Project Design and Management for Data Science

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P & B

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Chapter 1

Introduction

This report examines the complete journey of developing a solution tailored to meet a specific user requirement. The approach used is **Design Thinking**, a method aimed at addressing complex challenges through a creative, iterative, and user-focused process. This methodology steers teams through various stages, including observation, empathy-building, brainstorming, prototyping, and evaluation. The report specifically delves into two key phases of Design Thinking: **Desirability** and **Feasibility**.

The **Desirability** phase centers on gaining a profound understanding of what is desirable by exploring questions such as what is meaningful to people and what aligns with their values, whether there are needs that remain unmet, if certain needs could be addressed more effectively or efficiently, how critical the need is to the user, and whether there is supporting quantitative data. This stage emphasizes the exploration of users' emotional and psychological needs. Innovators work to identify who the users are, what they seek, what they prioritize, and what they find significant. The chapter on Desirability offers methods for pinpointing user needs, formulating and testing need-based hypotheses, creating need statements, and evaluating them through an iterative approach. The process begins

with generating a broad range of options and concludes by refining these choices, transitioning from broad to focused thinking.

In the **Feasibility** phase, the focus shifts to designing and assessing solutions that not only address functional requirements but also resonate with users' values and emotional context. This section provides techniques for solution creation, detailed descriptions, and evaluation processes, along with results. Through these steps, viable solutions are identified, refined, and assessed.

This project is particularly concerned with the **art sector**, investigating how Design Thinking can help discover new audiences and create innovative engagement methods to interact with artistic heritage.

Chapter 2

Desirability

In the desirability phase, we focus on understanding users' needs. We will select the most appropriate methods and tools to target our user base and their specific needs. Then we formulate need hypotheses and test them iteratively to refine our understanding of what users value.

2.1 Methods

To ensure our design solutions effectively meet user needs, we used a range of research and validation methods. Each method played a key role in helping us gather insights, generate creative ideas and validate our assumptions. Here's a breakdown of the approaches we used and their specific purposes.

2.1.1 Users and Needs

Brainstorming

Is an organized collaborative method designed to stimulate creativity while minimizing the risk of ideas being compromised due to social pressures. Initially, the team is divided into four subgroups of one person each. This setup encourages

individuals to share their ideas without the fear of judgment. To enhance the creative process, we establish some ground rules: sessions are limited to 30 minutes, criticism is avoided and participants refrain from using adverse conjunctions like ”but” when discussing others’ ideas. This approach prioritizes quantity over quality. At the end of this procedural phase, we synthesize, refine and formally articulate the identified users and needs. Each proposal is then voted on by the team using an absolute majority method to eliminate less promising ideas. To optimize the flow of ideas in generating need hypotheses and identifying users, multiple structured brainstorming sessions are conducted. This method helps establish specific parameters for the divergent ideation process.

Web Research

This approach involves utilizing various digital platforms, such as Wikipedia, ChatGPT, ISTAT, industry reports, social media and forums, to collect data that can inform the design process. By exploring existing literature and user discussions, we can identify trends, preferences and pain points that users experience in real life. One of the key advantages of web research is its accessibility; it allows teams to gather a wide range of perspectives without the limitations of time and geographic location. For instance, using Wikipedia provides a broad overview of topics, while ISTAT offers reliable statistical data relevant to user demographics and behavior. ChatGPT can facilitate quick access to diverse viewpoints and generate insights through conversational inquiry.

2.1.2 Need Hypothesis

Benchmarking

Is a strategic method used to compare our findings with industry standards or competitor practices to validate and justify the percentages assigned in our need hypotheses. This process involves gathering quantitative and qualitative data from

various sources, such as competitor analyses, case studies and market research reports. In our project, benchmarking serves to provide a context for our identified user needs, allowing us to support our hypotheses with empirical evidence. For example, if we determine that a certain percentage of users express a specific need, we can cross-reference this with data from similar platforms or products to assess its validity. By establishing benchmarks, we ensure that our need hypotheses are grounded in reality, making our design process more focused and effective in meeting user's actual demands. For example for the Tourist need hypothesis, where we propose that over 55% of users would find a tool for personalized itineraries useful and reusable for future trips, benchmarking helps justify this percentage. To support our assumption, we researched similar tools in the digital tourism industry, such as travel planning platforms and personalized itinerary apps, gathering data on user satisfaction and reuse rates. By employing benchmarking, we not only substantiate the 55% figure in our hypothesis but also enhance the reliability of our process, ensuring that potential user expectations are based on concrete and comparable data.

2.1.3 Need Statement and assessment

Interviews

Interviews are a qualitative research method that involves direct, in-depth conversations with individuals to gather insights about their experiences, opinions and needs. This method allows researchers to explore complex topics in detail and gain a deeper understanding of the perspectives of the interviewees. By asking open-ended questions, interviewers can encourage participants to share their thoughts and feelings, leading to richer data that might not be captured through surveys or quantitative methods. In our project, we utilized interviews to validate the hypothesis regarding the **need for increased access to tactile art for individuals with**

visual disabilities. By speaking directly with potential users and stakeholders, we aimed to uncover their experiences with existing tactile art offerings in Italian museums. This qualitative feedback will help us determine the interest level among disabled individuals for a more widespread availability of tactile art. Through this approach, we can gather valuable insights that will support our hypothesis and inform potential solutions to enhance accessibility in the art world.

Focus Group

We employed focus groups as a methodological tool for both validating our hypotheses and assessing the significance of various factors. By convening a diverse group of participants, we gathered rich qualitative insights into their experiences and perspectives. This interactive format fostered dynamic discussions, enabling us to explore different viewpoints and enhance our understanding of user needs. Furthermore, the feedback obtained from these sessions played a critical role in calculating the importance scores for our hypotheses, ensuring that our conclusions were firmly anchored in actual user experiences and priorities. For example, we organized sessions with **visitors of Pisa** to assess their need for a personalized and accurate guide. Insights from these sessions highlighted the significance of creating a multilingual guide to enhance their experience and minimize reliance on human assistance.

Wheel of emotions

The Wheel of Emotions (Figure 2.1) is a method developed by psychologist Robert Plutchik to categorize emotions and illustrate how they relate, intensify and combine to form complex emotional experiences. By identifying core emotions—such as joy, trust, fear and anger—and understanding their combinations, this tool helps us to analyze the emotional drivers behind user needs.

In our project, the Wheel of Emotions allows us to validate the emotional component of user desires by grounding our hypotheses in recognized emotional re-

sponses. For example, in the hypothesis that **young gamers** want to customize their game characters, the Wheel helps identify emotions like joy (satisfaction from creativity) and trust (authentic self-expression). Using this model, we can predict and measure how these emotions might drive the desire for customization, giving depth and validity to our hypothesis. This ensures our project not only meets functional needs but resonates emotionally, making our approach more holistic and user-centered.

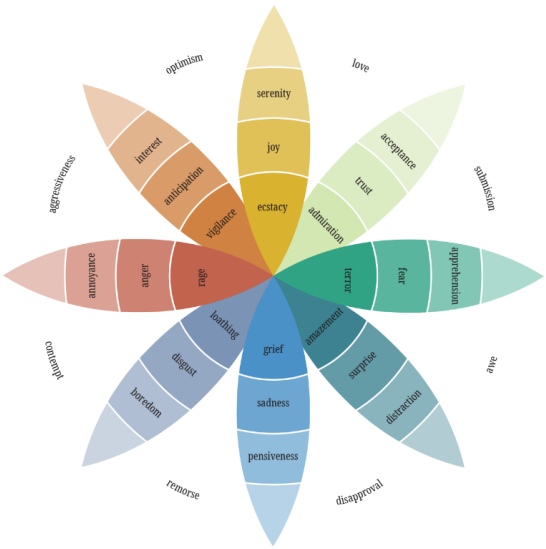

Figure 2.1: Wheel of emotions

PANAS

The Positive and Negative Affect Schedule (PANAS) (Figure 2.2) is a psychological tool used to assess two distinct dimensions of mood: positive affect and negative affect. It comprises a list of adjectives that describe various feelings and emotions, which participants rate based on their experiences over a specified time frame, such as the past week or the present moment. The positive affect dimension includes adjectives like ”enthusiastic”, ”active” and ”alert”, while the negative affect dimension includes terms such as ”upset”, ”nervous” and ”ashamed.” Respondents

indicate the extent to which they have experienced each emotion using a Likert scale, allowing researchers to quantify levels of positive and negative affect. We employed the PANAS method to measure users' emotional responses to each need statement. This approach enabled us to calculate the importance of each need by assessing the extent of positive and negative feelings associated with them. For example, if a significant number of users reported high levels of positive affect regarding a specific need statement, this indicated strong user engagement and satisfaction, which informed our prioritization in the design process. Conversely, high levels of negative affect could highlight areas requiring improvement, ensuring that our solutions effectively address user needs and enhance overall satisfaction. By integrating PANAS into our evaluation, we gained valuable insights that shaped our understanding of user priorities and informed our project's direction.

Positive and Negative Affect Schedule (PANAS)

Instructions:

This scale consists of a number of words that describe different feelings and emotions. Read each item and indicate to what extent you have felt this way during the past week.

		Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1	Interested	1	2	3	4	5
2	Distressed	1	2	3	4	5
3	Excited	1	2	3	4	5
4	Upset	1	2	3	4	5
5	Strong	1	2	3	4	5
6	Guilty	1	2	3	4	5
7	Scared	1	2	3	4	5
8	Hostile	1	2	3	4	5
9	Enthusiastic	1	2	3	4	5
10	Proud	1	2	3	4	5
11	Irritable	1	2	3	4	5
12	Alert	1	2	3	4	5
13	Ashamed	1	2	3	4	5
14	Inspired	1	2	3	4	5
15	Nervous	1	2	3	4	5
16	Determined	1	2	3	4	5

Figure 2.2: PANAS

Maslows‘ Pyramid

Maslow’s Pyramid or Maslow’s Hierarchy of Needs (Figure 2.3) , is a psychological method that categorizes human needs into five ascending levels, from basic physiological needs to self-actualization at the top. Each level builds upon the satisfaction of the previous one, suggesting that individuals focus on fulfilling more fundamental needs—such as food, water and safety—before progressing to higher needs like social connection, esteem and personal growth. This hierarchy allows for a structured approach to understanding how individuals prioritize their needs.

In our project, we used Maslow's Pyramid as a tool to calculate the importance of each user's needs by aligning it with the pyramid's levels. We calculated the importance of each user's needs by examining both primary and secondary components. First, each need was divided according to Maslow's levels, identifying a primary component and a secondary one. The primary component was weighted at 70% and the secondary at 30% to reflect their relative influence on the overall importance of the need. The importance was calculated using the formula:

$$Importance = (Level_{primary} \times 0.70) + (Level_{secondary} \times 0.30)$$

This method allowed us to objectively prioritize user needs based on Maslow's hierarchy, ensuring that needs fundamental to user's well-being were given higher importance in our analysis.

Figure 2.3: Maslow's Pyramid

Proxy Variable Analysis

The Proxy Variable Analysis is a method for estimating confidence when direct data

on the target need or audience is limited or incomplete. This approach relies on identifying surrogate variables, known as **proxies**, which indirectly reflect the interest and relevance of the product or service in question. Each proxy is selected for its ability to represent a critical aspect of the target's interest and is evaluated based on its relevance.

The analysis process involves several stages:

1. **Identification of Proxies**: Variables are selected that can indirectly represent the main target need. Proxies should correlate with the target need and be capable of indicating an existing interest or demand for the product or service.

2. **Assignment of Scores**: Each proxy is scored on a scale from 0 to 1, where a higher score indicates greater reliability and relevance of the proxy in representing the need. This scoring is based on available data, market research, industry studies and other relevant sources.

3. **Weight Assignment**: Each proxy is assigned a weight according to its relative importance in representing the need. Proxies with a closer correlation to the target interest receive higher weights than those with less relevance.

4. **Calculation of Total Confidence**: The overall confidence is calculated as a weighted average of the proxy scores. The result is a value between 0 and 1, representing the confidence in the existence and relevance of the need.

Application Example: Personalized Multilingual Guide for Tourists in Pisa

In the context of evaluating a multilingual guide for foreign tourists in Pisa, Proxy Variable Analysis was used to estimate the potential interest in a product that assists non-Italian-speaking visitors. Four proxies were selected:

1. **Percentage of Foreign Visitors in Pisa**: A critical proxy for estimating the number of potential users, with a score of 0.8 and a weight of 0.4.

2. **Current Language Accessibility in Pisa's Attractions**: Evaluates the availability of multilingual materials at local attractions, with a score of 0.7 and a weight of 0.3.

3. **Feedback from Non-Italian-Speaking Tourists**: Reflects visitor opinions on language barriers, with a score of 0.6 and a weight of 0.2.

4. **Trend of Digital Multilingual Guide Usage in Other Italian Tourist Destinations**: Represents the general interest in digital guides, with a score of 0.75 and a weight of 0.1.

The total confidence, calculated as a weighted average, resulted in **0.705**, indicating a moderate-to-high confidence level in the need for a multilingual guide in Pisa. This outcome suggests that a personalized guide is likely to meet a real need, supported by a significant presence of foreign tourists and limited language accessibility at local attractions. However, targeted surveys or more specific data could further increase the accuracy of this estimate.

Reliability of sources

The Reliability of Sources method is an approach for assigning a confidence score to information based on the reliability of the sources used. This method categorizes sources according to their authority and data collection methodology, assigning a weight proportional to their level of credibility. Overall confidence is determined by the score of the underlying sources, which are classified into three main categories:

- **Category A: Institutional and Certified Sources** (score 0.5)

  This includes official, highly reliable sources such as government agencies,

public research institutes and certified databases (e.g., ISTAT, Eurostat, World Bank). These sources collect data according to rigorous and verified standards, providing a high guarantee of accuracy and impartiality. Due to their high reliability, Category A sources receive the maximum score of 0.5.

- **Category B: Academic and Scientific Sources** (score 0.3)
  This category includes peer-reviewed scientific articles, publications in recognized journals and research conducted by universities. While these sources are considered reliable, they are not directly managed by government bodies or public institutions but rather rely on academic review processes. For this reason, Category B sources are assigned a score of 0.3.

- **Category C: Unverified or Informal Sources** (score 0.1)
  This includes less reliable sources, such as blogs, social media and opinion pieces. In these sources, data may be presented without adequate verification or structured collection methods, which reduces their guarantee of accuracy. Although these sources can be useful for understanding opinions or trends, they offer a low level of reliability and are therefore assigned a score of 0.1.

2.2 Results

2.2.1 Users and Needs

The method used to identify users and needs involves structured brainstorming and web research, followed by filtering and refinement after the initial idea generation phase. The table below summarizes the results of this identification step:

User	**Need**
Italian Visual Artist	Connects with a community of artists and clients
Dj	Grow audience and reach to international public
Italian producer	Ensure clear credit attribution to support collaborative projects and recognize contributors
Visitor of Pisa	Access a personalized, accurate guide to enhance the travel experience and reduce language barriers
Prof and their student	Access comprehensive and relevant digital art resources to support in-depth learning and teaching
Disabled people	Make museum more accessible
Tourist	Make planning easier and more personalized
Young gamer 6-12yo	Create and personalize games to express creativity and enhance engagement

Table 2.1: User Needs Table

2.2.2 Need Hypothesis

As mentioned in the previous section, **Benchmarking** is used to retrieve hypotheses.

1. **Italian Visual Artists (especially from geographically and culturally marginal contexts)**

   We believe that Italy's cultural workers in the visual arts (especially those coming from geographically and culturally marginal contexts) lack spaces where they can engage, showcase their work and have opportunities to emerge.

   If we conduct a survey of these artists, we expect to discover that over 70% struggle to find platforms that allow them to share their work, engage with a community and feel a sense of belonging.

2. **DJs**

   We believe that emerging DJs struggle to find places where they can play their music.

   So if we interview emerging DJs and review their challenges, we expect to find that over 80% face significant barriers in reaching a global audience, which limits their potential to grow their listener base.

3. **Italian Producers**

   We believe that Italian producers need a way to merge tracks with clear credit attribution.

   So if we conduct focus groups with Italian music producers, we expect to discover that at least 75% encounter challenges in properly attributing credits in collaborative projects, impacting the frequency and quality of joint work.

4. **Visitors of Pisa**

We believe that Pisa tourists need a personalized and accurate guide.
So if we gather feedback from tourists visiting Pisa, we expect to find that over 60% of non-Italian-speaking visitors struggle to access reliable, language-specific guidance, which affects their overall satisfaction.

5. **Professors and Their Students**
   We believe that professors and students need to share their experiences with digital art resources.
   So if we gather insights from professors and students about their experiences with digital art resources, we will discover that over 70% struggle to find appropriate materials for their coursework.

6. **Disabled People**
   We believe that people with a visual disability should be able to experience art through various media, especially tactile art.
   So if we examine the availability of tactile art or adaptations available in Italian museums, we'll discover that if the offer was more widespread, 75% of visually disabled persons would be interested.

7. **Tourist**
   We believe that there are tourists who would benefit from a tool that creates personalized itineraries based on their interests and needs.
   So if we analyze feedback from tourists, we expect to discover that over 80% find that a personalized itinerary tool would enhance their travel experience and be reusable for future trips.

8. **Young gamers 6-12 yo**
   We believe that young gamers want to customize their own game characters.

So if we ask them how often they wish to have more personalization options, then we will find that over 65% desire greater customization in games.

2.2.3 Need Statement and assessment

The validation of only five validated need hypotheses was determined by interviews, focus groups, and wheels of emotion, while the remaining failed during the experiments. These five validated need hypotheses are converted into need statements with their associated goals.

User	Need	Goal
DJ	Grow audience and reach to international public	To reach a broader international audience by creating resources that facilitate global musical discovery and engagement
Italian Producer	Ensure clear credit attribution to support collaborative projects and recognize contributors	To establish a centralized repository for Italian producers, enabling track merging with clear credit attribution to foster collaborative projects and enhance user satisfaction
Visitors of Pisa	Access a personalized, accurate guide to enhance the travel experience and reduce language barriers	To create a multilingual guide for non-Italian-speaking visitors in Pisa, enhancing their experience and reducing the need for human assistance
Disabled people (visual)	Make museum more accessible	To improve accessibility for visually impaired individuals in museums by introducing touchable art options that enhance the sensory experience while preserving the artworks
Young gamers 6-12 yo	Create and personalize games to express creativity and enhance engagement	To produce an engaging gaming experience that encourages creativity by allowing them to personalize characters and storylines, enhancing both their involvement and creative expression

Table 2.2: User Needs and Goals Table

In addition, to reach a single user with the relevant need, an expression was considered for the calculation of the final final values.

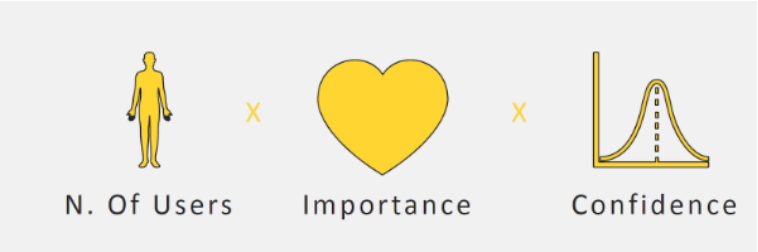

Figure 2.4: Expression for the final values

To find the **total number of users**, we relied on statistics and government reports, and we multiplied the relevant data by the correct percentage after validating the need statements, in order to account for the segment of users who might be interested in our solution. **Confidence** has been calculated (Table 2.4) using the methods described previously and giving a weight of 50% to Reliability of sources, 40% to Proxy Variable Analysis and 10% to Team Evaluation. To assess the **importance** (Table 2.3) of each need, we applied Maslow's hierarchy of needs and the PANAS method.

Computation of Importance

User	Maslow	PANAS	Total
DJ	1,7	1,3	3,0
Italian Producer	1,9	1,4	3,3
Visitors of Pisa	1,3	1,0	2,3
Disabled people (visual)	2,4	2,2	4,6
Young gamers 6-12 yo	1,6	2,3	3,9

Table 2.3: Computation of Importance

Computation of Confidence

User	Reliability of Sources	Proxy Variable Analysis	Team Evaluation	Total
DJ	0,1	0,288	0,025	0,415
Italian Producer	0,1	0,304	0,05	0,45
Visitors of Pisa	0,5	0,28	0,1	0,88
Disabled people (visual)	0,5	0,292	0,1	0,89
Young gamers 6-12 yo	0,1	0,332	0,05	0,48

Table 2.4: Computation of Confidence

User and Need assessment final table

User	N. users	Importance	Confidence	Total
DJ	0,25	0,5	0,415	0,052
Italian Producer	0,0025	0,575	0,45	0,0006
Visitors of Pisa	0,6	0,325	0,88	0,172
Disabled people (visual)	1	0,9	0,89	0,801
Young gamers 6-12 yo	0,75	0,725	0,48	0,261

Table 2.5: User and Need assessment final table

2.3 Decisions

The Desirability phase work led us to the conclusion that our case study's most attractive user and need is:

- **Visually Impaired Individuals with the need for enhanced accessibility in museums.**

In the next phases of the project, we are focused on finding an optimal solution for the user in order to try to solve the problem considered. By implementing this initiative, we hope to make museums more accessible and enjoyable, fostering a richer, more inclusive cultural experience for all.

Chapter 3

Feasibility

In the feasibility phase, we will examine the approaches employed to identify potential solutions for the selected need. Following that, we will assess the feasibility of the proposed solutions and in the final section, we will evaluate them to determine the most suitable option.

3.1 Methods

Identifying, evaluating, and communicating solutions is essential to ensure that design proposals are both innovative and feasible. To this end, we employed various methods to carry out these activities effectively.

3.1.1 Methods for solution identification

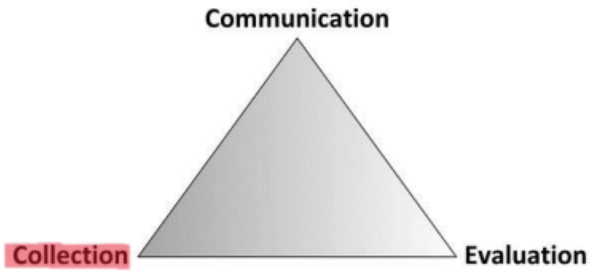

Figure 3.1: Identification phase

AI Tool - AI Trust Framework workshop

During time class we were able to follow the **AI Trust Framework workshop** with Chiara Lelli and Filippo Chiarello. This experience enabled us to identify three potential solutions to explore. Bellow, we'll explain the **divergent** and **convergent** processes we followed.

First, we separate the group. One representant overseeing three persons being the execution team. The team role was to perform the task using ChatGPT-4o and present the results to the representative. The representant was to manage the team and prepare the outputs. Each process was timed to structure our efforts.

The first phase was entirely **divergent**. The goal was to identify as many relevant solutions as possible using the AI tool given our selected users and needs. The solutions were to follow a structure: input resources, the process employed and how the output solution solves the need. To guide the AI we decide to direct his work by specifying which sensory engagement the solution should target. In the fifty minutes given, we were able to come out with 55 solutions.

The second phase was all about **convergence**. The objective was to identify the 3 best solutions from ours initial ones. The outputs were to use the same structure. We ask ChatGPT-4o to evaluate the large number of solutions with these criteria:

technical feasibility, product uniqueness and the fitting with the need.

This approach leads us to keep only 3 solutions that thoughtfully engage the senses of hearing, touch and smell.

SCAMPER

The **SCAMPER** method is used to generate solutions to our need. It has been developed by Bob Eberle in his book SCAMPER: Games for Imagination Development (1971). The acronym stands for : Substitute, Combine, Adapt, Modify, Put to another use, Eliminate and Reverse. Each verb corresponds to a strategy whose aim is to encourage creativity and see the solution under a new light. This set of steps provides a **structured framework** that encourages imagination rather than restraining it. This method is particularly useful when the need is to come out with a large amount of solution. In our project, we chose to apply the SCAMPER method to refine our three best solutions, which initially lacked precision in terms of output. This approach enabled us to arrive at more concrete and specific solutions.

SCAMPER	CONSIDERATION	OUTPUT	EVOLUTION OF THE SOLUTION (initially "**Wearable devices with audio guides**")
Substitute	What part could be replaced to improve the outcome?	An app will be better than a full device	A mobile app for audio guides
Combine	What ideas, functions, or processes can be combined with this?	Include the virtual map of the museum with a system of vibration to be able to stay on the right path of the exhibition	A mobile app for audio guides with a vibration system to choose and stay in your path
Adapt	What can be adapted to better suit the situation?		
Modify	What can be modified, magnified, or exaggerated?	We can make it AI-powered to create a conversational experience and maximize personalization.	A mobile app ai driven for audio guides with a vibration system to choose and stay in your path
Put to Another Use	How can we use this element differently?	It would also be useful in other situations where assistance with mobility and communication is needed (Station, public service facilities…)	
Eliminate	Can we get rid of unnecessary parts or steps?		
Reverse	Can we rearrange the sequence or structure?		

Figure 3.2: SCAMPER

3.1.2 Pretotype

The **pretotyping** phase allowed us to validate the interest in our solutions using quick and cost-effective methods. This approach allows for collecting valuable **feedback** to refine or confirm the ideas. To achieve this, we employed a combination of Fake Door, Mechanical Turk and Pinocchio methods tailored to each solution. Below, we describe the implementation and key insights for each proposal.

FakeDoor

For the **Fake Door**, we developed websites to gauge **user interest** in each proposed solution. For the AI-driven mobile app for audio guides with a vibration system, a page with ”Explore Demo” and ”Pre-book” buttons tracked clicks and interactions, while for the sensory necklace, a landing page promoted its features and collected form submissions from interested users. Similarly, for the AR gloves, a site showcased their ability to enable tactile interaction with virtual objects, measuring engagement through demo bookings and informational link clicks. These tests provided quantitative insights into **user interest** across all three concepts.

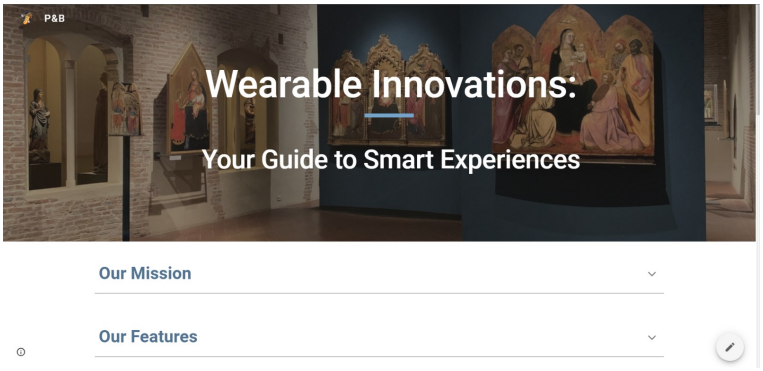

Figure 3.3: FakeDoor pretotyping

Mechanical Turk

We used the **Mechanical Turk** method to test the **impact** of the ”AI-driven mo-

bile app for audio guides with a vibration system." The experiment involved using a phone call to simulate an interactive audio guide, while the app remotely controlled vibrations to guide users until they were facing the correct direction. We invited blind and visually impaired individuals to participate in the test.

From this experience, we found that while the vibration system was effective in assisting movement, the audio guide, despite being designed for blind users, did not add much value to the museum or monument visit. This was because blind participants could not perceive the artwork through any of their senses.

After gathering feedback and testing other solutions, **we chose to exclude this one**. Although it could be useful in everyday situations, it did not meet the specific needs we identified for enhancing museum experiences.

For the sensory necklace, users interacted with hand-held fragrance diffusers and pre-packaged food kits to simulate the wearable's functionality.

Pinocchio

To create a **Pinocchio** for haptic AR gloves, we considered evaluating whether attempting to touch the artwork could effectively influence its perception and appreciation. We then found an open-source website that freely provides 3D-printable models of artworks. We contacted the 3D printing and rapid prototyping lab at the University of Pisa, within the Department of Civil and Industrial Engineering. Given the tight timeline, we decided to purchase pre-made simulations instead of creating custom ones from scratch. This allowed us to continue the development without compromising on the project's overall goals.

3.1.3 Methods for solution evaluation

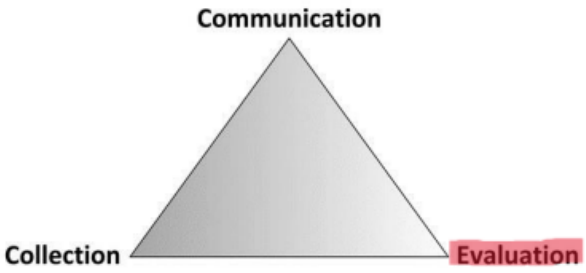

Figure 3.4: Evaluation phase

Weighted Scoring Model

The **Weighted Scoring Model** is a decision-making tool used to evaluate and compare multiple options based on a set of predefined criteria, each assigned a weight reflecting its relative importance. It originated from the need to incorporate multiple dimensions into a single evaluation framework, often utilized in feasibility studies. For this project, the Weighted Scoring Model was chosen to ensure a structured and objective comparison of the three solutions. The evaluation criteria were defined as **Cost, Time, Technical Feasibility and User Interest**, with respective weights of 20%, 25%, 25% and 30%. Each solution was scored on a 1–10 scale for each criterion based on qualitative and theoretical benchmarks.

- **Cost**: Cost was assessed through **Benchmarking** against similar technologies. For this evaluation, costs for each solution were estimated based on market research of comparable products.

- **Time**: Time feasibility was evaluated using a **Work Breakdown Structure (WBS)** combined with **Benchmarking**. WBS is a project management tool that decomposes a project into smaller, manageable tasks. This method was pioneered by the U.S. Department of Defense in the 1960s and is widely

used for scheduling and resource planning. WBS was constructed for each solution. This approach ensured that time estimations were systematically derived.

- **Technical Feasibility**: The **KANO Model** helped identify and prioritize features for technical assessment. The KANO Model, developed by Professor Noriaki Kano in the 1980s, is a framework for analyzing customer satisfaction with product features. It categorizes features into **Basic, Performance and Excitement** attributes. This method is particularly useful for understanding the technical feasibility of implementing various functionalities. This method helped identify and prioritize features for technical assessment.

- **User Interest**: User interest was simulated using the **Fake Door** method described previously. It's a pretotyping method used to gauge user interest by simulating product availability through a landing page. This technique is cost-effective and provides direct **user feedback**, making it ideal for early-stage validation. For this project, hypothetical landing pages were created for each solution.

3.1.4 Methods for solution communication

In this sub-part of the feasibility report we'll communicate the results of our project by using two design methods. It appears crucial to use appropriate ways to show results in order to guarantee that all the stakeholders get the results but also a good overview of the context and the impact of the project. The idea is to synthesize all the work done into charts or diagrams to inform our audience of the conclusion of our project.

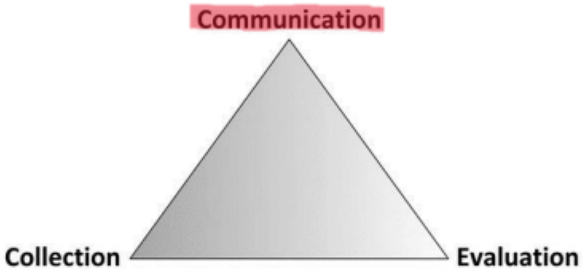

Figure 3.5: Communication phase

5W2H

”5W2H” stands for “Who? What? Where? When? Why? How? How much?”, encompassing all the essential questions to thoroughly cover the aspects of a result. This method is inspired by the **structured approach** journalists use in their interviews. By addressing each of these interrogative pronouns and adverbs, it becomes easier to produce a structured and comprehensive output tailored for stakeholders.

W	What ?	*What are we trying to achieve ?* Increase accessibility with an affordable solution, easy to use and to access.	What is our solution ? A technological necklace allowing an immersive and multi-sensory experience.
	Why ?	*Why is this a matter ?* Art shouldn't be a matter of discrimination.	
	Who ?	*Who are the stakeholders ?* • People with disabilities • Employee of the museum • Developers • Innovators • Art experts • Investors	
	Where ?	*Where can this problem be found ?* In museums or even in every institution displaying art.	*Where will the solution take place ?* In the exact same places.
	When ?	*When was this problem found ?* The problem occurs since museums exist. The demand for accessibility is now increasing.	*When does this solution start and finish ?* The solution is used during all the time of visit. Could be activated at specific moments to synchronize with particular artifacts.
H	How ?	*How is this done ?* The device uses fragrance dispersion and electrotactile technology to simulate taste sensation.	*How to start the process ?* The process start by connecting with art professionals and disable associations.
	How much ?	*How much will it cost ?* The costs will include development of the diffusers and stimulators as well as research to accurately pair sensory elements with the arts displayed. By taking advantage of government and EU grants or innovation funding programs, the price of development should not be based on users.	

Figure 3.6: 5W2H

BPMN

The **Business Process Model and Notation** is a graphical representation dedicated to a business process or part of a process. The flowcharting method is pretty close to the activities diagram. The diagram is composed of events, activities, gateway and connections. An event is represented with different circles depending on the meaning : start, end or intermediate event. The activities are represented as rounded-corner rectangles, they are works that the process performs (task, subprocess, transaction, ...). Gateways are diamond shaped elements that can describe forking and merging. Connecting objects are the link between flow objects. They can be a message flow of association. It will also be possible to mention swimlanes that add clarity to the chart, data objects or annotations. We will talk about it in section 3.3.

3.2 Solutions

By applying the methods we talked about in the previous section, the following potential solutions have been identified.

3.2.1 AR gloves

Description

AR gloves allow users to interact with virtual museum exhibits through touch, providing a tactile dimension to digital artifacts. These gloves use **haptic feedback** to simulate the texture, weight, or shape of objects, enabling users to ”feel” virtual items displayed in augmented reality. In particular, the revolutionary strength of this tool lies in its ability to ”materialize” not only sculptures but also paintings and other forms of art. This solution is particularly valuable for visually impaired individuals, offering them an opportunity to engage with artifacts in a way that

complements other sensory experiences.

Haptic technology is already used in gaming and medical training, where realistic tactile feedback is crucial for immersion and skill development. In museums, AR gloves can recreate historical artifacts that are too fragile or rare to be touched directly, allowing visitors to explore their properties safely. By combining augmented reality visuals with precise tactile feedback, this solution creates a highly interactive and inclusive museum experience.

Evaluation

For the AR gloves, we estimated the cost to fall between €1500 and €3000, assigning a score of 6. In terms of development time, the AR gloves are expected to take between 12 and 18 months, and we gave this a score of 5 due to the complexity of the project. The technical feasibility of the solution also received a score of 5, as it requires advanced software, augmented reality models and dedicated hardware, all of which contribute to its complexity. To test public interest, we created a landing page The click-through rate (CTR) was then measured, and for the AR gloves, the CTR was 12%, which earned the solution a score of 6.

3.2.2 Sensory journey with wearable necklace to stimulate taste and smell

Description

The sensory wearable necklace is designed to enrich the museum experience by engaging the olfactory and gustatory senses, creating a deeper emotional connection with the exhibits. The device incorporates fragrance diffusers and electrotactile stimulation to simulate taste, allowing users to experience **smells** and **tastes** associated with specific artifacts or cultural contexts.

Such multi-sensory approaches have been explored in immersive dining experiences and exhibitions where scents and flavors are paired with visual and auditory

elements to create a more engaging environment. By enabling localized scent dispersion and subtle taste stimulation, the wearable can transport users into a vivid sensory journey, making the experience more memorable and accessible.

Evaluation

For the sensory necklace, we estimated the cost by taking into account the materials, which include the hardware of the necklace, as well as the sensors for taste and smell and the electrostimulation system. Based on this, the sensory necklace is expected to cost between €800 and €1500 and we assigned it a score of 8. The development of the sensory necklace involves creating the necklace itself, integrating the sensors for taste and smell and incorporating the electrostimulation system. We anticipate that the development time for this solution will range from 6 to 12 months and it received a score of 7. While the technical complexity of the sensory necklace is moderate, particularly with the taste and smell sensors, it requires less software development compared to the AR gloves, which contributes to its relatively higher feasibility score. For the public interest test, we created a dedicated website showcasing the idea of a ”sensory journey” with the necklace. The click-through rate (CTR) for the sensory necklace was measured at 18%, which earned it a score of 8.

3.2.3 AI-driven mobile app for audio guides with a vibration system

Description

The AI-driven mobile app integrates real-time audio guides with a vibration feedback system, designed to provide an accessible and personalized museum experience. The app leverages **artificial intelligence** to offer context-aware audio content, tailored to the user’s location and the exhibits they’re interacting with. Simultaneously, it uses vibration signals to help users navigate through the museum,

guiding them along pathways or highlighting specific points of interest.

This solution builds on technology commonly used in navigation apps for visually impaired individuals, where haptic feedback plays a key role in directing the user. With a user-friendly interface, the app ensures a hands-free experience, allowing visitors to focus fully on the exhibits while receiving relevant information through both audio and tactile cues. By combining these modalities, the app enhances the museum experience, making it more inclusive and immersive for audiences with visual impairments.

Evaluation

We decided not to pursue it further based on our evaluation. During the testing phase, we observed that while the vibration system was effective in helping with movement, the audio guide, which was specifically designed for blind users, did not contribute significantly to the overall museum experience. This was primarily because blind participants were unable to engage with the artwork using their remaining senses. After gathering additional feedback and exploring alternative solutions, we concluded that, although the system could have practical applications in everyday scenarios, it did not address the specific needs we had identified for improving the museum experience. As a result, **we chose to exclude** this solution from further consideration.

3.3 Results and final decisions

The weighted total for each solution was calculated by multiplying the score for each criterion by its respective weight and summing these values. This approach facilitated a clear ranking of the solutions based on their overall feasibility.

Solution	Cost	Time	Technical Feasibility	User Interest	Weighted Total
AR Gloves	1,2	1,25	1,25	1,8	5,5
Sensory Necklace	1,6	1,75	1,75	2,4	7,5

Table 3.1: Solution evaluation final table

Business Process Model and Notation

We present the Business Process Model and Notation (BPMN) to describe how a user interacts with the chosen solution. The process is mapped from the user's perspective, focusing on their expectations and emotions at each stage.

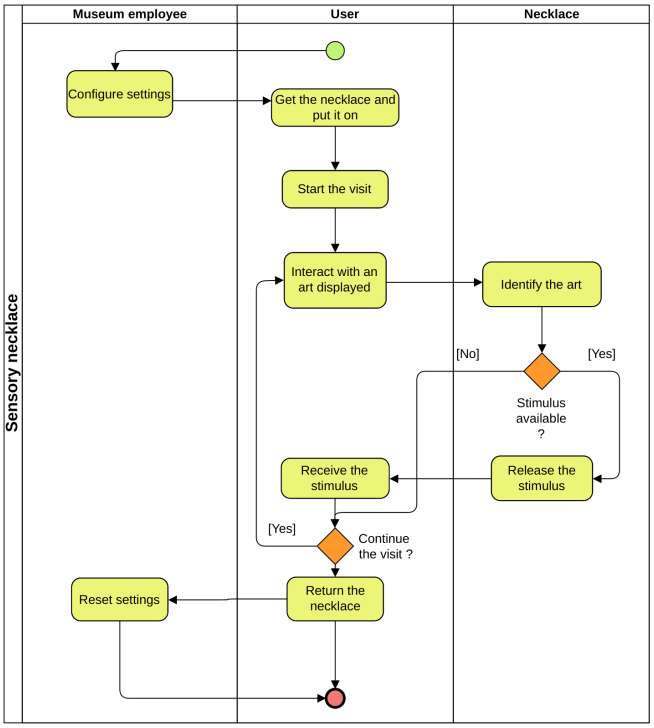

Figure 3.7: BPMN for sensory necklace

Chapter 4

Conclusion

To sum up this project successfully achieved the goals fixed at it inception in September. Our solution, a sensory necklace, was developed through the application of various methods that harnessed both divergent and convergent thinking. The work was carried out in two main phases: **Desirability** and **Feasibility**. The project began with the identification of the users, who formed the foundation of our approach. From there, the need to fulfill was determined and formulated the following need statement: **”Improve accessibility for visually impaired individuals in museums by introducing a solution that enhance the sensory experience while preserving the artworks”**.

The next step was to identify the solution and to evaluate it by using various methods. This process culminated in the find of our sensory necklace, which was prototyped, evaluated and communicated about. Our final solution, being relevant to various stakeholders, demonstrates the effectiveness of the methods and tools employed. Nonetheless, a prospective next step would be conducting a **viability** study for the necklace, which would mark the final phase before potential commercialization.