. Based on this input, an art piece will be generated, serving as a visualization of the participant's experience at the museum. All generated pictures will be displayed in a picture mosaic on a separate monitor, providing a visual overview of the general visitor experience.

Chapter 5. Specification

The specification phase aims to define the specific details and requirements of the selected concept. This chapter will begin by providing a general specification of what the prototype should include and its rationale. It will then present a flowchart outlining the necessary actions. Following that, the requirements for the final concept, listed using the MoSCoW method [24], will be presented. Each requirement will be numbered and briefly explained. The goal of this chapter is to provide a clear understanding of how the system should function and look.

5.1 Application specification

The application serves as the backbone of the entire prototype, responsible for handling input and output and displaying the appropriate screens at the expected times. Moreover, it should ensure that users can interact with the system without unnecessary frustrations. The application needs to fulfil the following six actions:

1. Obtain informed consent from users to allow information storage, ensuring they fully understand the implications.
2. Enable users to freely draw their favourite part of the museum. The system should provide drawing options, such as different brush sizes or colours, and implement error-prevention techniques to enhance the drawing experience.
3. Gather relevant information about visitors' experiences in order to provide Oyfo with insights. This includes assessing these three factors: physical setting, services provided, and level of engagement. The system should prioritize participant privacy and securely store the information.
4. Combine the user's sketch with the insights gathered from the visitor experience and send them to the application generation software, allowing it to generate an image.
5. Display the generated image in the application and provide the user with a summary of the system's actions.
6. Showcase the generated images together with other generations in a picture mosaic.
7. Enable replay functionality without external support, facilitating a smoother flow for multiple interactions.

5.2 Image generation software

The system should have the capability to merge the sketch with the before mentioned insights from the visitor experience. In order to provide visitors with an image that effectively captures their experience at Oyfo, the system should transform the initial sketch into a refined version, ensuring that elements from the visitor experience are visible in the generated image. It is crucial to maintain the recognizability of the original sketch in the generated image, as this

will enable visitors to understand that the image represents their own creation. The generation process should be completed within 90 seconds to prevent visitors from becoming annoyed or frustrated due to excessive waiting times.

5.3 Hardware specification

The hardware utilized in the system should prioritize simplicity and straightforwardness, avoiding excessive elements that might distract the user. Some form of hardware input for drawing should be incorporated, with a touchscreen being the most apparent choice, although other possibilities should also be considered. To encourage user engagement and enable other visitors to interact with the system, the picture mosaic should be displayed on a separate visible screen. Moreover, the prototype should include a computer-like system capable of handling all the various processes simultaneously

5.4 System flowchart

A flowchart has been created, this flowchart provides an overview of the interactions with the image generation software and the application. The flowchart has been made in the online diagram maker Lucidchart [26].

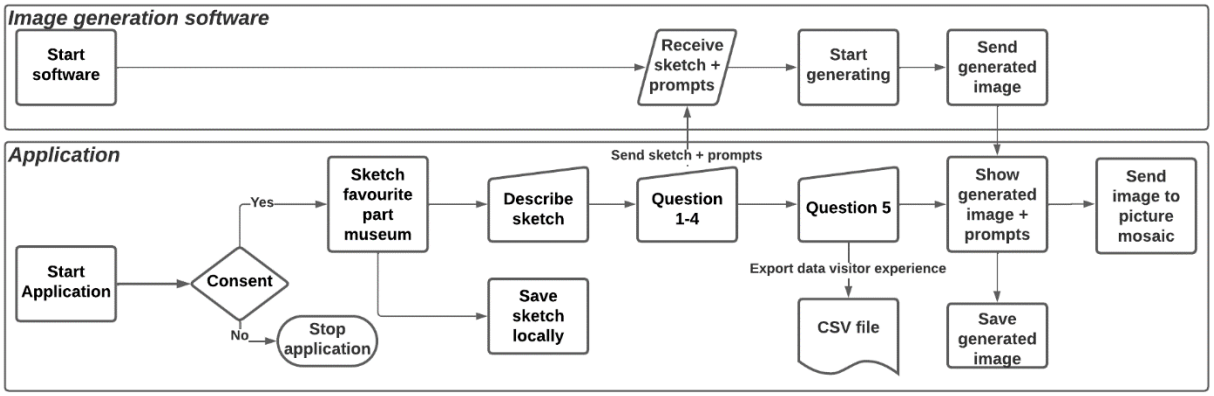


Figure 11: Flowchart system, made in Lucidchart [26]

5.5 MoSCoW list requirements

To conclude the specification phase, a requirements list for the system has been created. The list has been prioritized using the MoSCoW [24] method and it is shown in table 4.

MoSCoW	Requirement	Number
Must	The system **must** obtain explicit consent from participants before they can participate.	R1
	The system **must** securely store the obtained data to protect the privacy of participants.	R2
	The system **must** be accessible to visitors of different demographics at Oyfo.	R3
	The system **must** provide an insight into the visitor's experience.	R4
Should	The system **should** allow participants to sketch their favourite part of the museum.	R5
	The system **should** gather information on the three main aspects of a visitor's experience: physical setting, service provided, and level of engagement.	R6
	The system **should** convert the sketch and information on the visitor's experience into a generated image.	R7
	The system **should** generate the image within 90 seconds to maintain user attention.	R8
	The system **should** display the generated images in a single picture mosaic.	R9
	The system **should** prioritize user-friendliness by minimizing lag, bugs, and other disruptions.	R10
Could	The system **could** offer users various drawing options, such as different colours and brush sizes.	R11
	The system **could** include error prevention in the flow of the system	R12

Table 4: MoSCoW listed requirements

6. Realisation

In this chapter, the realisation of the system will be explained, including the choices made and their justifications. First, the choice for the image generation software will be elaborated upon and explained. Second, the chapter will delve into the application development software and its functionalities. Thirdly, the chapter will discuss the picture mosaic software. Finally, this chapter will explain how these three elements work together in the actual prototype.

6.1 Image generation software

To generate images from a sketch combined with prompt words, we have chosen an AI-based software. This section will explain our selection and provide a deeper understanding of how the software fulfils the requirements outlined in Chapter 5.

6.1.1 Different options

The entire system relies on image generation, and in this section, we will discuss the selection process and the reasoning behind it. We identified three main options: Midjourney [27], Leonardo.AI [28], and Stable Diffusion [29]. Table 5 showcases the capabilities of each software. For each generation, we used the input image shown in Figure 12 and the following prompt: "a steam machine, warm colours, fun, chaotic."

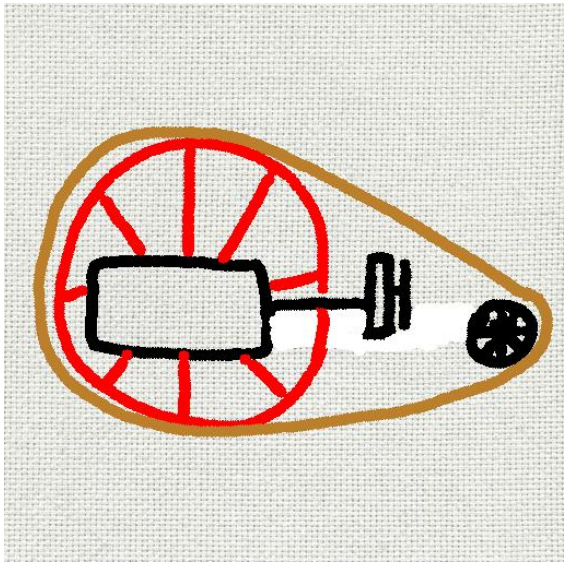


Figure 12: input image for test

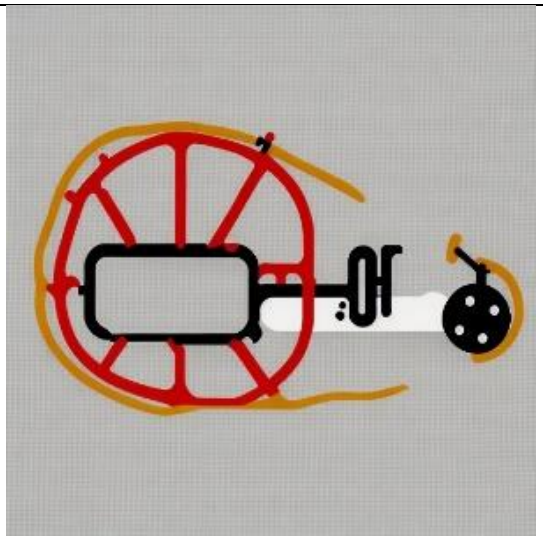
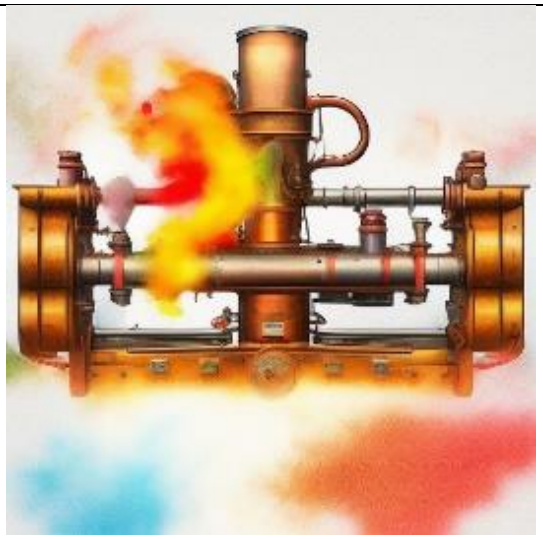
Software	Output
Midjourney	
Leonardo.AI	
Stable diffusion	

Table 5: Different generation options

Analysing the table, we observe that Midjourney produced the most impressive generation by adding the necessary details expected in a steam engine. Leonardo.AI retained

the original sketch quite well but might be considered too basic. While the Stable Diffusion generation exhibited nice colours, the original sketch was no longer recognizable. Based on this comparison, we initially decided to use Midjourney. However, upon thoroughly reading the terms of service, we discovered that automation is strictly prohibited with Midjourney. This led us to shift our focus to Leonardo.AI.

We reached out to an administrator on the Leonardo.AI development team and received guidance on the best approach for automation, which involved using Stable Diffusion and configuring it to meet our requirements. Following this conversation, we redirected our entire focus toward utilizing Stable Diffusion. One significant advantage of Stable Diffusion is that the software runs locally on the computer, minimizing the risk of external errors beyond our control.

6.1.1 Stable Diffusion

The Stable Diffusion software [29], an AI-based image generation tool, utilizes deep learning models to generate images based on text descriptions and input images. We have selected the Automatic 1111 GUI [30] as our base program due to its extensive support and capabilities. Our objective is to generate images quickly while preserving the essence of the original input. Figure 13 presents an overview of the available sampler methods and the corresponding number of steps required. After careful consideration, we have opted for the "k_euler_a" sampler as it consistently produces visually appealing results with a minimal number of diffusion steps.

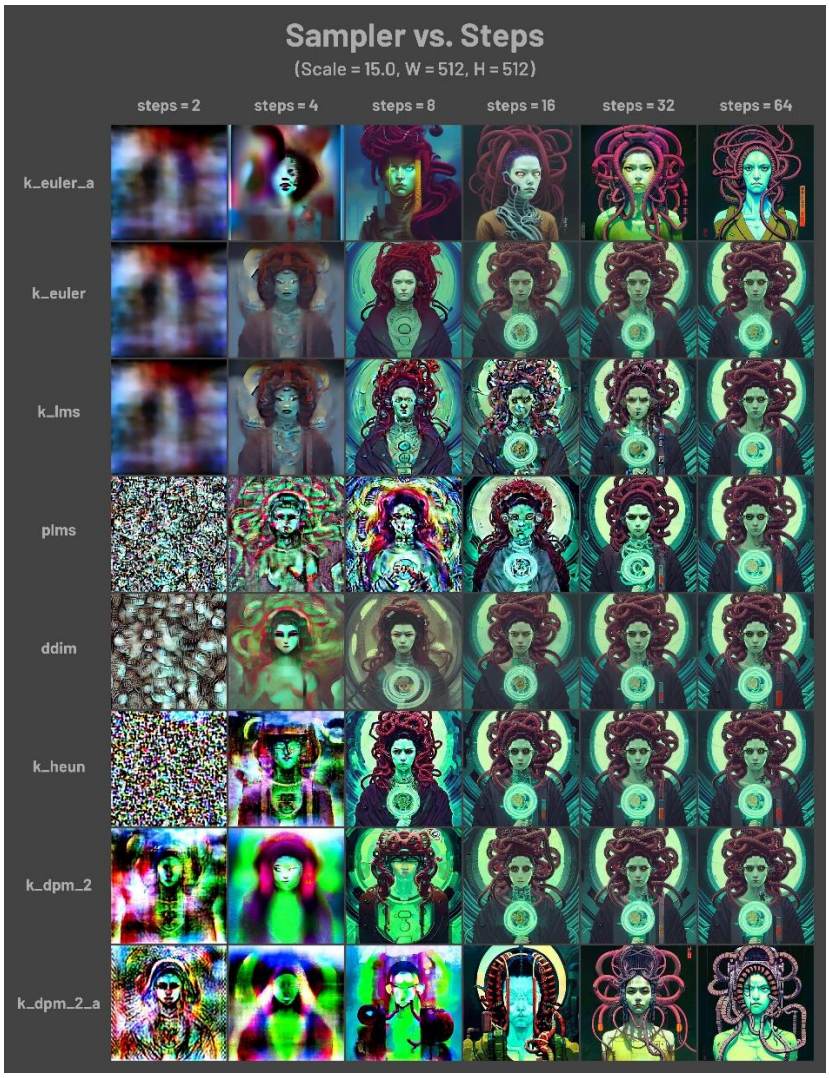


Figure 13, Stable Diffusion Sampler vs Steps [31]

For enhanced image generation quality and to align with our preference for the Midjourney model, we have chosen to use the openjourney model [32] within Stable Diffusion. This model is an open-source variant fine-tuned on Midjourney images, contributing to more detailed and refined image generation capabilities.

Further experimentation and testing have revealed that utilizing 15 diffusion steps allows us to generate high-quality images within a generation time of under 90 seconds.

6.2 Application

To develop the application that supports the entire interaction system, we have chosen Unity as our preferred software. This decision is based on the accessibility and user-friendliness of Unity, as well as the abundance of useful information and guidance available online. Moreover, the developer of this project is already proficient in Unity, which will streamline the development process. The Unity application will be created within a 2D environment since all user-system interactions occur within a 2D graphical user interface. To

simplify the system's complexity, all interactions and screens will be contained within a single main scene managed by a central class.

6.2.1 Languages

The system offers participants the choice between two commonly spoken languages in the museum: Dutch and English. This language option has been implemented to enhance the system's accessibility and increase the response rate among visitors from diverse backgrounds. The translation process has been facilitated through the use of the Google Cloud Translate API [33]. The initial interaction between participants and the system involves selecting their preferred language, as depicted in Figure 14.

Figure 14: The language selection screen

6.2.2 Consent

To ensure that participants provide proper informed consent based on their age group, the system's second interaction is a consent screen. In this screen, participants are prompted to select their corresponding age group from the following options:

1. "Aged 11 years old and younger"
2. "Between 12 and 16 years old"
3. "Older than 16 years old"

Depending on their choice, the system will provide a different workflow, as illustrated in figure 15. When the participant is younger than 16 years old, they will be shown the standard information letter. If the participant is older than 16 years old, the system will show the simplified information letter. The simplified information letter will contain less complicated words. The simplification of information letter should increase the likeliness of the participant actually being able to understand everything and thus being able to give informed consent. The two different information letters will be included in appendix A & B.

We have divided the information letter into five sections to reduce the amount of text displayed simultaneously. This approach aims to prevent participants from feeling overwhelmed with information and increases the likelihood of them reading and comprehending everything, thereby facilitating informed consent. The five sections are as follows: (1) Purpose of the research, (2) Interaction with technology, (3) Withdrawal and personal information, (4) Usage and storage of data, and (5) Personal information.

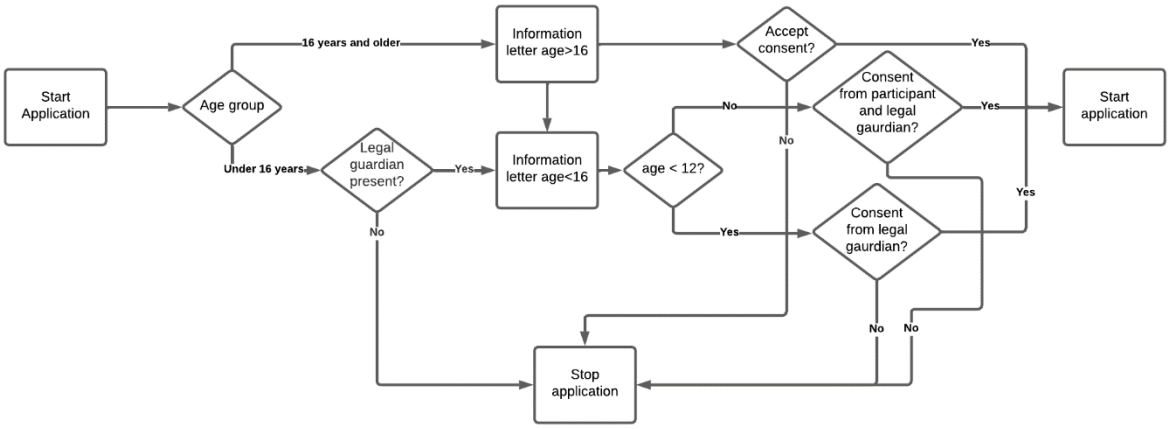


Figure 15: The consent workflow, made in Lucidchart [26]

The system provides different interactions based on the selected age group to ensure that data storage from the participants is allowed. The differences in interactions are as follows: Group 1 will be asked if they personally agree to everything stated, Group 2 will be asked for personal agreement and then for consent from their legal guardian, and Group 3 will only require consent from the legal guardian. If any participant or legal guardian disagrees with the terms, the application will stop, and a message will be displayed indicating that they are not allowed to participate.

6.2.3 Drawing system

The system prompts participants to sketch their favourite part of the museum, utilizing a drawing system within the application. We developed the system to generate a circle each time the user touches the touchscreen. Additionally, it offers various colours, brush sizes, and an eraser for error correction. These features provide users with greater creative freedom to recreate different aspects of the museum and are likely to enhance the accuracy of the image generation process. To ensure an uninterrupted flow for participants, the drawing system is programmed to prevent any potential disruptions. Upon pressing the "done" button, the system locally saves the sketch along with a generated identification number.

6.2.4 Prompt description

The system will prompt the participant to provide a brief explanation of their drawing. This step increases the likelihood of the generated image accurately representing their intention, as the image generation software may interpret drawings differently. The participant's explanation will be added to a public string named “prompt input” in the manager class, which represents the collection of prompt words for the image generation. To ensure proper separation between prompts, a comma will be inserted between each addition to the string, preventing any unintended merging of prompts."

6.2.5 Questions

The system will prompt the participant with a few questions about their museum experience to gain insight into their perception. The questions will cover three factors of the visitor experience: physical setting, service provided, and the level of engagement. To maintain participant engagement, only four questions will be asked, minimizing the risk of boredom or annoyance. The system will indicate the current question number (x) out of the total number of questions (y) in the format: x/y.

The system will ask the following questions:

1. *What did you think of the layout of the museum? (Likert-scale)*
    a. *Very unclear ←→ Very clear*
2. *Which words best describe your visit at Oyfo? (Open question)*
3. *What did you think of the assistance that you received at the museum? (Likert-scale)*
    a. *Very absent ←→ Very pleasant*
4. *Would you recommend this museum to acquaintances, and why? (Open question)*

These questions have been carefully chosen to align with the three main factors of the visitor's experience and their potential to generate informative prompt words. Question 1 specifically targets the evaluation of the physical setting of the museum. Question 3 centers around assessing the quality of the service provided. Questions 2 and 4 have a broader scope and aim to capture the overall experience of the visitor. Additionally, these last two questions serve to gauge the level of engagement, as we anticipate that participants will naturally include their engaging factors in their responses to the open-ended questions.

The answers to these questions will be locally saved in a CSV file. Before the saving process, the participant will be asked to confirm their intention to save their answers. It is important to note that the answers will be stored anonymously and cannot be removed once saved.

6.2.6 Unity link to image generation software

This section explains the process of combining and composing input for the generation software. The Unity application communicates with the local Stable Diffusion server to facilitate the input-output system. The drawn sketch is saved in a local folder, and the system counts the number of images in the folder to assign the next count to the sketch image. This count is temporarily stored in a manager class and will later be used to link the input to the output image.

The answers to the questions are saved by adding them to a string called "prompt input" in the manager class. This string can be combined with the sketch image and sent to the Stable Diffusion server. When a participant answers an open-ended question, their answer is inserted into the string along with a comma sign. However, if the language is set to Dutch, the answer is first translated using the Google Translation API [33]. For Likert-scale questions, the prompt words are predetermined as shown in Table 6 below.

Question	Multiple choices	Prompt words
Q1	Very unclear ←→ Very clear	Very chaotic ←→ Very clean and organised
Q3	Very absent ←→ Very pleasant	Very cold colour palette ←→ Very warm colour palette

Table 6: Translation choices to prompts

Unity sends the data to the Stable Diffusion server after question 3 has been answered. This reduces the waiting time for the participant, as the generation process has already started while they are still answering question 4. Since question 4 is an open-ended question with various possible answers, including the answer in the prompts could potentially confuse the system. The input for the image generation software is composed as follows: Sketch image + "description, prompt1, prompt2, prompt3".

6.2.7 Ending

After the image generation software converts the input into a generated output image, the system showcases the newly generated image. The application displays the original sketch next to the generated image, with the prompt words shown underneath. This provides participants with a clear understanding of the process and how their answers influenced the generation.

6.2.8 Development support

During the development of the application, we relied on various external sources of support, which are mentioned in this section. The integration between Stable Diffusion and Unity served as the foundation for our application. We utilized an existing project called 'Stable-Diffusion-Unity-Integration,' created by GitHub user dobrado76 [34]. The original project aimed to generate in-game art using Stable Diffusion with the txt-img technique. However, we modified the project to enable img-img generation in the build version of our application. Thankfully, dobrado76 had already included an img-img configuration script, making this adaptation more feasible.

Understanding the Stable Diffusion process posed challenges, and while modifying the code, we encountered several difficulties. To ensure effective testing of our concept, we sought support from ChatGPT [35]. ChatGPT helped us decipher certain errors we encountered. Although our proficiency in C# programming was decent, ChatGPT proved invaluable during the development of the drawing system and the Stable Diffusion integration. We did not directly copy any code from ChatGPT but instead interpreted and applied the provided code to our own application.

The visual aspects incorporated into the application were generated using Midjourney [27] based on a basic description. Midjourney allows for quick image generation through the use of prompts. We selected the style 'Inspired by Studio Ghibli,' which helped maintain a consistent aesthetic throughout the application.

6.2.9 Application structure

This section provides a general overview of the class structure of the application. Note that due to the large number of classes, only a brief coverage will be provided. The application has been developed using Unity version 2021.3.13f1, which was chosen for its support for various features.

The application is built within a single scene, where different screens (game objects) containing different interactions are called through a manager class at the appropriate moments. The "Manager" script handles the main flow of the system by keeping track of the currently displayed screen and enabling navigation to the next screen when the "next" button is clicked. Additionally, it facilitates communication between different classes and includes features such as exporting data to a CSV file.

To ensure language localization, a "Localization Manager" script has been implemented, allowing the entire application to be displayed in either Dutch or English. To enable this, two text files containing all the text elements in either Dutch or English are included.

The drawing aspect of the system is managed by the "Draw On Image" script, which works in conjunction with the "Drawing Panel" script, responsible for handling the various drawing options.

The integration between Stable Diffusion and Unity is achieved through the "Stable Diffusion Image 2 Image" script, which manages the input and output of images towards the local stable diffusion server. This script is supported by the "Stable Diffusion Configuration" script, offering detailed configuration options such as the preferred diffusion method and the number of diffusion steps.

6.2 Picture mosaic

To visualize the different generated images, a picture mosaic has been created. However, due to the extensive time required to program a picture mosaic in Unity, we opted for an alternative website called *Mosaically.com* [36]. This website provides a user-friendly and straightforward method for creating picture mosaics. The only drawback is the lack of automation in the generation process, which means that we will need to manually add each freshly generated image to the mosaic after every interaction.

Within Mosaically, users can select one image as the base image, which serves as the reference for organizing the different pictures. In this case, the base image is a photo of the Technical Museum Oyfo taken from a high perspective, as shown in Figure xx. All the added photos will be arranged to resemble this base image. Mosaically allows for an adjustable colorization level, which determines the extent to which the generated images can be altered to resemble the base image. For this mosaic, we have set the colorization level to 5%. This allows users to vaguely recognize the photo while minimizing any distortion in the generated images. The resulting picture mosaic can be seen in Figure 16.

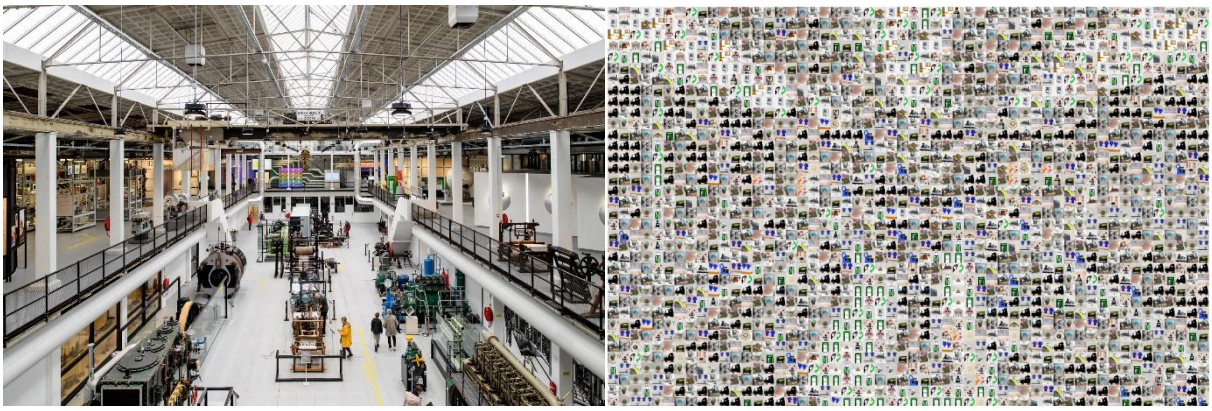


Figure 16: Base image and the picture mosaic

7. Evaluation

The evaluation phase is the final stage of the Creative Technology design process. During this phase, the created prototype is tested and evaluated with users. This project incorporates three different methods for evaluating the prototype, each with a unique evaluation goal:

1. Results from the application: These results provide insight into the data collected by the application and its usefulness for the team.
2. Results from interviews: These results offer insights into how visitors from diverse demographics experience the application.
3. Results from observations: These results support the interview findings and may reveal important aspects that participants may not identify themselves.

The following sections describe the procedures for each evaluation method. The results will be analysed using grounded theory [37], and an overview of each method will be presented along with tables showing categorized results. These categorized results will then be briefly summarized and further analysed in the discussion section.

7.1 Evaluation setup

We physically performed the evaluation at the technological museum Oyfo in Hengelo in June 2023. To properly assess the effectiveness of the system, we conducted user tests over a period of 5 days. For the user tests, a physical prototype setup was created and placed at the exit of Oyfo to ensure that participants could provide feedback about their entire experience. The setup consisted of a monitor displaying the picture mosaic, a tablet controlling the input and output of the Unity application, and a hidden laptop running the entire process. The setup can be seen in figure 17.

Figure 17: the user testing setup.

7.2 Evaluation procedure

We performed the user tests for 5 full days 10:00-16:00, and all visitors that left the museum where asked whether they wanted to participate in testing a new prototype that could replace the classic survey. Each of the participants had to conform to the following inclusion criteria:

1. They speak and understand either English or Dutch,
2. They have just visited museum Oyfo,
3. They had to be able to give informed consent.

After the participants had interacted with the system, We asked them whether they wanted to answer a few questions regarding their interaction with the prototype, most of the participants were willing to evaluate the system. Table 7 shows the amount of participants each day, from this table it is clear that there were 21 participants of the system, from which 18 participants were willing to answer a few questions regarding their experience.

The museum itself was quite calm and empty during the user testing period, as the temperatures in the Netherlands were very hot. Additionally, there were quite a few visitors who were not willing to participate in the user-testing. The demographics of the participants was diverse, it ranged from toddlers with their parents to elderly couples. This diversity was

desired to obtain feedback from visitors with diverse demographics and increase the quality of feedback.

Date	14/6	15/6	16/6	17/6	18/6
Participants system	4	5	4	2	6
Interviewees	4	3	3	2	6

Table 7: Amount of user tests.

7.2.1 Interview procedure

We have set up semi-structured face-to-face interviews to assess the effectiveness of the system, these interviews are aimed at discovering whether museum visitors are willing to leave feedback with the application and they are aimed at retrieving any functional feedback regarding the application. The interviews were initiated with participants who have just interacted with the system. The participants were asked whether they had time and motivation to answer 5 questions regarding their interaction, they were informed that the goal of the interviews was to help the researcher to properly analyse the prototype and not test them in any way, the information letter and consent form can be found in Appendix C & D. The interviews were designed to be quick and effective, as the participant has already given feedback on the museum, and asking them to give feedback on the feedback collection system can be seen as quite overwhelming. Before the interviews, the participants were asked to read a written information letter and whether they agreed to the information letter. During this interview the participants were asked to answer the following questions:

1. *How would you describe your interaction with the prototype?*
    a. *Are there any elements that either attracted or repelled you?*
2. *What did you think of the image that was generated on your input?*
3. *Would you say that this generation is representative of your experience at Oyfo?*
4. *Why did you decide to participate with this system?*
5. *How would you compare this system to the classic survey?*

The interview has been conducted in a semi-structured manner, this allowed the researcher to dive deeper into certain aspects that the participant mentioned and to further explore any unforeseen answers.

7.2.2 Observation procedure

Observation served as another valuable source of information regarding the effectiveness of the system. Participants consented to being observed by the researcher. Observations were important because people sometimes struggle to vocalize their steps in

approaching the system, may not notice their own reactions, or may answer more cautiously to avoid causing offense. The observations were aimed at the following 5 different aspects:

1. The level of attraction of the system, why are visitors participating.
2. Emotions during the interaction with the system, more specifically noting down which emotions could be linked to which parts of the system.
3. Noteworthy quotes, these can help to make sense of the evaluation.
4. Their estimated age group and the amount of people who interact with the system at the same time.
5. Specific reactions to the drawing system and the output of the generation

These observations have been quickly noted down with pen and paper, this method has been chosen as the speed of this action can prevent missing other observations.

7.3 Evaluation results

We have categorised the results from the evaluations using the grounded theory method, this entailed that the answers have been coded and categorized. From these categories we will create theories in the conclusion chapter. Each of the categories has been noted down together with the quantity of that category occurring. First, the results from the application will be shown, afterwards the results of the interviews will be shown and finally the results of the observations will be shown.

7.3.1 Results from application

There are 23 participants that have used the system, the results to each question will be shown in tables 8-12. At the fourth table, covering the question regarding recommendation, all answers where “yes” and only the reasoning is shown in the table. To reduce the size of the results we have removed the categories that only occur.

Description of their drawings:

Description	**X**
Steam engine	4
T-shirts hanging from the ceiling	2
Body scanner	2
Phone cell booth	2

Table 8: System results descriptions

Question 1: What did you think of the layout of the museum? (Likert-scale)

Description	X
Very unclear	*0*
Unclear	*0*
Neutral	*4*
Clear	*14*
Very clear	*5*

Table 9: System question 1: Layout

Question 2: How would you describe the museum?

Description	X
Fun	*10*
Interesting/educational	*8*
Interactive	*3*
Historically interesting	*2*

Table 10: System question 2: Museum description

Question 3: What did you think of the assistance that you received? (Likert-scale)

Description	X
Very absent	*0*
Absent	*0*
Neutral	*4*
Pleasant	*10*
Very pleasant	*9*

Table 11: System question 3: Service

Question 4: Would you recommend this to acquaintances? And why?

Description	X
Educational	*8*
Fun	*6*
Suitable for kids	*4*
Interactive	*4*
Technical	*2*

Table 12: System question 4: Recommendation

Summarized results

This is the information that Oyfo would receive, each of the questions will be briefly summarized.

- Table 9 shows that the respondents have a broad array of interests with a slight preference towards the steam engines.

- Table 10 shows that the respondents have no problem with the layout of Oyfo, however there is still room for improvement as the majority of respondents has chosen for clear rather than very clear.
- Table 10 shows that the respondents describe this museum mostly as fun or interesting, while a minority of respondents also describe it as interactive or historically interesting.
- Table 11 shows that the majority of the respondents find the assistance either pleasant or very pleasant, with a small minority having a neutral opinion regarding the service.
- Table 12 shows the respondents would recommend Oyfo to their acquaintances mostly based on the educational and fun aspects at Oyfo, other recommendations are based on the interactivity, technicality and the how suitable the museum is for children.

7.3.2 Results from interviews

We conducted 19 semi-structured face-to-face interviews, each consisting of 5 questions. These interviews provided us with valuable insights into the participants' interactions with the system. The answers from the interviews were categorized and are presented in tables 13-17. It is worth noting that categories that occur only once have not been removed from these tables, as they can still provide us with unique insights or information.

The semi-structured nature of the interviews allowed for flexibility and a deeper understanding of the participants' experiences. Some answers from the interviews and observations may cover multiple categories, as individual responses can align with multiple categories of the results. By categorizing and analysing the interview data, we aim to gain a comprehensive understanding of the participants' perspectives and feedback on the system.

Question 1: How would you describe the interaction with the system? Are there any elements that attracted or repelled you?

Code	***X***	***Code***	***X***
Fun	*11*	*Drawing is a nice interaction*	*2*
System is interesting	*8*	*A bit slow, not smooth*	*2*
Ai is interesting	*5*	*Straightforward*	*1*
Something new	*4*	*Suitable for kids*	*1*
Functional for collecting feedback	*4*	*Picture mosaic is very interesting*	*1*
Visually pleasing	*2*	*Fitting in this museum*	*1*

Table 13: Interview Question 1

Question 2: What did you think of the generated image?

Code	X	Code	X
Visually nice to see	*7*	*Not similar to my input*	*4*
Funny to see the change	*6*	*Interesting*	*3*
Nice to see what AI can make	*5*	*Simpler than the other AI generations*	*1*
Unexpected	*4*	*Too nice to be drawn by a person*	*1*

Table 14: Interview Question 2

Question 3: Was the image somehow representative of your experience?

Code	X	Code	X
No, it was not similar to my sketch	*9*	*Only because you explained how it works*	*1*
Yes, the image was fitting to the musuem	*6*		

Table 15: Interview Question 3

Question 4: Why did you participate?

Code	X	Code	X
Curiosity	*8*	*Felt like part of the experience*	*5*
Wanted to help a student	*6*	*You asked me*	*3*

Table 16: Interview Question 4

Question 5: How would you compare this to a traditional survey?

Code	X	Code	X
This is more fun to do	*15*	*New and surprising*	*2*
Surveys are boring and overdone	*14*	*This method still contains the "classic survey questions"*	*1*
I think this is more effective at collecting feedback	*8*	*If this replaces surveys, drawing can become repetitive*	*1*
This method fits the museum	*3*	*This is more suitable for kids*	*1*

Table 17: Interview Question 5

Summarized results

From the conducted interviews we will summarize the results of each question.

- Table 13 shows that that the respondents mostly describe the system as either fun, interesting, refreshing or functional for collecting feedback. Other noteworthy descriptions are: fun to draw, the system is a bit slow and visually pleasing.

- Table 14 shows that the respondents had mixed reactions on the generated image, the majority found it either funny or aesthetically pleasing to see the change. Other important reactions were the following: the generated image was not similar to their sketch, or the image was either deemed interesting or unexpected.
- Table 15 shows that the majority of respondents did not feel that the generated image represented their experience at Oyfo. The minority of the respondents found the generated image fitting to the Oyfo experience.
- Table 16 shows that the majority of the respondents participated in the interaction due to curiosity, two other reasons for participating were either willingness to help out a student or because it felt like part of the Oyfo experience. A minority answered that they only participated due to the researcher approaching them.
- Table 17 shows that almost all of the respondents found this method of collecting feedback more fun than classic surveys, and they found surveys overused or boring. Some respondents thought that this method would be more effective at collecting feedback. A minority of respondents thought that this method either fits Oyfo very well, or is refreshing. However a small minority of the respondents mentioned that this method still uses standard survey questions and that implementing this system everywhere can become repetitive.

7.3.3 Results from observations

The observations were aimed at analysing the initial attraction, the emotions, the reactions and any noteworthy quotes. Not all participants have been individually observed, as there was only one researcher present at the evaluation and multiple interactions happened at the same time. The elements have been separated into the following factors; attraction, pleasures, and frustrations, shown in table 18-20.

Observations: Attraction

Code	***X***	***Code***	***X***
Curiosity	*5*	*Attracted by other people interacting*	*3*
Not attracted, was asked	*4*	*Approached the researcher directly, rather than the installation*	*3*

Table 18: Observation attraction

Observations: Pleasures

Code	X	Code	X
Invoked curiosity in AI and system	*9*	*Enjoying the drawing*	*3*
Impressed with the system	*5*	*Enjoying the visual aspects*	*3*
Satisfied with generation	*4*	*Intrigued with the picture mosaic*	*1*

Table 19: Observation pleasures

Observations: Annoyances

Code	X	Code	X
Consent information is a lot of text	*4*	*System has input delay*	*2*
Insecure about their drawing skills	*3*	*Too time consuming*	*2*
Generated image not similar to sketch	*3*	*Multiple choice question has neutral as basic option*	*1*

Table 20: Observation frustrations

- Table 19 shows that the participants were approached the installation due to four main reasons: they were either curious about the installation, asked by the researcher, attracted by other interactions or interested in the researcher rather than the installation.
- Table 20 shows that the majority of the participants became more curious through their interaction, other participants were either impressed or satisfied with the system. The drawing system, visual design and the picture mosaic were other noteworthy elements.
- Table 21 shows that the participants still experienced quite some annoyances, the main annoyances are in the amount of consent information, the drawing system or the mismatch between sketch and generated image. Furthermore, some participants expressed annoyance regarding input delay of the system, the time that was needed or the fact that the multiple choice questions already had neutral selected.

7.4 Evaluation limitations

During the evaluation period, we encountered some unforeseen limitations that could have influenced the results. Here, we will briefly discuss these limitations and their potential impact:

The first limitation relates to the weather conditions during the evaluation period. As the weather was hot, the museum experienced a lower number of visitors, which in turn reduced the overall number of participants in our study. Ideally, we would have conducted the evaluation during Dutch holidays when the museum receives a higher influx of visitors, potentially leading to a larger participant pool.

The second limitation concerns the attractiveness of the physical installation. Due to the researcher's presence behind the setup, it may have appeared less professional and less inviting to participants. Consequently, many people did not approach the system intuitively. To ensure an adequate number of participants, the researcher had to actively approach most of them. However, this impacted our research since the initial plan was to assess the system's attraction level organically.

These limitations highlight the potential influence of external factors on the evaluation process and participant engagement. While we acknowledge these limitations, we will interpret the results within the context of these constraints and provide a comprehensive analysis of the findings.

8. Discussion & Future work

This chapter will discuss the findings and suggest future improvements based on the discussion. This project was researched and developed to try to find a method to improve the quality of feedback at museums, given by visitors with diverse backgrounds. An interactive feedback collection method that attracts participants through an AI based image generation software.

8.1 Museum feedback results from application

First, we will examine the effectiveness of collecting valuable feedback through the application and its ability to provide Oyfo with insights into how their visitors experience the museum. The results from the application successfully provide Oyfo with this insight, as they cover three key factors contributing to the visitor experience:

- Physical setting*:* The application provides an overview of how participants evaluated the layout of the museum. The majority of respondents found the layout to be clear or very clear.
- Service provided: The application offers insights into how participants evaluated the assistance received at the museum. The majority of respondents found the assistance to be either pleasant or very pleasant, with a small minority having a neutral opinion.
- Level of engagement*:* The application provides insights into the factors that engage respondents. The question about drawing and describing their favourite part of the museum offers Oyfo an understanding of which elements are highly regarded by participants. Additionally, the question about recommending the museum to acquaintances provides an overview of engaging and repelling elements. However, it's worth noting that the answers to the questions regarding the museum's description and recommendation yield similar responses. One of these questions could be replaced with a question covering another topic, such as "What would you like to add to this museum?

From the above mentioned results, we can determine that the application is effective at providing Oyfo with an insight into how their visitors experience the museum. The questions could still be adjusted to prevent two questions covering the same topic.

8.2 Evaluation factors

In this section, we will summarize the results obtained from the interviews and observations. These evaluation methods aimed to assess the effectiveness of the system and its features. We will analyse different factors based on the obtained results.

8.2.1 Initial attraction

The level of initial attraction helps determine whether visitors would approach the system. It is important to note that during the evaluation, a rough prototype was used, and participants were actively approached to ensure an adequate number of participants. For this discussion, we will trust participants' reasoning and assume that if the system were fully implemented into Oyfo, they would approach it out of curiosity.

From the interviews, we obtained varied responses. Many respondents stated that they were either curious about the system or felt it was part of the Oyfo experience. This supports the method of integrating the system seamlessly into the museum, creating a sense of automatic participation. However, some participants mentioned participating to help a student or because they were approached by the researcher. The observations provide a slightly skewed perspective on attraction, as the researcher approached most participants, and not every interaction could be observed. To gain a better understanding of the actual level of attraction, future research should design a system without prototype elements, resembling the museum's style, to assess the attraction levels for different demographics.

8.2.2 Interactions

We evaluated two interactions: the drawing system and the touchscreen. We will first discuss the participants' evaluation of the drawing system. Overall, respondents reacted positively to the drawing system and found it fitting to the level of interactivity at Oyfo. However, some participants experienced frustrations due to input delays, which caused minor disruptions. Additionally, some participants felt insecure when drawing, potentially due to being observed by us or their companions. Despite these concerns, the majority of participants enjoyed the drawing interaction, with younger children showing the highest enjoyment and the elderly expressing the least enthusiasm. The observation of some participants spending over 5 minutes on their drawings further supports the idea of using drawing as an interaction method. However, it may be beneficial to include an alternative interaction option to cater to those who do not enjoy drawing.

The second interaction evaluated was the tablet as the main input for the questionnaire. The input delay between the system and the tablet caused frustrations for some participants. The inclusion of a touchscreen keyboard aimed to leverage participants' familiarity with typing on screens, but it resulted in errors and frustrations due to limited correction options. Some participants suggested using a record and play audio interaction, as it could reduce the interaction time and increase efficiency. Exploring audio-based interactions or improving error prevention on the touchscreen keyboard could be valuable directions for future research.

8.2.3 Image generation

We designed the system around the image generation software, the goal was give the feeling of accomplishment back to the participants in return for leaving feedback. For this to work the goals that we set out were the following: Time needed for generation should be less than 90 seconds and the generated image should resemble the experience of the visitor. We will now discuss both element and discuss whether the system achieved these goals:

First, we will discuss the generation time. Overall, there were no remarks regarding the generation time. The system was designed to initiate the generation process after question 3, and while the participant was answering question 4, the image generation had already begun. Consequently, in some cases, the generation was completed before participants finished the questionnaire, creating a sense of instant generation. Some participants with a basic understanding of AI-based image generation expressed great admiration for the quick generation time. In conclusion, the generation time was remarkably fast and did not disturb any participant, allowing for the possibility of implementing more stable diffusion steps to further enhance the quality of the generated images.

Secondly, we will discuss the quality of the generated image. The results revealed a mixed perception of the quality of the generated images. Some respondents found it enjoyable and interesting to see what their sketch had produced. However, there were also participants who did not recognize their sketch or had other confusing experiences. One issue was that the system did not clearly explain how participants' answers were translated into the generated image, leading to confusion among some participants. For example, someone drew a green telephone and rated the assistance as "very good," the software combined the sketch with the prompt "very warm colour palette," resulting in a red phone. The application should provide clearer explanations of its processes. Another problem arose with the description of the sketches. Since most participants were Dutch, the translation software sometimes made mistakes due or incorrect translations or spelling mistakes in general. For instance, the Dutch word for a construction crane is the same as the word for a faucet, and in one case, a participant drew a construction crane but described it using the Dutch word for crane. However, the software generated an image of a faucet instead. Overall the participants liked the generations, but often did not recognize their drawing. A finer configuration of the stable diffusion software combined with more steps in the diffusion process could help to prevent these mismatches.

8.2.4 Picture mosaic

In order to further encourage people to provide feedback, we introduced the picture mosaic feature. The underlying idea was that offering the option to contribute to a larger picture

would increase participants' willingness to participate. During the evaluation, the picture mosaic was displayed on a regular-sized monitor and created using Mosaically.com. However, this website does not support automation, resulting in some generated images not being immediately incorporated into the mosaic. As a consequence, the mosaic often went unnoticed or was forgotten during the evaluation process. Most participants were primarily focused on the image generation itself and considered their task complete once they saw the generated image. Unfortunately, the mosaic did not achieve the desired effect in this prototype. Nevertheless, there was some participants who expressed genuine excitement about the mosaic and its potential to quickly visualize diverse experiences. When asked about the mosaic, the majority of participants acknowledged it as a good idea but showed no further enthusiasm. For future research, integrating the mosaic directly into the application and animating the transition of the generated image into the mosaic could help draw attention and enhance the sense of contribution to the bigger picture. It is worth noting that Oyfo expressed keen interest in receiving the mosaic to potentially use it in a future exhibition centered around AI.

8.2.5 Influencing the participants

In this section we will discuss how the participants may have been influenced by certain factors associated with the project being a graduation project conducted by a student of the University of Twente. Based on our observations, we noticed that participants experienced some frustrations related to the amount of consent information required to participate. Ideally, the interaction should be as streamlined as possible, and the volume of text that participants need to read before they can participate should be minimized. While most participants were willing to read everything to assist the researcher, it would be interesting to explore whether reducing the amount of consent information could help reducing unnecessary frustrations.

A similar consideration applies to the presence of the researcher during the evaluation. As previously mentioned, some participants could have been influenced by the researcher. The presence of an observer sometimes made them feel insecure or prompted them to act more favourably. To conduct a more effective test of the system's performance, it would be interesting to have the system run independently while the researcher observes from a distance.

8.2.6 Survey comparison

In this section, we will discuss the comparison between this system and the traditional survey. We will explore the trade-off between engaging interaction and faster interaction with a larger group. Additionally, we will analyse the perspectives of the respondents.

Based on the interview results from question 5, it is evident that almost all respondents have an inherent dislike for surveys. The answers reveal that surveys are perceived as repetitive, boring, and often go unanswered. In contrast, this prototype is seen as novel, refreshing, and enjoyable. The element of fun associated with this prototype should encourage visitors to provide feedback. However, the time required to interact with the application could potentially be a disruptive factor. Considering that the museum experiences peak times with up to 500 visitors per day, not every visitor would have the opportunity to interact with the system. In comparison, a survey that can be distributed to everyone would perhaps receive more responses due to a larger sample size.

Another noteworthy perspective shared by some respondents is related to the effectiveness of this system within the museum context. This project aligns well with the interactive nature of the Oyfo museum. However, its value may diminish in museums with less interactivity. Implementing this system in other sectors, such as providing feedback on Amazon deliveries, would not yield the same level of effectiveness. Furthermore, one respondent raised an interesting point about the format in which the questions were asked. Despite the inclusion of image conversion elements, the questions still followed a survey format, which triggered to answer the questions could be an intriguing topic for a potential future prototype.

8.2.7 Additional remark

To close up this discussion there is one last aspect worth discussing, the timing of the evaluation. The Oyfo museum experiences varying numbers of visitors throughout the year. Ideally, the evaluation would have been conducted during a school vacation or one of the Dutch holidays, such as Easter or Pentecost. However, due to the graduation project deadline and the development duration of the project, the evaluation took place during a period of lower visitor turnout. Consequently, the small number of visitors resulted in a lower participation rate, making this research more exploratory rather than definitive. It would be intriguing to conduct a second iteration of this prototype during a week when the visitor count can reach as high as 500 visitors in a single day.

9. Conclusion

This research aimed to investigate a method for improving the quality of feedback provided by visitors with diverse backgrounds at museum Oyfo. The main research question focused on determining the manner in which the quality of feedback can be enhanced. Additionally, four sub-research questions were addressed: reforming the current questionnaire into a more immersive method, integrating the collection method into the existing Oyfo experience, making the collected feedback accessible for Oyfo, and evaluating participants' perceptions of this mode of feedback.

To answer the main research question, we developed and employed an interactive feedback collection system that utilized AI-based image generation software. The results demonstrated that this system effectively provided Oyfo with valuable insights into how visitors experienced the museum. The questionnaire covered three factors contributing to the visitor experience: physical setting, service provided, and level of engagement. The participants' responses indicated a clear understanding of the museum layout, positive evaluations of the assistance received, and insights into the engaging elements of the museum. However, it was also identified that some questions in the questionnaire covered similar topics, suggesting a need for adjustments to prevent redundancy and potentially introduce new topics for evaluation.

Regarding the reformulation of the current questionnaire into a more immersive method (*sub-RQ1),* the interactive elements of drawing and touchscreen interaction were evaluated. Participants generally responded positively to the drawing system, finding it fitting to the interactivity level at Oyfo. However, some participants experienced frustrations related to input delays and feeling observed while drawing. Incorporating additional interaction options to cater to individuals who do not enjoy drawing could be an interesting direction. The touchscreen interaction, although familiar to participants, had issues with input delays and error prevention. Some participants expressed a preference for an audio-based interaction method, which could enhance efficiency. To answer this sub-research question, the questionnaire can be reformed through interactive elements and other immersive elements.

To address the integration of the collection method into the current Oyfo experience (*sub-RQ2*), the research investigated the level of initial attraction and participants' perceptions of the system. The findings indicated that participants were generally attracted to the system due to curiosity and the perception of it being part of the Oyfo experience. However, participants who were approached by the researcher expressed motivations related to helping a student or being approached. A recommendation for future research is to design a system that seamlessly blends into the museum environment without any visible prototype elements.

This would provide a more accurate assessment of the system's attraction level and determine if different demographic groups approach the system equally. However, the level of interactivity and the topic of Artificial Intelligence matched the current Oyfo atmosphere and thus the concept of the collection method has been integrated according to the Oyfo experience.

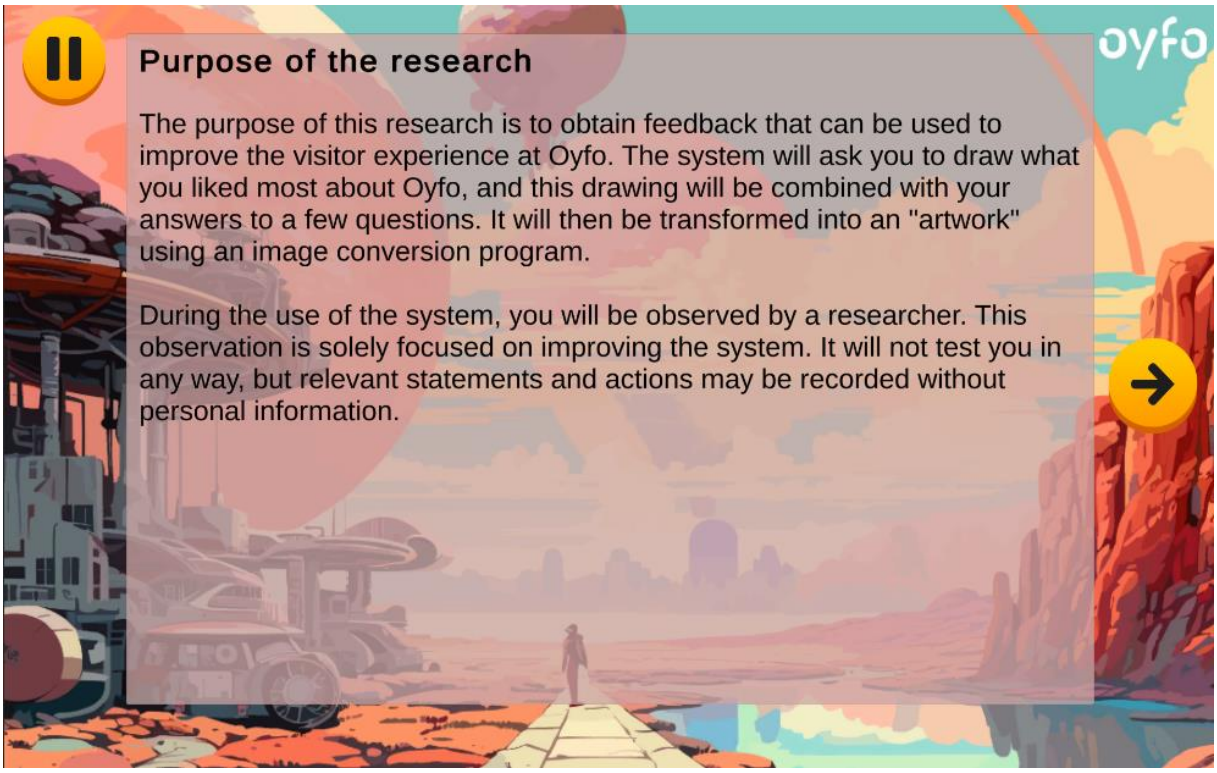
Regarding the accessibility of the collected feedback for Oyfo *(sub-RQ3*), the application exports the obtained results in a local csv-file. The open questions do not allow for easy processing of the data, however the csv file does allow for interpretation by museum Oyfo. The picture mosaic offers Oyfo an quick insight into how the visitors experience the museum, as the colour and level of chaos of the mosaic represent how the visitors have experienced the museum.

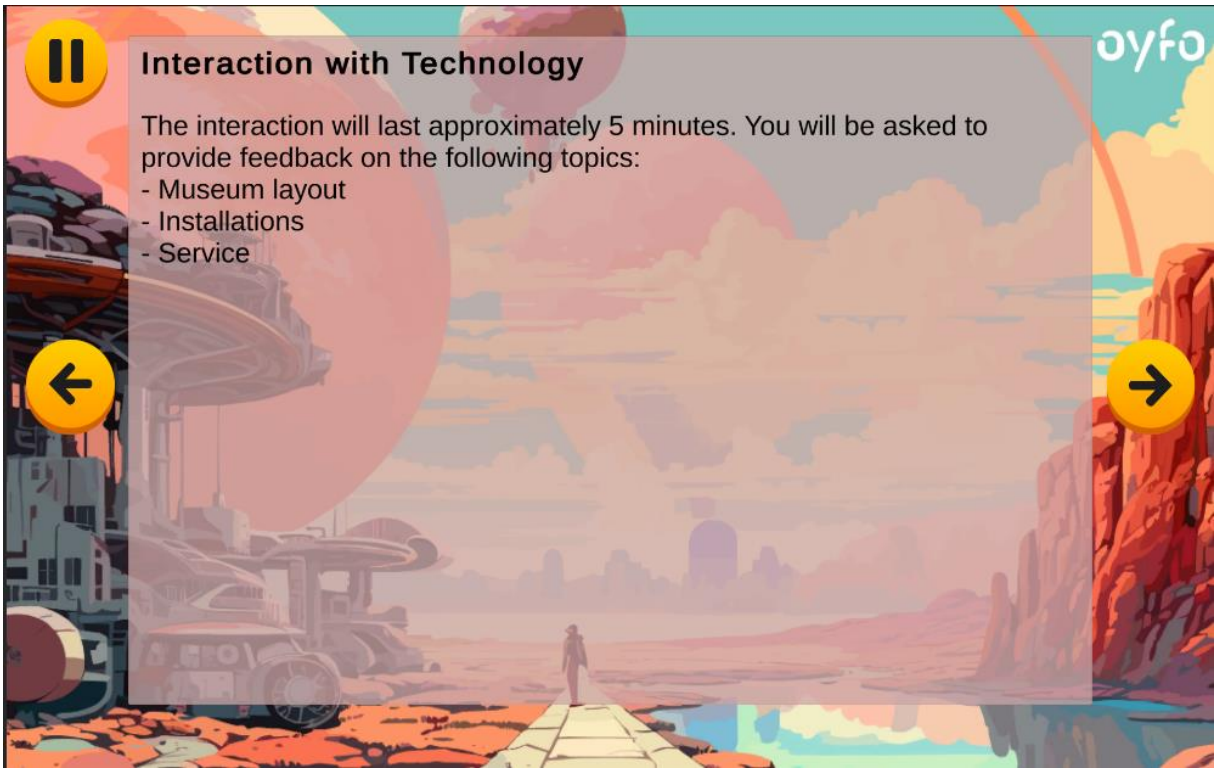
Finally, *sub-RQ4* focused on participants' evaluation of this mode of feedback. The findings highlighted a dislike for traditional surveys and a preference for the novel and enjoyable nature of this interactive prototype. However, the time required for interaction could potentially limit the number of participants, especially during peak visitor periods. A trade-off between engaging interaction and faster interaction with a larger group was identified. Additionally, participants acknowledged the suitability of this system for the interactive nature of Oyfo but recognized its limitations in other contexts. Suggestions were made to explore alternative question formats and reduce the amount of consent information required to streamline the interaction process.

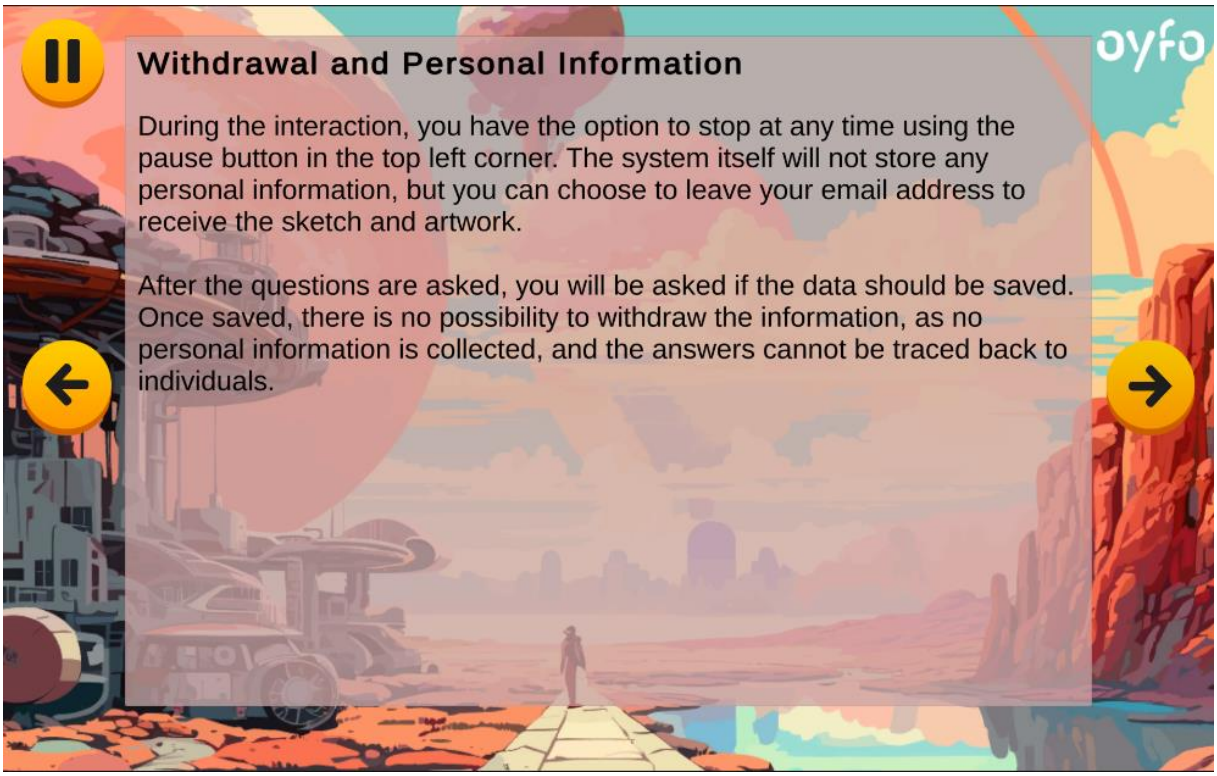
In conclusion, this project represents the first step towards a new method of collecting visitor feedback in museums. By utilizing an interactive system that provides participants with something in return for their feedback, we can enhance the quality of feedback at Oyfo museum from visitors with diverse backgrounds. The use of AI-based generation as a means of giving back to participants has proven effective, invoking a sense of curiosity and engagement. Moreover, integrating the system seamlessly into the Oyfo experience lowers the threshold for visitors to provide feedback.

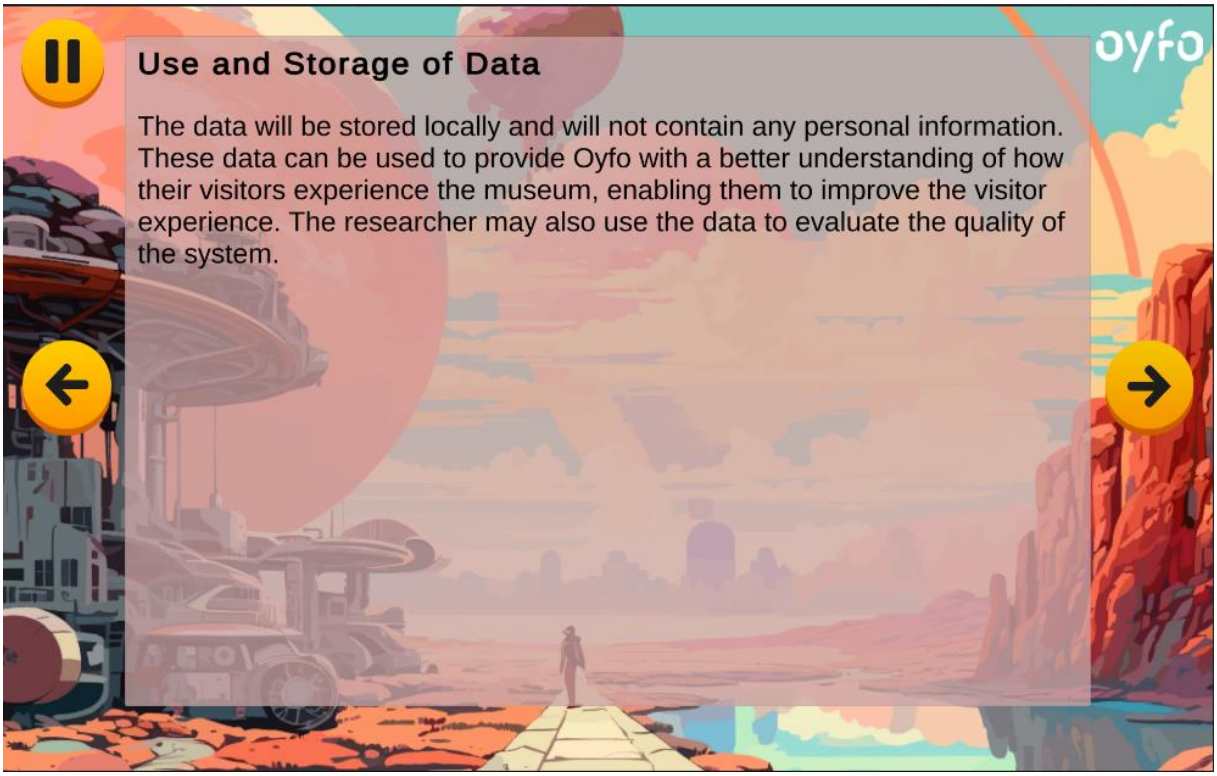
The conclusions drawn from this project can serve as valuable design guidelines for future iterations or entirely new methods of visitor feedback collection. Building upon these findings, further enhancements can be made to refine the system and optimize the feedback collection process at Oyfo museum. By continuously iterating and improving upon this innovative approach, museums can better understand and meet the needs of their visitors, resulting in a more enriching and engaging experience for all.

Appendix A: Information letter application 16+



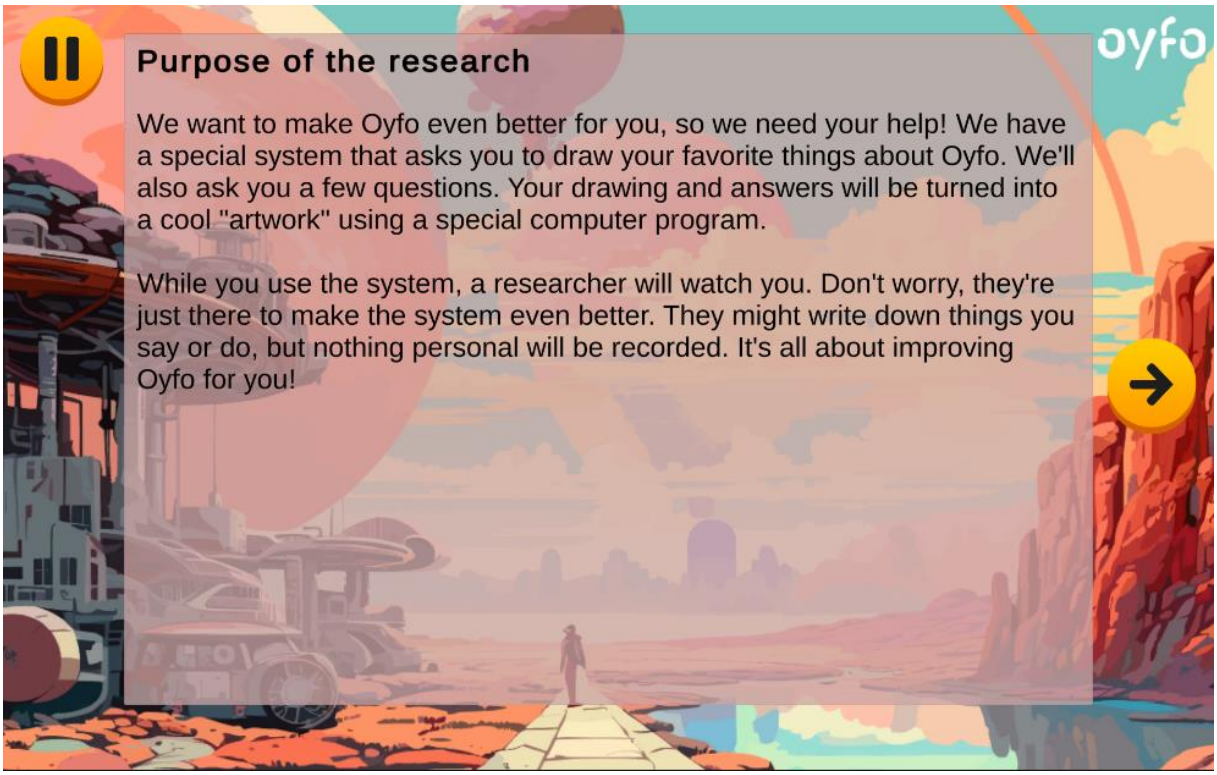


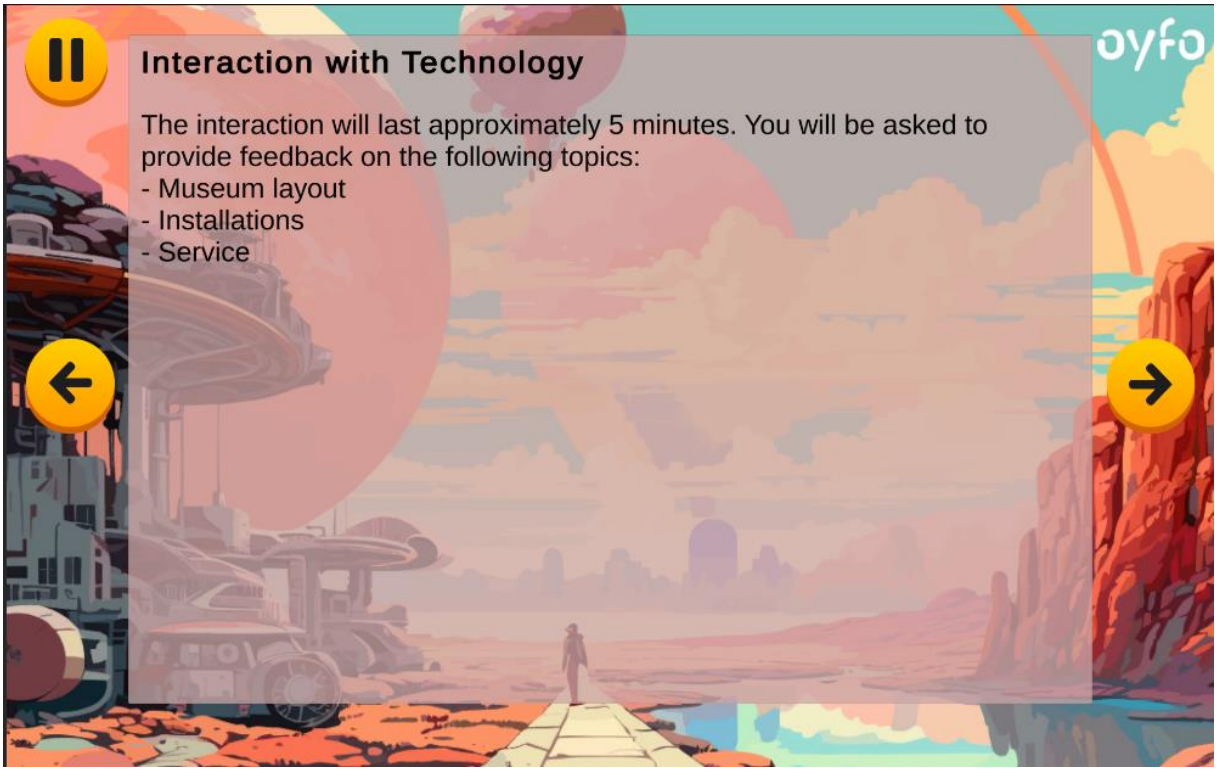

oyfo
Withdrawal and Personal Information
During the interaction, you have the option to stop at any time using the pause button in the top left corner. The system itself will not store any personal information, but you can choose to leave your email address to receive the sketch and artwork.
After the questions are asked, you will be asked if the data should be saved. Once saved, there is no possibility to withdraw the information, as no personal information is collected, and the answers cannot be traced back to individuals.

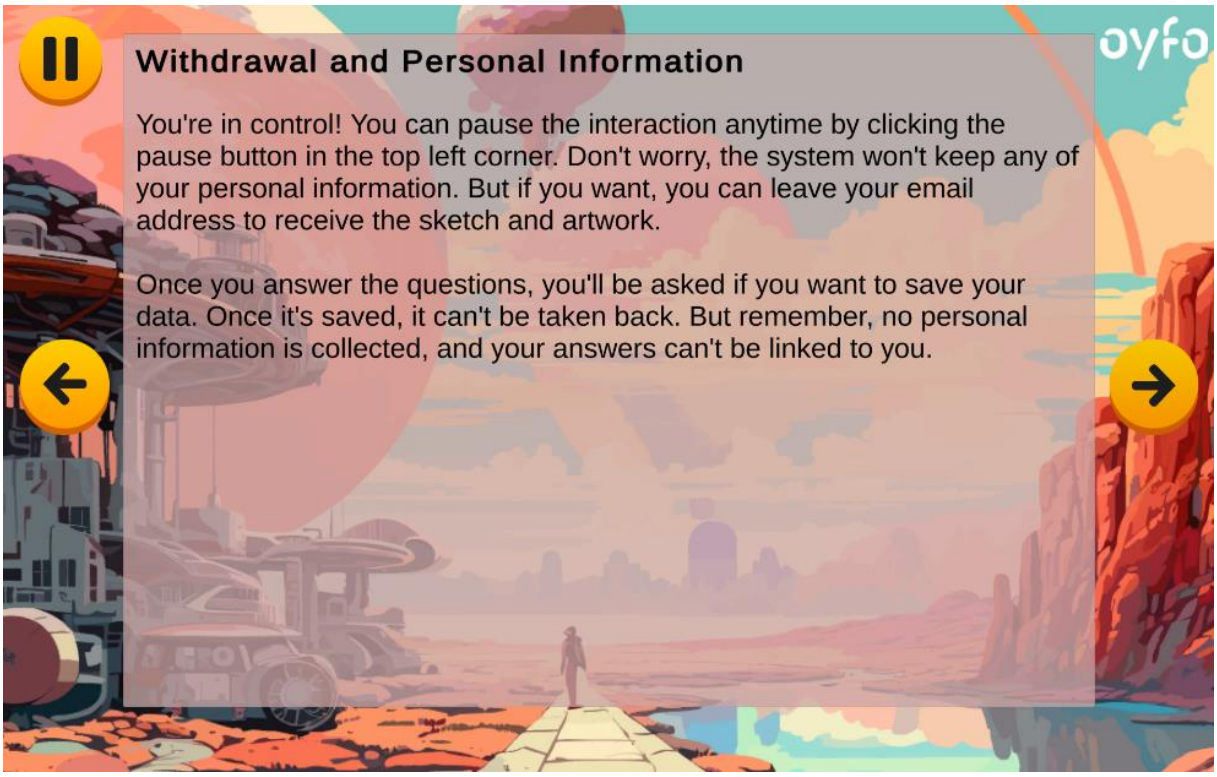

oyfo
Use and Storage of Data
The data will be stored locally and will not contain any personal information. These data can be used to provide Oyfo with a better understanding of how their visitors experience the museum, enabling them to improve the visitor experience. The researcher may also use the data to evaluate the quality of the system.

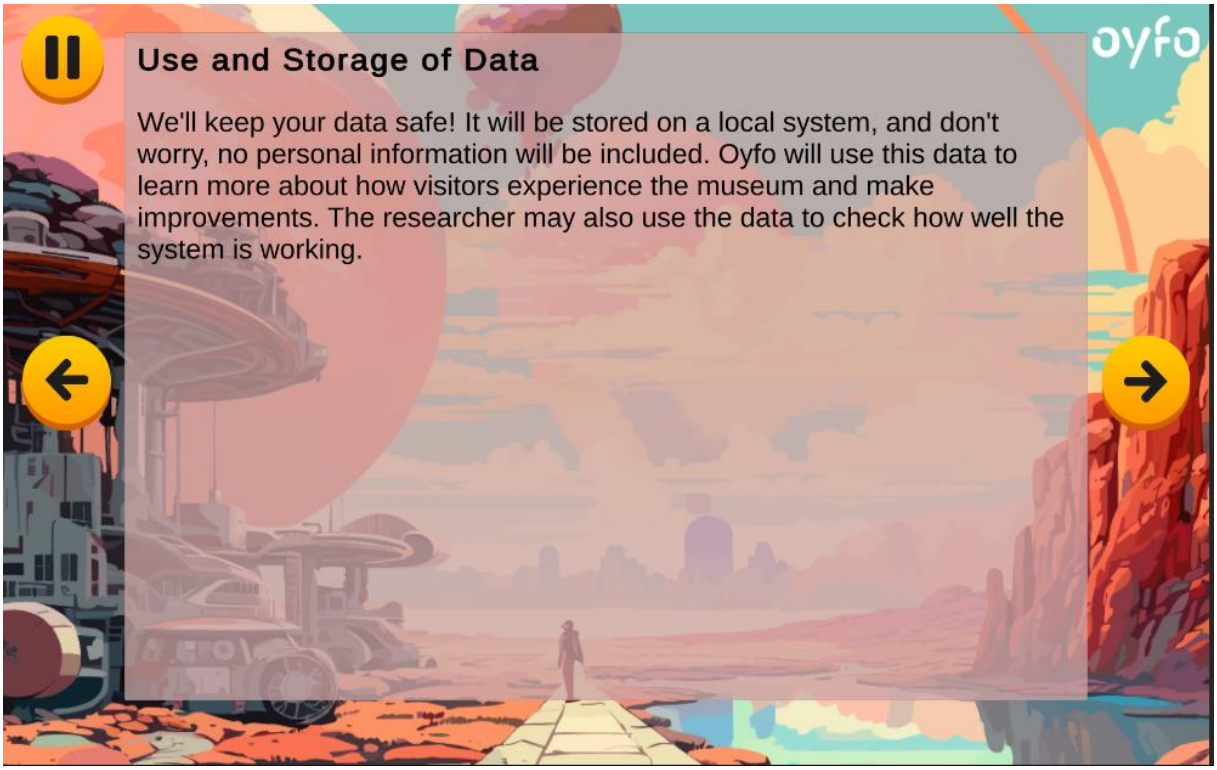

Contact Information
If you have any questions about the research or the use of data, you can contact the principal investigator:
Roland Wit, Creative Technology
r.a.wit@student.utwente.nl
Student number: 2150565
If you have any questions about your rights as a participant in the research, or if you want to obtain information, ask questions, or discuss any concerns about this research with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science:
ethicscommittee-CIS@utwente.nl

Appendix B: Information letter application 16-






oyfo
Withdrawal and Personal Information
You're in control! You can pause the interaction anytime by clicking the pause button in the top left corner. Don't worry, the system won't keep any of your personal information. But if you want, you can leave your email address to receive the sketch and artwork.
Once you answer the questions, you'll be asked if you want to save your data. Once it's saved, it can't be taken back. But remember, no personal information is collected, and your answers can't be linked to you.


oyfo
Use and Storage of Data
We'll keep your data safe! It will be stored on a local system, and don't worry, no personal information will be included. Oyfo will use this data to learn more about how visitors experience the museum and make improvements. The researcher may also use the data to check how well the system is working.


Contact Information
If you have any questions about the research or the use of data, you can contact the principal investigator:
Roland Wit, Creative Technology
r.a.wit@student.utwente.nl
Student number: 2150565
If you have any questions about your rights as a participant in the research, or if you want to obtain information, ask questions, or discuss any concerns about this research with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science:
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Appendix C. Information letter interview

Information letter for "Interview on Interaction"

Bijgewerkt op: 12/6/2023

Purpose of the research

The purpose of this research is to test the effectiveness of the system through a face-to-face interview. This data will be used to evaluate the functionality of the system. Participants for this interview will be selected from the participants of the feedback collection system.

Interview

The interview will take approximately 5 minutes. You will be asked to provide feedback on the following topics:

- General response
- Technology
- Appeal
- Effectiveness

Withdrawal and personal information

During the interview, you have the option to withdraw at any time without any consequences. The collected answers will be destroyed in such cases.

Use and storage of data

The data will be stored locally in a Word file on the researcher's computer. The data will be used to evaluate the effectiveness of the system. The data does not contain personal information, after participation, there is no possibility of withdrawal as the data cannot be traced back to an individual. The obtained data will be stored and used until the end of July, and it may be used in the scientific report on the research.

Contact information

If you have any questions regarding the research or the use of data, please contact the principal investigator:

Roland Wit, Creative Technology

r.a.wit@student.utwente.nl

student number: 2150565

If you have questions about your rights as a research participant or if you wish to obtain information, ask questions, or discuss any concerns about this research with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science:

ethicscommittee-CIS@utwente.nl

Appendix D. Consent form interview

Consent form for the interview regarding the interaction

Please tick the appropriate boxes:	Yes	No
Taking part in the study		
I have read and understood the information letter dated 12/6/2023. I have been able to ask questions about the research, and my questions have been satisfactorily answered.	○	○
I voluntarily consent to participate in this research and understand that I have the right to refuse to answer questions and withdraw from the study at any time without providing a reason.	○	○
I understand that participation in the research involves answering questions about my experience with the feedback collection system. The answers I provide will be recorded by the researcher	○	○
Use of the information in the study		
I understand that the provided information will be used for the evaluation of the console and may be used in the report relating to this research	○	○
I understand that personal information collected about me, such as my name, will not be shared outside the research team.	○	○
Future use and reuse of the information by others		
I consent to the archiving of the questionnaire responses I provide in a local Word file on the researcher's computer for future research and learning. This data does not include personal information.	○	○

Signatures

Name of participant	Signature	Date
Name of legal guardian	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Researcher name	Signature	Date

Study contact details for further information:

Roland Wit, r.a.wit@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: ethicscommittee-CIS@utwente.nl

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