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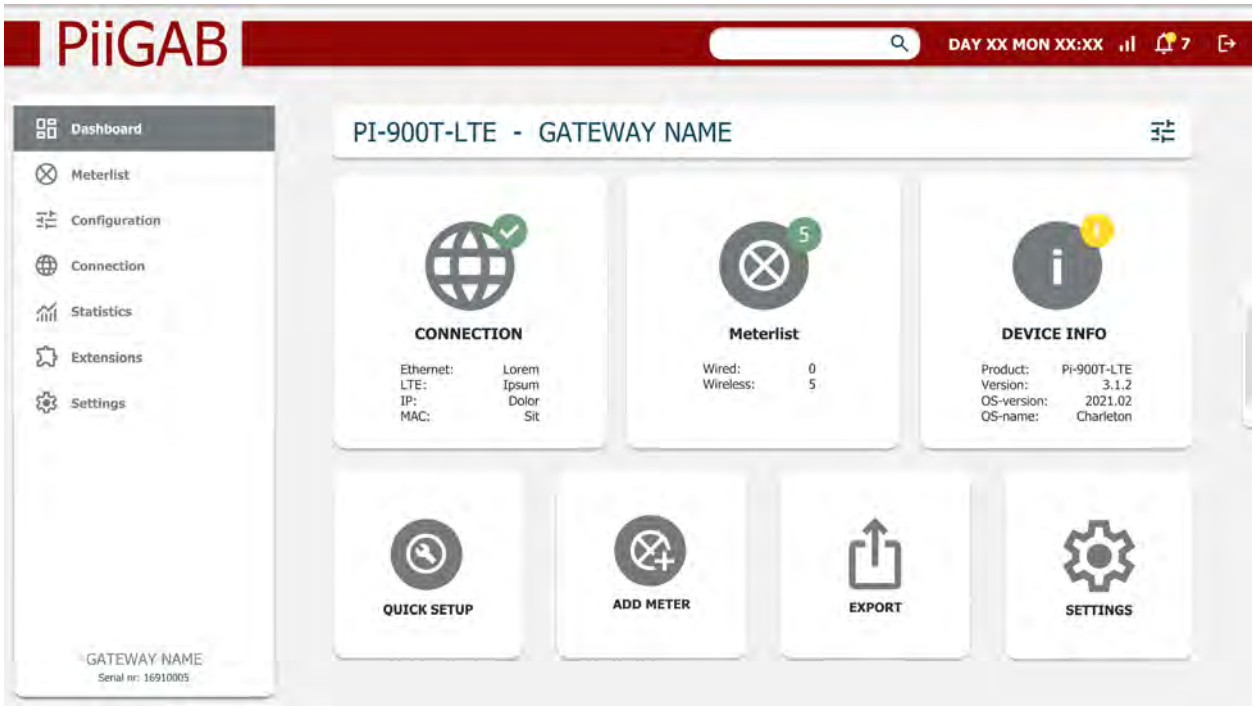

Optimizing User Experience:

A Design-Driven Approach to Enhancing Web Application Interfaces

Master's thesis in Interaction Design & Technologies

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Abstract

This Master's thesis delves into the realm of user-centered design principles and their impact on optimizing user experience through a design-driven approach in web application interfaces. Focused on the relatively unexplored domain of configuration systems, the study aims to deepen our understanding of how user expertise influences user experience, bridging the gap between designers and programmers. By combining interaction design principles with data engineering knowledge, the research seeks to enhance the existing body of knowledge in UX design for configuration systems.

The thesis outlines the design process of the user interface for an existing application, emphasizing frontend programming aspects and interaction design methodologies. A Minimum Viable Product (MVP) prototype is developed to improve usability, performance, feedback, functionality, and visual design in web interfaces. Evaluation results confirm the positive trajectory of the prototype design, showcasing enhancements in user experience aspects.

Reflecting on the challenges faced and insights gained, the thesis offers recommendations for future research, highlighting potential avenues for exploration and the ongoing evolution of design practices. The study advocates for challenging established design principles to foster innovation and creativity in interface design, paving the way for transformative advancements in user interface design and user experience optimization.

Overall, this thesis serves as a foundational step in the exploration of user-centered design principles in configuration systems, providing valuable insights for researchers and practitioners in the field of Interaction Design & Technologies.

Keywords: Human-computer interaction, Rapid prototyping, User Experience, Design Process, Constructive Design Research, User-Centered Design, User Interface.

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Kevin Pham, Gothenburg, May 2024

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

GUI	Graphical User Interface
HCI	Human–computer interaction
HMI	Human Machine Interface
MVP	Minimum Viable Product
UCD	User-Centered Design
UI	User Interface
UX	User Experience
CDR	Constructive Design Research

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1
Introduction

In the realm of Human-Computer Interaction (HCI), system configuration is a common process where human administrators set parameters to control a system's behavior. This interaction, however, often leads to configuration problems when the system fails to perform as expected. Recently, the attention on configuration problems has intensified due to their increasing prevalence and the severity of resulting misconfigurations [32]. Studies reveal that configuration problems account for a substantial portion of technical support cases in various companies, underscoring their significance [33].

The challenge lies in traditional configuration interfaces that require administrators to set parameters without providing insights into how these settings impact the system. Unlike developers, administrators often view systems as black boxes, lacking understanding of their internal organization. This knowledge gap hampers their ability to troubleshoot configuration issues effectively. Additionally, administrators face limitations in debugging, relying on external manifestations like error codes and system logs due to the unavailability of interactive debugging tools and source-code information. In commercial systems where source-code access is restricted, the common debugging practices become impractical for misconfiguration troubleshooting and leads to an overwhelming increase in customer support. Improving these interfaces holds great potential to help administrators avoid cognitive biases, addressing the root causes of many configuration problems. Moreover, fortifying against misconfigurations at the interface level proves to be more time- and cost-efficient than dealing with the resulting system failures and anomalies [33].

Furthermore, the first impression can last throughout the entire User Experience (UX) and set the foundation for a negative cognitive bias. If the start page already appears disordered and does not align with the user's habits, it can significantly impede efficiency [5].

1.1 Context

PiiGAB is a property automation company based on the outskirts of Gothenburg, that specializes in creating products for data collection in properties, offering a unique opportunity to engage with innovative solutions in Internet of Things (IoT), property automation, and data collection. The products serve as a foundation for the sustainability transformation in the real estate industry, with the company expe-

riencing rapid growth through the introduction of new solutions alongside a diverse range of longstanding products in the market. All development and final assembly operations are centralized at the Mölnlycke office, reflecting the collective efforts to propel the business forward.

PiiGAB currently offers two types of data collection devices, PiiGAB 810 and PiiGAB 900. The 810 is a fully transparent collection unit that requires no configuration. On the other hand, the PiiGAB 900 is a smart collection unit capable of handling multiple protocols and converting them into the desired output protocol. This unit necessitates configuration through an interface that has evolved over several years with new programs and functionalities. The interface connects the data collection to the sub-applications that the converter uses for protocol translation.

The data collectors use a field bus called Metering Bus (M-Bus), specialized for the transmission of data from gas, heat, water, and other meters. M-Bus was originally designed as a wired interface for communication over two wires; however, it has recently adopted a wireless alternative known as Wireless M-Bus (WM-Bus). This protocol facilitates Industrial Internet of Things (IIoT) technology, enabling communication between more devices and imposing fewer limitations. This allows meters to deliver the data they have collected to a common master, such as PiiGAB 900, which can periodically read all utility meters in a building. Common meters in properties can vary and include electricity meters, water meters, temperature and humidity sensors, etc. [30, 35].

1.2 Problem Definition

At present, PiiGAB developers invest substantial time in customer support to assist users in setting up the product and addressing fundamental issues. This not only consumes valuable time but could be considered unnecessary if customers could achieve greater independence and reduce their reliance on support through an improved User Interface (UI).

The evolution of PiiGAB's product interface has unfolded in distinct stages, introducing features to enhance capabilities. To optimize user-friendliness, a meticulous review of the connection between these added features and applications is imperative. A coherent structure must be developed to facilitate both future developers and end-users during device configuration. This task involves extensive exploration in collaboration with employees and customers, gathering pertinent information to refine and streamline the interface flow. Additionally, consideration is given to the implementation of smart configuration features to enhance efficiency and whether adjusting settings based on user expertise would be beneficial.

To sustain innovation, PiiGAB recognizes the need for more than functional enhancements alone; a comprehensive redesign is essential to elevate usability and enhance the overall UX.

1.3 Research Question

Based on the problem definition, concerns, and context of PiiGAB, the following research question will serve as the foundation of the thesis, with the hope of providing comprehensive answers:

What strategies can enhance the web interface design for a data collection device to accommodate users with varying levels of expertise and improve user experience?

1.4 Aim

The thesis aims to fill a significant gap in current knowledge and research on UX in configuration systems, where there is a notable lack of exploration, particularly in relation to User-Centered Design (UCD) and established HCI design principles. The study seeks to deepen our understanding of how user expertise influences the UX in configuration systems, addressing a relatively unexplored area in the field, as traditional principles predominantly focus on end users [32, 19]. Personally, my aim is to contribute valuable insights that enhance the existing body of knowledge in UX design for configuration systems, which may be used as design guidelines or principles in the future. Furthermore, by combining my newly acquired knowledge as an interaction designer with my background in data engineering, I aspire to bridge the gap between designers and programmers. This effort aims to facilitate a harmonious integration of their needs and preferences, ensuring the delivery of a high-quality product to both PiiGAB and research.

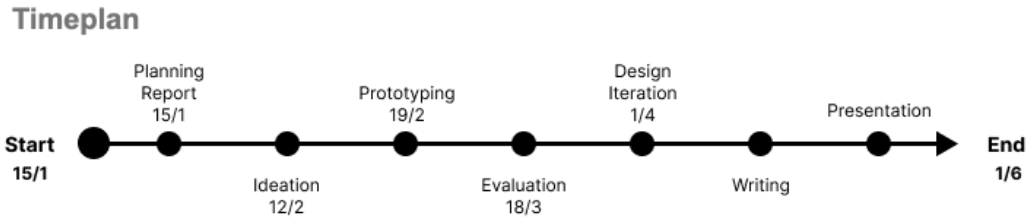
1.5 Limitations

The thesis will focus on the design process of the UI for an existing application, specifically addressing minor technical aspects related to programming the frontend interface of PiiGAB's products. The discussion will be limited to functionalities that are either pre-built or provided through an extended Application Programming Interface (API), with references made through function calls or fetching, rather than delving into detailed descriptions of the underlying code. The scope will exclude backend programming, the discussion of its structure, and its connection to the API.

The prototype developed will be a Minimum Viable Product (MVP), subject to potential exclusion from the existing product if found unstable or non-applicable; essentially, it will be an early beta version. The primary focus of the thesis lies in the interaction design approach and the utilization of methodologies within a programming environment to enhance user experience. Detailed consideration of every minor design change in the UI will not be addressed unless it significantly contributes to the overall improvement of the user experience. Additionally, the prototype is not designed to be compatible with small screens, such as those on mobile smartphones. It is intended for use on computer screens.

1.6 Timeplan

The thesis is planned to run from mid-January, to late May. A preliminary schedule of the project milestones and planned working time is visualized in the following timeline in Figure 1.1 and the Gantt chart in Figure 1.2. The thesis will begin with a planning report structuring the thesis report and making the foundation of the work to be done with literature reviews and pre-studies of the existing user interface. Additionally, analysis of the stakeholders needs will be done followed by ideation, prototyping, and refinement in design iteration. The thesis is planned to end with a evaluation analyzing the results and documented in a report.



Planning Report	Ideation	Prototyping	Evaluation	Design Iteration	Writing	Presentation
Lit review	Brainstorming	Figma	Observation	Refinement	Finalizing	Powerpoint
Pre-Study	Wireframing	Coding	Analytics	Adjustments	Revising	Manuscript
User Studies	Mockup	Testing	Feedback	Testing	Proofreading	Opposition
User Needs	Sketching		Documentation	Prototyping	Opposition	Publication

Figure 1.1: Timeline Illustrating Methodological Progression and Milestones for the Master's Thesis.

The timeline follows a linear start-to-end design process with seven main stages: Planning Report, Ideation, Prototyping, Evaluation, Design Iteration, Writing, and Presentation. Each stage includes crucial design methods that will be used in the thesis. **Planning Report:** Lit Review, Pre-study, User Studies, and User Needs. **Ideation:** Brainstorming, Wireframing, Mockup, and Sketching. **Prototyping:** Figma, Coding, and Testing. **Evaluation:** Observation, Analytics, Feedback, and Documentation. **Design Iteration:** Refinement, Adjustments, Testing, and Prototyping. **Writing:** Finalizing, Revising, Proofreading, and Opposition. **Presentation:** Powerpoint, Manuscript, Opposition, and Publication.

In addition to the timeline timeplan, the Gantt Chart features a weekly schedule of distributed time for each design stage task, beginning with the Planning report. The Gantt chart gives a moderate overview of the time span and will be color coded on efficiency, green for on time, yellor for late, turqoise for ahead on time and red for cancelled. The chart will be updated weekly and evaluated for reflection at the end of the thesis for future studies. The Gantt Chart is updated and further discussed in Chapter 7.

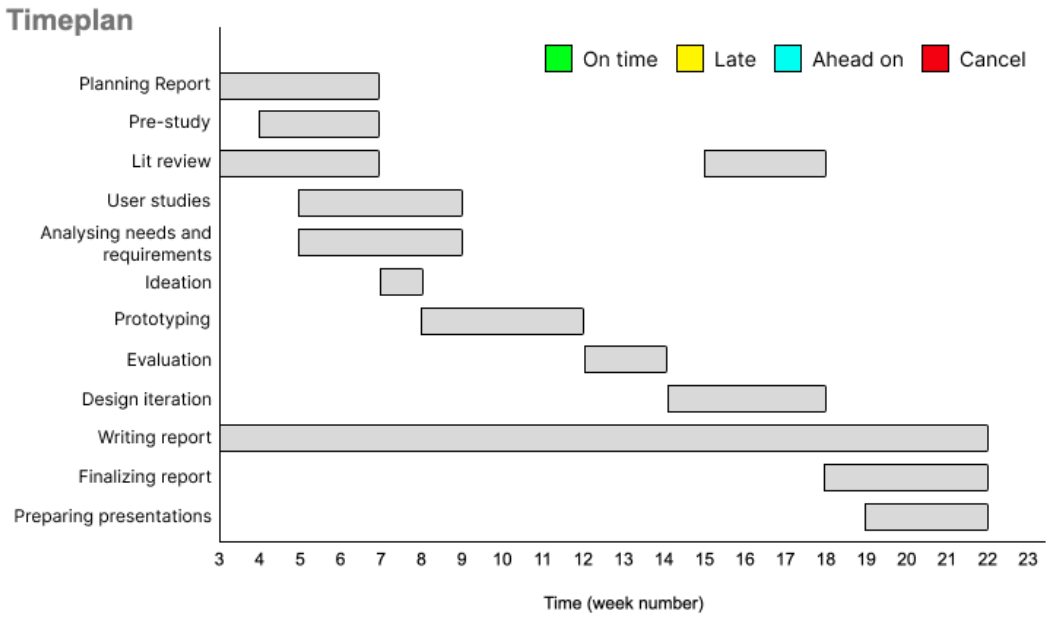


Figure 1.2: Gantt Chart of Timeplan

2
Background

This chapter aims to explore the relevant literature and related work in connection to the research topic, establishing the foundation of the thesis. I begin by providing context on how general design problems occur in similar projects. Subsequently, I present relevant design studies whose results can contribute to the improvement of the thesis prototype. Finally, I address the stakeholders, outlining their goals and interests in the final product, emphasizing their significance in the design process.

2.1 Related Work

In the upcoming section, I present common problems encountered in projects with similar contexts, discussing their contributions to research. The following design studies have been selected because their identified problems align with those of this thesis, and the gained knowledge from these studies can be applied to enhance the current research.

2.1.1 Programmers vs. Designers

In many projects, programmers and designers typically work independently. Designers often contribute at the beginning, delivering their work to programmers who then implement it into the product, finalizing it. In smaller companies lacking dedicated designers and relying solely on developers, the overall product interface may become overly complex for users to navigate [6].

A crucial aspect of a designer's role is to identify typical users and involve them early in the design process, resulting in a user-friendly system. When developers take on design responsibilities, they base their decisions on knowledge of the underlying mechanisms, leading to interfaces that provide direct access to control points or configurations. However, users are primarily concerned with accomplishing tasks, leading to potential confusion. Moreover, developers might use terminology that is clear to themselves but may complicate the user interface, especially when dealing with error messages. Therefore, a proposed solution is to introduce a black-box model, where the system's underlying mechanisms are hidden from the user, and users learn to interpret certain actions as indications of how the system operates [8].

In modern projects [6], streamlined approaches to interactive software design have emerged, aiming to foster the generation of alternative design solutions. These ap-

proaches combine the agility, power, and flexibility of sketching with a structured framework to provide a more comprehensive model of the product. Inspired by semiotic engineering, the design process assesses the product as a conversation between users and designers. The objective is to understand the users - who they are, what they want or need to do, and their preferred way of accomplishing tasks and why. The end result is a system designed with user instructions aligned with their desires [6]. Additionally to further adress communication-oriented concerns, scenarios and sketches that represent user interfaces and interaction fragments, combined with an interaction model can be significant to visualize a blueprint or global view of the systems behavior and display possible interactions like wireframes [6].

2.1.2 UI navigation

One of the primary reasons for users abandoning shopping carts in online shopping applications is poor support for basic navigation, leading to reported frustration [25]. While this thesis primarily focuses on configuration processes, it is essential to recognize that navigation structures share the same global principles and must be modeled correctly. It is, therefore, recommended to generate specific routes through the system that remind users of their past routes, highlighting the current location within the application's hierarchy. Studies have indicated that users are more willing to perform tasks confidently when reminded that they are on the correct path using design patterns. Design patterns serve as a set of instructions, and common navigation design patterns include expandable hierarchies and breadcrumbs [25]. Moreover, this thesis aims to further study design patterns to derive clearer insights into their impacts and how they affect the UX.

2.1.3 Configurators

In recent studies, public configurators have been found to deviate from general Human Machine Interface (HMI) guidelines, leading to a poor UX [19]. However, applications can still achieve success if personalization is supported by a seamless UX that offers high customization capability while also concealing the internal complex mechanisms.

Configurators are software tools for customization, comprising interactive applications where users specify requirements by selecting options and specific parameter values. This process results in a product that addresses the users' needs. When a user makes an error, such as attempting to include incompatible options or parameter values in the configuration, the system should promptly alert and explain the invalidity. Conversely, the system could also exclude such options to prevent invalid selections or guide choices to simplify the task. Furthermore, it is recommended to avoid empty controls, empty boxes, inappropriate choices of controls, and inconsistent semantics grouping. Additionally, when designing configurators, HCI principles should be acknowledged to ensure good UX practices. The absence of essential configurator-specific functionalities can result in a poor UX, affecting users' motivation to continue using the product and diminishing trust [19].

2.2 Identifying Stakeholders

Stakeholders play a crucial role in design processes, and it is essential to identify them and understand their needs. Ensuring that everyone's perspectives, opinions, and thoughts are considered is vital when making changes to systems that may significantly impact them. Failure to identify stakeholders can lead to poorly designed systems, resulting in potential time and resource costs. Recognizing and involving stakeholders is key to mitigating risks and meeting expectations [34, 29].

The primary stakeholders for this thesis are PiiGAB and its customers. While the focus of the design is on enhancing usability and the overall customer experience, the impact also extends beyond customers. The changes may also influence the marketing strategies of the sales team and have implications for external developers involved in the product. In addition, stakeholders' potential goals and interests have been assessed to gain insight into how the changes may impact them and what holds significance when refining the products. These have been identified in Figure 2.1.

Stakeholder	Goals and Interests
Developer	Improve product functionalities
Designer	Improve the overall UX
Salesperson	Attract more customers through effective marketing of a quality product
Administrator	Simplifying navigation for configuration of settings
Technician	Less complicated setup process
Property Owner	Visualization of property data
PiiGAB management	Reduce recurring support cases
Author of thesis	Find a best-practice solution for designing the UI of configurators.

Table 2.1: Stakeholders of PiiGAB's products

3
Theory

In this chapter, I present relevant literature and design studies to delve into the crucial terminology that forms the foundation of this thesis. Additionally, I explore the significance of this terminology and the requisite knowledge needed to achieve the desired outcome of a superior UX. Furthermore, I discuss essential design concepts, including principles and guidelines, aimed at addressing and avoiding the problems identified in the thesis.

3.1 Principles and Guidelines

There are several documented principles and guidelines in HCI on how to design effectively and what to avoid. Well designed interfaces improve how users interact with their devices which affords effectiveness, efficiency and satisfaction since the users can complete their tasks with quality in a satisfactory time [21].

A primary goal of UX design for interaction designers is to minimize unnecessary interaction work. Users typically engage in four types of work: cognitive, memory, visual, and physical. Unnecessary interaction steps are referred to as excise or streamlining and, as emphasized by Cooper [4], should be eliminated wherever possible as a fundamental design principle. In addition, navigating across multiple application views or pages can be disorienting and is best kept to a minimum. Similarly, scrolling should be minimized due to the tradeoff between paging and scrolling information. To avoid disorienting users, it is recommended to support linking and provide visual cues to keep users in the loop. Excise exists in many applications, and therefore, a guideline has been proposed to effectively eliminate it:

- Reduce the number of places to go
- Provide signposts – Points of reference
- Provide an overview
- Properly map controls to functions
- Avoid hierarchies
- Don't replicate mechanical models

Additionally, simplistic, minimalistic interfaces are generally better for UX, as cool and flashy interfaces can be overwhelming and affect the UX due to the tradeoff between usability and interface. In conclusion, when a system, product, or application's communication with a user is well-orchestrated, it almost becomes invisible, transparent, and apparent [4].

Excise can be disorienting and the UX should be a smooth process without unecessary complications. The users may be imposed with mental cognitive load which is limited by the capacity of a person's working memory and ability to process information. As systems evolve and become more complex, cognitive load can increase and must be considered in the design. Traditionally, subjective measures have been used to achieve reliable results for cognitive load assessments. However, considering a user-centered design process, it would fit significantly to consult users to describe in fine detail their perception of cognitive load induced by tasks in a system. This forces users perform a self assessment of their mental demand and brings many unexplored perspectives. In contrast, a nonintrusive observation of users behaviorial activities can bring implicit analysis of user's cognitive load based on them completing tasks without knowing they are being recorded. It ensures users to be in a natural setting without interference.

The HCI community has developed methods to assess users' cognitive load for usability, employing subjective or performance measures that prove valuable in interface evaluation. In non-intrusive settings, linguistic features can be collected from people's spoken and written language, offering unobtrusive insights without diverting users' attention from tasks. However, it is crucial to understand the changes in individuals' spoken and linguistic behavior when completing tasks versus performing cognitively loaded tasks. These changes can be valuable for testing users' working memory capacity, providing necessary resources, and indicating where information integration or separation is required.

The primary motivation is to eliminate redundant and nonessential information to reduce overall cognitive load and enhance task performance. When users need to split their attention between items placed in distant isolation, requiring constant referral, the usability principle of "aesthetics and minimalist design" can be applied early on to ensure the final product does not overload cognitive working memory and guarantees a better UX [22].

3.2 User Experience

When designing products for users and their interaction with those products, it is commonly referred to as User Experience. The standard definition of UX is: "a person's perceptions and responses resulting from the use and/or anticipated use of a product, system, or service" [18]. UX is generally considered as subjective, context-dependent and dynamic affected by the user's expectations, needs and motivation [18]. Additionally, the scope of UX can be broadened to encompass a person's interaction with any technology, product, or service, viewed as the overall experience [28]. However, it's crucial to acknowledge that a person can not design a user experience but rather design for a user experience, emphasizing the context that will be addressed and further discussed.

Moreover, UX is significantly sensitive to emotional aspects, making an understanding of users' moods and feelings essential variables in the design process. Positioned

within the realms of interaction design and HCI, UX requires consideration of various perspectives and exploration areas to enhance products and designs. In conclusion, UX is defined by how a product behaves and how users engage with it [29].

3.3 Usability

In the context of UX, usability is a crucial factor that impacts the overall user experience. Traditionally, usability focuses on meeting specific criteria such as efficiency, in contrast to aesthetic pleasure, which is also a significant aspect of UX. Usability is often fundamental to the product's quality and works hand in hand with other aspects that contribute to the overall UX [29].

In ISO 9241-11 [13], the standardized definition of usability is as follows: "the extent to which a system, product, or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.". This definition highlights three measurements of usability: effectiveness, efficiency, and satisfaction, two which can be objectively estimated. Effectiveness can be defined and measured in terms of the user success rate, i.e., the percentage of users who complete tasks correctly. Efficiency is determined by the resources needed to execute a task and achieve certain results compared to other methods. Resources refer to the time users spend completing tasks or the number of steps necessary to reach the goal. In contrast to effectiveness and efficiency, satisfaction is generally considered subjective and relates to attitudes, emotions, and the comfort of using a system, product, or service.

Apart from this standardized definition, there are many popular criteria, such as Jakob Nielsen's Usability Heuristics, Ben Shneiderman's Golden Rules, and Bastien and Scapin's Ergonomic Criteria [21]. However, these criteria will not serve as the foundation of this thesis but will be considered.

Historically, HCI was primarily concerned with usability, but it has since broadened its scope to include understanding, designing for, and evaluating various UX aspects. Concerning usability, it is essential to ensure that interactive products are easy to learn and effective to use, providing an enjoyable experience from the user's perspective. This involves optimizing interactions to enable users to carry out their tasks. Usability can be broken down into six specific goals:

- Effectiveness
- Efficiency
- Safety
- Utility
- Learnability
- Memorability

These goals are typically operationalized as questions, providing interaction designers with the necessary resources to assess various aspects of a product and UX. By

answering these questions, designers can identify potential problems and conflicts early in the design process, exploring possibilities [29].

4
Methodology

In this chapter, I present relevant interaction design methodologies commonly employed in design processes, which will be applied in the thesis project. These versatile methods are tailored for specific outcomes and are integral to user-centered practices, fostering the exploration of new ideas and an iterative approach based on user feedback. These methodologies form the foundational structure of the project and play a crucial role in shaping the results. I have chosen them based on my prior successful utilization in user-centered projects, feeling confident in my mastery of these methods. Recognizing a gap in the current product's incorporation of user needs, I believe these methods will enhance the project significantly. Additionally, this chapter includes a tentative timeline outlining the progression from start to end, indicating where and how the design methods will be applied. Ethical considerations essential to the thesis are also addressed.

4.1 Design Process

In this thesis, my objective is to employ a design approach to enhance the UI and UX of the product. To achieve this, a comprehensive understanding of the design process is crucial—comprehending its significance, the underlying rationale (what is being done, why it is being done, and how it is done), and the potential outcomes that can be achieved. A typical design process that will be utilized and lay foundation of this project's methodology can be depicted in Figure 4.1. Only with this understanding can a design process be seamlessly incorporated into a project predominantly dominated by programming.

In traditional software design and development projects, waterfall processes are commonly applied. The waterfall process is a linear sequential development model, well-known for its ease of implementation and low resource requirements. In this model, the output of one stage becomes the input for the next, proceeding continuously in one direction, much like a waterfall. Despite its simplicity, the model is often overlooked as being time-consuming and costly due to its rigid development life cycle. Changes are only possible in the next phase, resulting in a poorly structured system for applying feedback [1]. Additionally, designers focus solely on visual design—shaping the look and feel of the system through mock-ups. These designs are then handed over to developers responsible for implementing the design and programming the business logic and functionality. Due to differences in expertise, requirements, preferences, complexity, and resources, the design and development

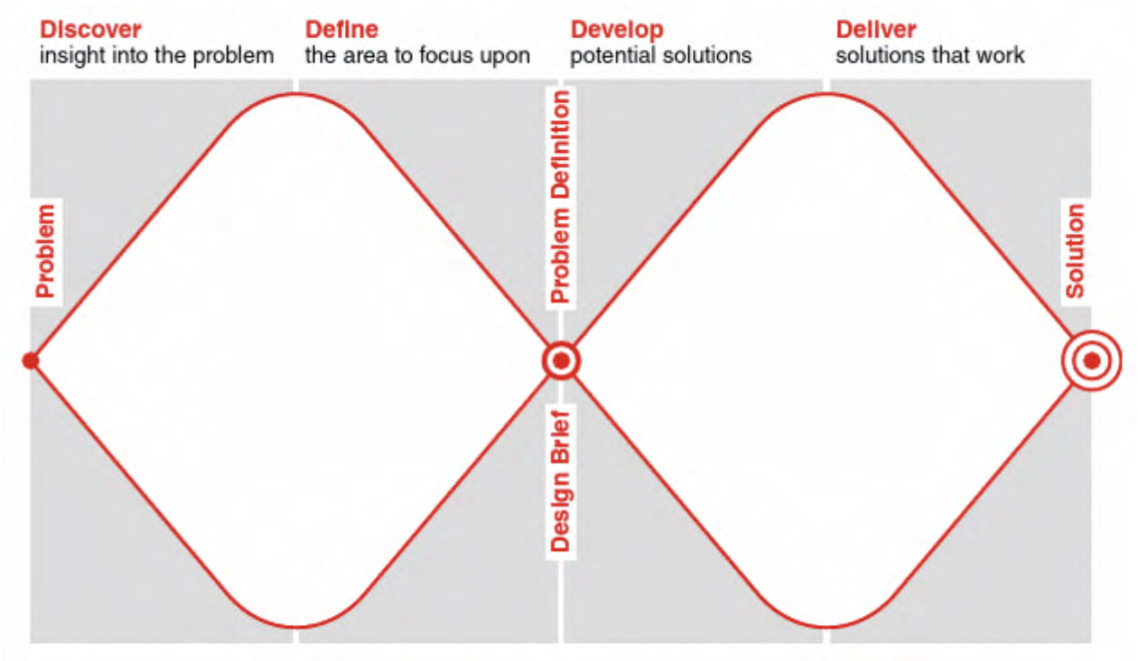


Figure 4.1: The Double Diamond of Design[29]

processes are often kept separate, leading to conflicts and poorly designed systems. An ideal approach is to implement a concurrent design and development system where the presentation of data and user interaction is decoupled from business logic and data access. In such a setup, interaction designers play a crucial role in minimizing gaps and facilitating the revision of feedback. This approach ensures a certain standard in both design and the product development [36].

4.1.1 Constructive Design Research

My intention in this design endeavor is to address the relatively underexplored realm of enhancing UX in configuration systems through prototyping. To contribute academically, I will adopt a constructive design research approach, which emphasizes critical thinking within design research to foster improvement and innovation while maintaining a user-centered mindset [31].

Constructive Design Research (CDR) has emerged as a valuable methodology in recent years, offering significant insights and garnering widespread appreciation. This approach enables designers to generate knowledge based on their expertise and capabilities within the design field, blurring the lines between design practice and research. In the modern age, designers often seek inspiration from art and design before establishing a research basis [17]. The results are not only usable for designers but also relevant to various audiences. However, CDR often involves collaborators from industries, which can lead to results aligned with industrial interests. Yet, it may encounter challenges in targeting specific audiences, potentially being perceived as irrational, unpredictable, or less meaningful [20]. Despite this, the primary contribution of CDR lies in design practice, driven by artistic curiosity. Similar to this

thesis, theoretical foundations seldom serve as the starting point; instead, they are integrated to qualify and distinguish aspects throughout the process [2].

In this project, significant emphasis will be placed on the design process itself as a means to generate knowledge and insights. The artifact produced will serve as a speculation of future possibilities, embedding theoretical thinking and experimental components to test hypotheses [31].

4.1.2 Design

The existing design will be discontinued and not further developed due to its failure to address the stakeholders' requirements adequately. Instead, a new low-fidelity prototype will be created through sketch processes, taking into consideration the goals and interests of the stakeholders as previously discussed in Chapter 2 and depicted in Table 2.1. This approach allows for the exploration of alternative designs and layouts, starting with a brainstorming session. Color profiles will be developed, considering the company's logos and themes, to give the current user interface a fresh and modernized look while retaining its functionalities and trademark. At this stage I aim to design an interactive Figma prototype that visualizes the layout of the product. The design phase begins as soon as the stakeholders and their requirements have been established in the design process.

4.1.3 Prototyping

After the design phase, the prototyping stage commences with higher-fidelity mock-ups. During this phase, interactions are integrated into the design, providing users with a preview of the final product. The prototype will be refined through trials and errors, exploring realistic implementations of interactive elements while considering design principles and guidelines, as outlined in previously Chapter 3.1 in this thesis. As specified earlier in this thesis, the prototype will be developed as an MVP, offering a usable product with minimal functionalities, serving as an early product iteration for deployment. Stakeholders will actively test the prototype in parallel with development, and the collected data will be analyzed in the next phase.

4.1.4 Evaluation

To fulfill stakeholders' requirements, a comprehensive analysis of the collected data is essential. While the product may meet all functional needs, assessing its UX performance requires evaluating users' reflections during product testing. The evaluation process involves collecting data through observations and analyzing common themes in user feedback. Based on the results, the design process will continue with further iterations, refining the prototype until achieving a subjectively satisfactory UX.

4.1.5 User-Centered Design

The change of focus from system design to users was first proposed by Norman and Draper [27] where the approach would lay foundation in the users' perspective, such as context, activities, goals, work environment and interaction among users. This change indicated that users should be involved in early stages of design and throughout the system design process to ensure acceptance and value to users [14].

In this thesis, documenting and incorporating stakeholders' feedback throughout the design iterations is essential to ensure the quality of the product. Therefore, adopting a user-centered design process is both necessary and beneficial, especially when considering the drawbacks of a waterfall process and the specific needs of this project.

4.1.6 Rapid Prototyping

As the thesis aims to produce a prototype quickly while also exploring alternative solutions, a rapid prototyping methodology is deemed suitable. This approach ensures efficient product development by seamlessly integrating feedback and development throughout the process. The primary project focus will prioritize user needs and capabilities, emphasizing their importance at the outset of the design processes. It is therefore crucial to have good knowledge on the users or stakeholders early on [9]. The rapid prototyping approach will be employed to explore design potential and features, facilitating quick feedback for revision in the subsequent design iteration [7]. This ensures a high quality product that the stakeholders have agreed on and potentially co-designed, resulting in recognition, reduced maintenance and enhancement costs which can also increase the likelihood of end user acceptance.

4.1.7 Observation

To identify problems, understand the context, and derive results for the research question, an evaluation employing an analysis method is necessary. This thesis utilizes observations to examine how stakeholders interact with and perceive the system.

Observations can occur at any stage of product development. When conducted early in the design phase, they assist designers in comprehending users' context, tasks, and goals. If performed later in development, observations help assess how well the prototype supports these tasks and goals. In the context of this thesis, observations will take place in the field, allowing users to interact with the technology naturally without feeling overly scrutinized. This approach aims to uncover the reasons behind users' specific interactions, providing valuable data for a more comprehensive analysis and better results [29].

4.2 Ethical Considerations

In the realm of design projects, a multitude of ethical considerations threads through the entire process. At the heart of the interaction designer's role is crucial tasks such as conducting user studies adhering to unwavering ethical standards. A substantial challenge arises in maintaining transparency with all stakeholders [3]. Upholding ethical principles not only safeguards the integrity of the design but also builds trust among users, clients, and team members. Striking a balance between innovation and ethical responsibility is paramount for creating designs that not only excel in functionality but also withstand ethical examination.

In this particular project, the approach includes non-intrusive, naturalistic observations conducted in real-life settings. The importance of obtaining explicit consent cannot be overstated, given that stakeholders are observed from a distance. Their actions and reflections are meticulously documented in connection with the prototype. Following this, the collected data undergoes comprehensive storage and analysis - a crucial phase in evaluating and enhancing the prototype. As a result, the establishment of trust becomes essential, offering stakeholders a sense of security as they interact with the product. Furthermore, the prototype undergoes a series of tests to ensure both reliability and effectiveness. Its introduction to the market hinges on a dynamic of trust between the developers and users. The reliability of the product extends beyond mere functionality; it holds the potential to preempt financial complications and protect the reputation of the designers.

While trying to enhance the user experience, several additional ethical considerations are important.

- Providing clear instructions and assistance, particularly during significant interface changes, ensures user guidance and understanding of new features.
- Actively encouraging and incorporating user feedback into the design process establishes a vital feedback loop, fostering transparency about how user input influences application improvements.
- Maintaining integrity in usability testing involves ensuring participants comprehend its purpose and avoiding deceptive practices.
- Explicitly obtaining user consent before collecting personal or sensitive information and transparently communicating the purpose and use of such data uphold ethical standards.
- Transparently communicating changes in the user interface keeps users informed about updates that may affect their experience.

Furthermore, the pursuit of a functional product can extend beyond usability concerns. PiiGABs products, designed for remote setups, offer a centralized network overview to customers. The potential reduction in travel emissions is noteworthy, as these products allow for remote troubleshooting before resorting to physical intervention, mitigating the environmental impact of faulty designs. Moreover, PiiGAB's field of expertise lies in providing systems that measure and collect data in facilities. This data can persuade their customers to eventually lower their usage of water,

electricity, and other resources for a healthier, sustainable environment. It is therefore crucial as an interaction designer to design a positive UX, which, in turn, may lead to greater user engagement, customer loyalty, and ultimately business growth [3].

5

Design Implementation

This chapter provides an explanation of the different design phases and processes executed in the master thesis project, along with a brief discussion on how the previously mentioned design methodologies were applied within their respective contexts. The design process of this project is structured into distinct sections, each representing a progression from the initial stages where changes and decisions might deviate from previously established material. This divergence is natural as the exploration of potential design solutions often yields unforeseen results.

Furthermore, this chapter outlines the developmental stages from a foundational concept to a low-fidelity prototype, culminating in the creation of an interactive high-fidelity prototype. The implementation commenced with a pre-study aimed at discovering and defining the issues encountered by stakeholders and those perceived as problematic. This was followed by user studies to identify the stakeholders, understand their needs and requirements, and observe their actions to recreate the encountered problems and align them with their intentions. Additionally, an analysis of design identity and ideation were conducted with a co-design approach to ensure the process remained user-centered.

5.1 Pre-Study

Prior to brainstorming ideas and creating prototypes, it was essential to define the concept and research question thoroughly. This involved conducting literature reviews of academic work involving similar projects to ensure the validity of the research question and establish a scope feasible for implementation. Furthermore, identifying existing problems to address and opportunities for improvement providing a foundational understanding to guide the project.

In addition, it was crucial to identify stakeholders to encompass all affected perspectives and gather insights into their needs and requirements. This step would ensure that the resulting solution would be comprehensive and address diverse concerns. Moreover, gaining an understanding of the current interface and its underlying structure was imperative. This would allow for informed decision-making during the design process and ensure compatibility with existing systems or frameworks.

5.1.1 Literature Review

The pre-study literature review played a crucial role in gaining an understanding of the topic. However, it posed challenges in categorizing the subject effectively, particularly due to its classification as a moderately unexplored research area, where most systems remain outdated. Similarly, configuration systems found to face similar issues, demanding increased attention.

The literature review entailed researching configuration systems similar to this project and exploring academic literature on common web interface principles, which proved both intriguing and highly applicable. Additionally, the findings and insights obtained from the research area were evaluated. The focus of the literature review was on academic sources to lend credibility to the thesis within the research field. Consequently, the material remains well-aligned with the scope of this research area, carefully selected to avoid any potential deviation or unwanted outcomes in an unexplored research domain.

5.1.2 Workshops

To kickstart the project with maximum effectiveness and efficiency, two workshops were conducted with the company to gain a comprehensive understanding of its background and the current state of its products. Understanding the business thoroughly is essential for effectively grasping the complexities of its systems and their context.

5.1.2.1 Introduction to PiiGAB

On the first workshop a brief introduction to PiiGAB was provided to explain the application of their products and their significance in the business context. Subsequently, the evolution of the product's design and development journey was outlined from its inception. Many design flaws were attributed to the absence of user studies and the prioritization of functionality over usability. Additionally, issues concerning the integrity of the design were highlighted from the company's standpoint, along with their determination to address them. Upon my first impression of the web interface, it became evident that there was a considerable desire and necessity for restructuring functionalities through redesign. The complexity of the current design was apparent, and even minor alterations could have a significant impact on the UX. In Figure 5.1, a visualization of the system was sketched out on a whiteboard to guide me as a newcomer through the setup process of the product. The steps are categorized by the navigation page and the available options.

5.1.2.2 Interaction mapping

During the second workshop, which followed the introduction session, we endeavored to visualize potential interactions with the current web interface. This included sketching use cases, interaction trees, and mapping out frequently used functionalities. However, these efforts proved to be challenging.

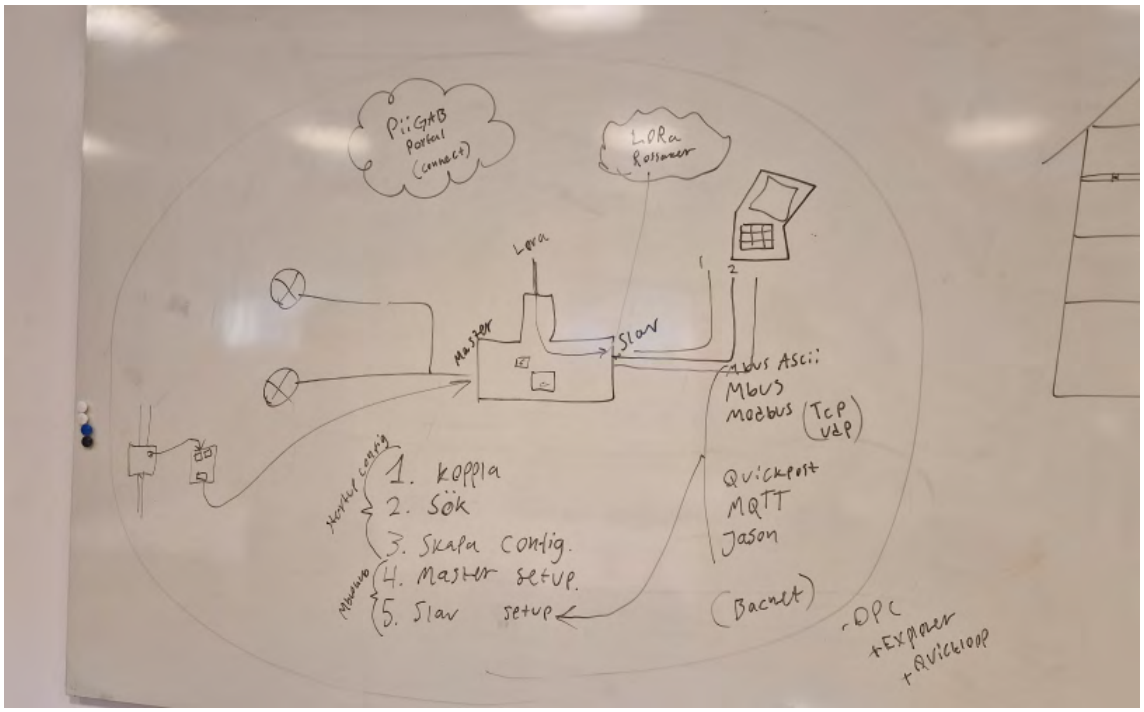


Figure 5.1: Whiteboard sketch of the product's setup process during first workshop

Notably, simplifying the setup process for the products was identified as crucial, as it currently demands a significant amount of knowledge and experience. Additionally, there was a request for better categorization of functions, as well as planning for a new technical framework and implementation strategies, including the choice of programming language.

In this stage, I approached decision-making with caution, drawing on my perspectives as both a designer and programmer. This allowed me to appreciate the complexities involved in implementing a design with code. Nevertheless, it was evident that the redesign would significantly impact the future development of the products and lay the foundation for structural rework.

However, with opportunities came challenges, particularly concerning future implementations. Questions of feasibility, scalability, flexibility, and modularity arose. While the setup process offered various options depending on the user's context, not every action was deemed common. Therefore, we chose to proceed from the perspective of a new customer whose primary desire is simply to set up the product. An overview of the interaction map can be seen in Figure 5.2 where we had sketched the simplified structure of the system.

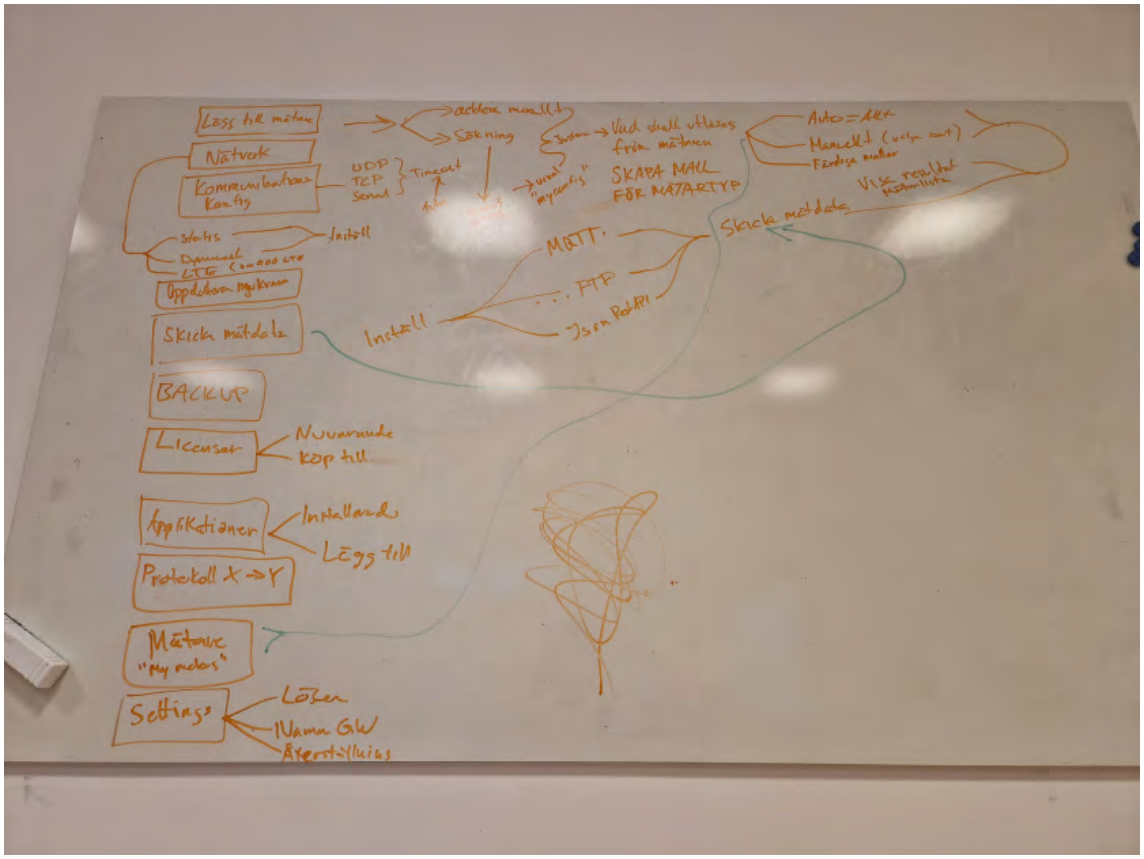


Figure 5.2: Overview of interaction map on whiteboard

5.1.3 User Studies

Before developing a solution for the users, it was crucial to identify the stakeholders and their respective needs and requirements. This ensured that the solution would address the concerns of all parties involved and avoid excluding anyone. Conducting a user study through observations helped to identify these factors. Furthermore, it provided insights into the origins of perceived problems and facilitated their replication for subsequent studies.

5.1.3.1 Stakeholder observations

Observations were conducted discreetly during technical support meetings with PiiGAB customers requiring developer assistance in product configuration. Throughout these sessions, stakeholders voiced their needs, problems, and desires for future implementations. The observations were conducted online, often utilizing screen mirroring features to visualize and reflect the customers' navigation in the web interface. To preserve the natural flow of customer interactions and avoid influencing their thought processes, me as the observer remained off-camera and refrained from speaking until the conclusion of each support case. Additionally, in separate observations, developers and salespeople at the company were tasked with performing specific actions to showcase the functionalities and use cases of the web interface. The pace of these demonstrations varied significantly depending on the individuals' familiarity and expertise in interacting with the interface.

5.1.3.2 User Journey

By combining the knowledge gained from workshops and observations, a general user journey was defined to pinpoint where the perceived problem arises during interaction. To facilitate understanding, an initial simple user flowchart was created illustrating the typical intentions of a user. In Figure 5.3, the user flow of the setup process is visualized, grouping each action into its respective page. To simplify even further, another user flow was made illustrating specific desires or actions within the setup process, as shown in Figure 5.4. Although we could state that there obviously already existed a problem with the design, there needed to be an indication of discovery before defining it. Therefore, in a slightly refined user flow, branches were added to highlight common points where stakeholders get lost, and where the support team at PiiGAB are integrated into the process as visualized in Figures 5.3, 5.4, 5.5, 5.6, 5.7, 5.8.

After discovering and defining the problem, it became possible to address potential concerns by applying the user journey to different users. By doing this, user needs and requirements could be mapped to specific tasks in the user journey, thereby highlighting the user's expectations and evaluating possible risks and solutions. This process was conducted for new users, intermediate users, and salespeople at the company, as there was sufficient data available to apply in these scenarios, illustrated in Figures 5.9, 5.10, 5.11.

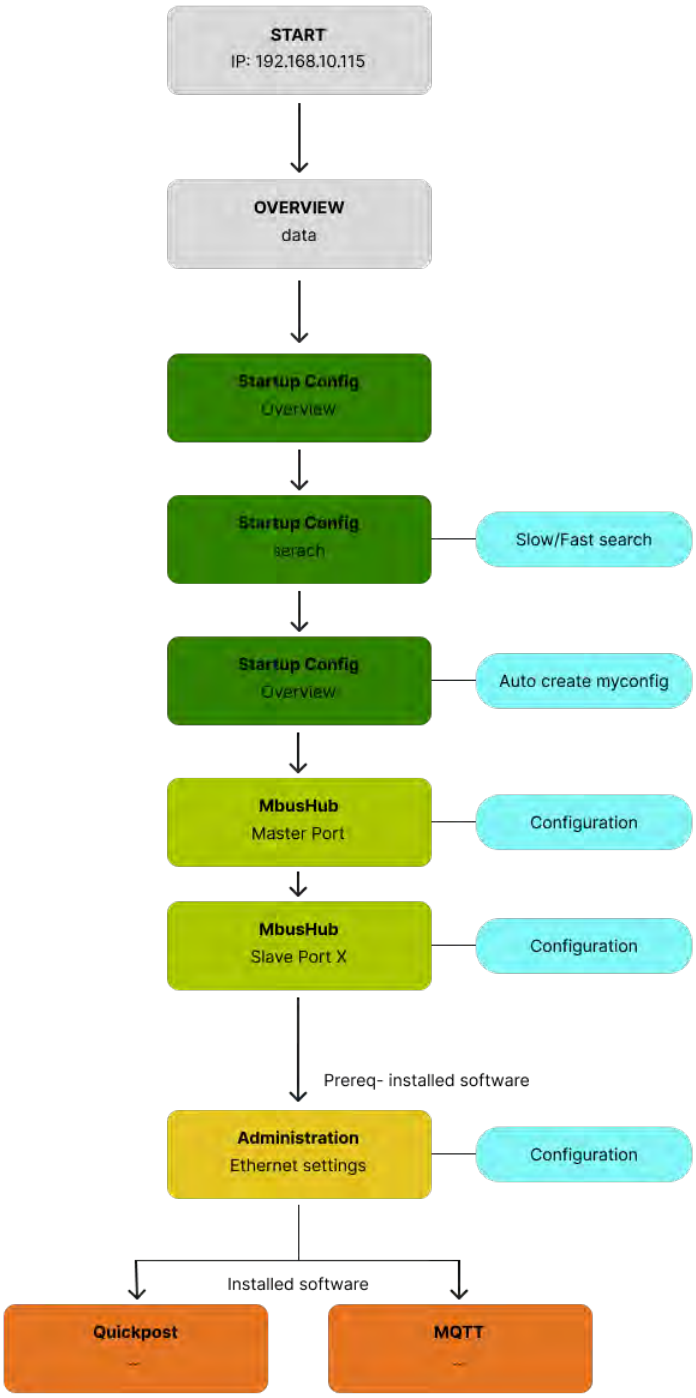


Figure 5.3: Flowchart of simplified setup process

Figure 5.4: User journey of users desired interactions from left to right with icons

Figure 5.5: User journey including branch of contacting support

Figure 5.6: Limited view of user journey branching into the path of contacting the support

Figure 5.7: Desired user journey

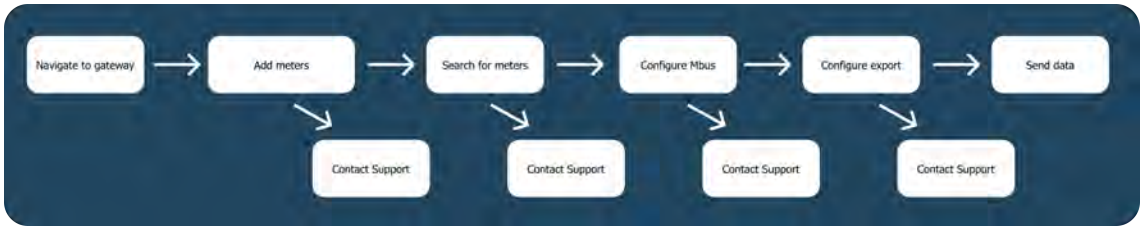


Figure 5.8: User journey with branches where support are contacted

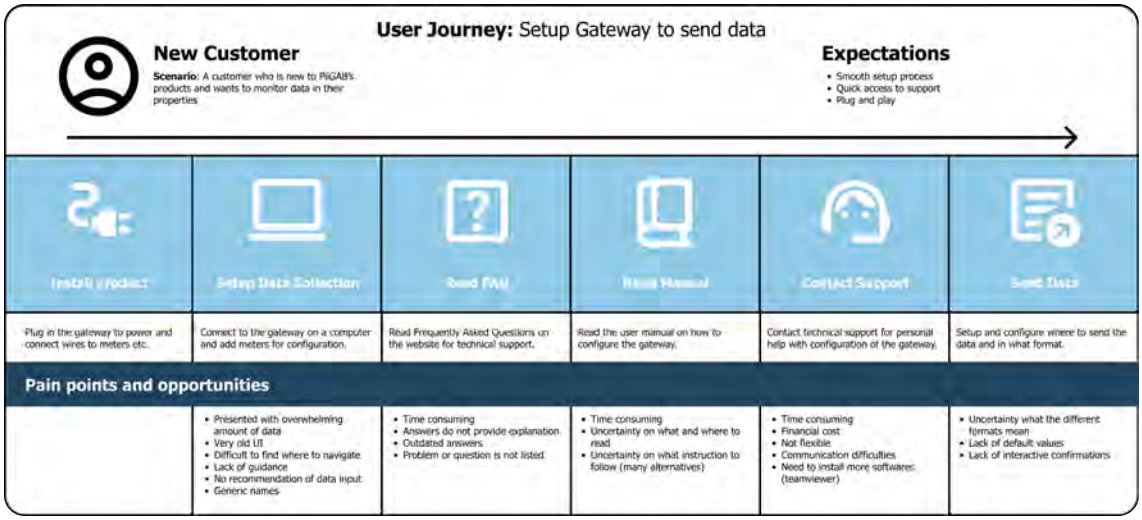


Figure 5.9: User journey of a new customer with expectations and thoughts

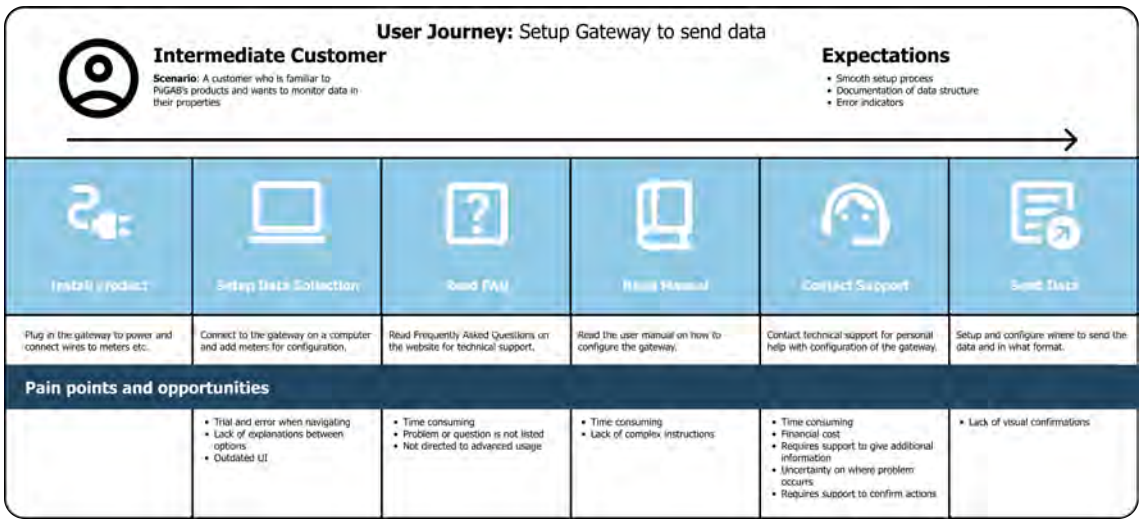


Figure 5.10: User journey of a intermediate customer with expectations and thoughts

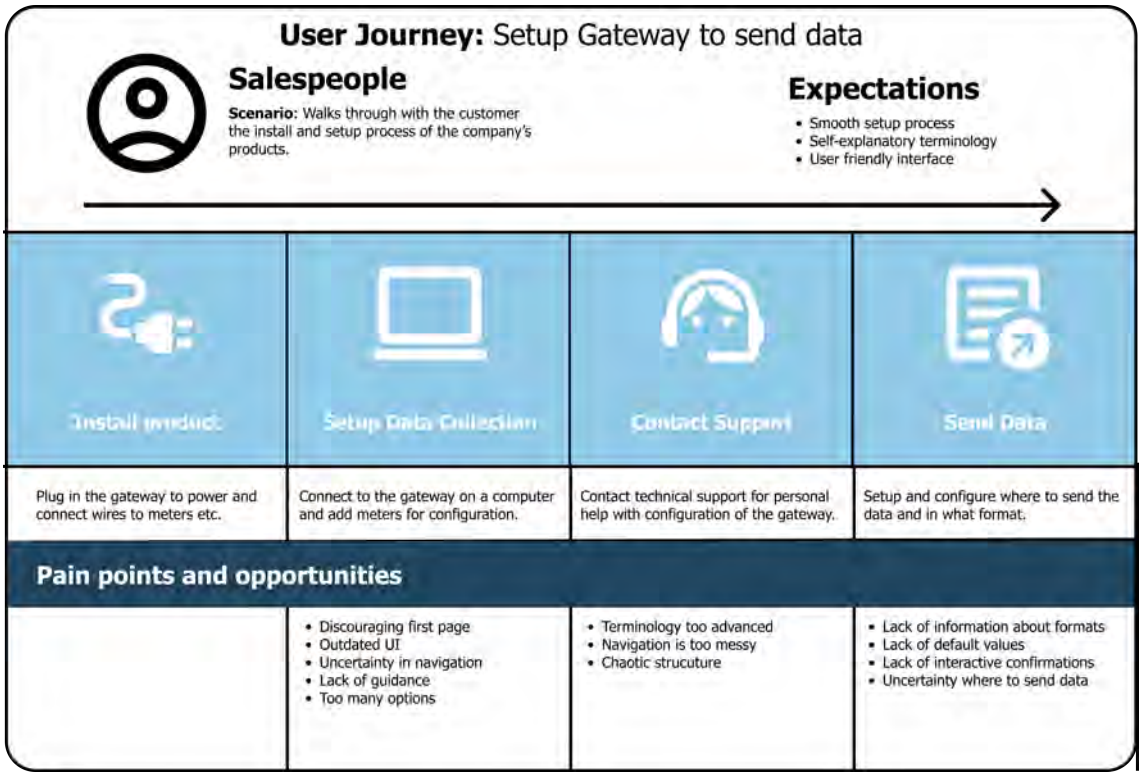


Figure 5.11: User journey of a salesperson with expectations and thoughts

5.2 First Iteration

In anticipation of creative block, I conducted research on common web interface designs to find inspiration and potential value. The current interface shares similarities with modem designs, which often vary across manufacturers and may include outdated elements. However, studying these designs could offer insights into feature categorization. Moreover, comparing updated modem interfaces with older versions could reveal unnecessary design elements. Additionally, I explored the interfaces of prevalent IoT devices, which often feature modern, clean, and minimalistic designs, offering potential insights into current design trends.

5.2.1 Design Identity

PiiGAB currently utilizes three distinct web interfaces, each serving a unique purpose. These interfaces were developed at different times and by different individuals, resulting in minimal similarities beyond the company's logo. Envisioning a cohesive future concept necessitated a consistent design across all facets of the company's work, highlighting a notable absence of the company's design identity in current usage. An analysis of the design elements of the web interfaces was conducted to document the aspects considered valuable by the designers from the existing design identity. While the colors shared a similar hue, the layout lacked consistency in contrast, and the fonts varied without discernible logic or structure. However, the more recently designed web interfaces displayed significantly improved categorization of

Figure 5.12: Design analysis of gateway web interface

features, were noticeably more intuitive upon first impression, and were aesthetically pleasing. All the discoveries can be seen in Figures 5.12, 5.13, 5.14.

As previously mentioned, PiiGAB already has a defined design identity that they intend to continue using. This identity comprises a collection of defined icons associated with specific areas of use, a font with varying styles depending on the context of use, and colors specific for layering. The design for this master thesis would therefore proceed from the design identity as a starting point. However, in the context of ideation, the design identity was temporarily excluded to allow for creative freedom. The design identity of PiiGAB can be seen in Figure 5.15.

5.2.2 Ideation

Effective brainstorming and ideation sessions are foundational to innovative problem-solving. Prior to diving into these sessions, it is crucial to establish a conducive environment. This involves conducting warm-up exercises and framing the problem statement in an open-ended manner to encourage creativity. Particularly for individuals new to high-volume brainstorming, where prioritizing quantity over quality can be daunting, adopting a 'beginner's mind' can foster fresh perspectives and overcome preconceived limitations [15]. As someone experienced in facilitating such sessions, I am confident in my ability to guide the team (PiiGAB staff) towards successful outcomes.

Drawing from academic insights, I have recognized the challenge developers face when brainstorming under pressure, often defaulting to immediate problem-solving

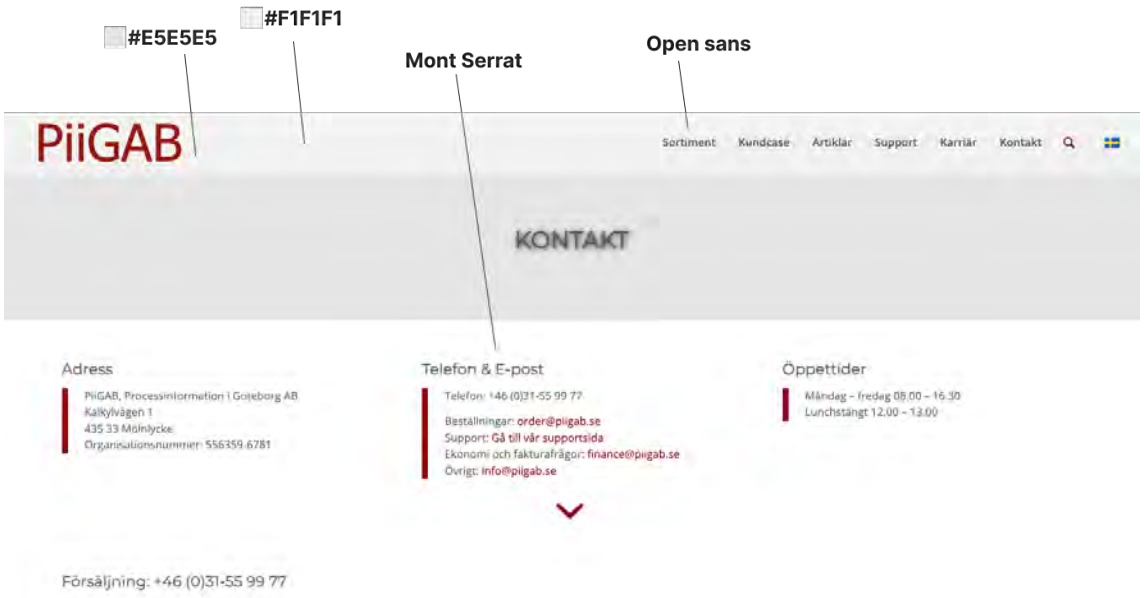


Figure 5.13: Design analysis of PiiGAB website interface

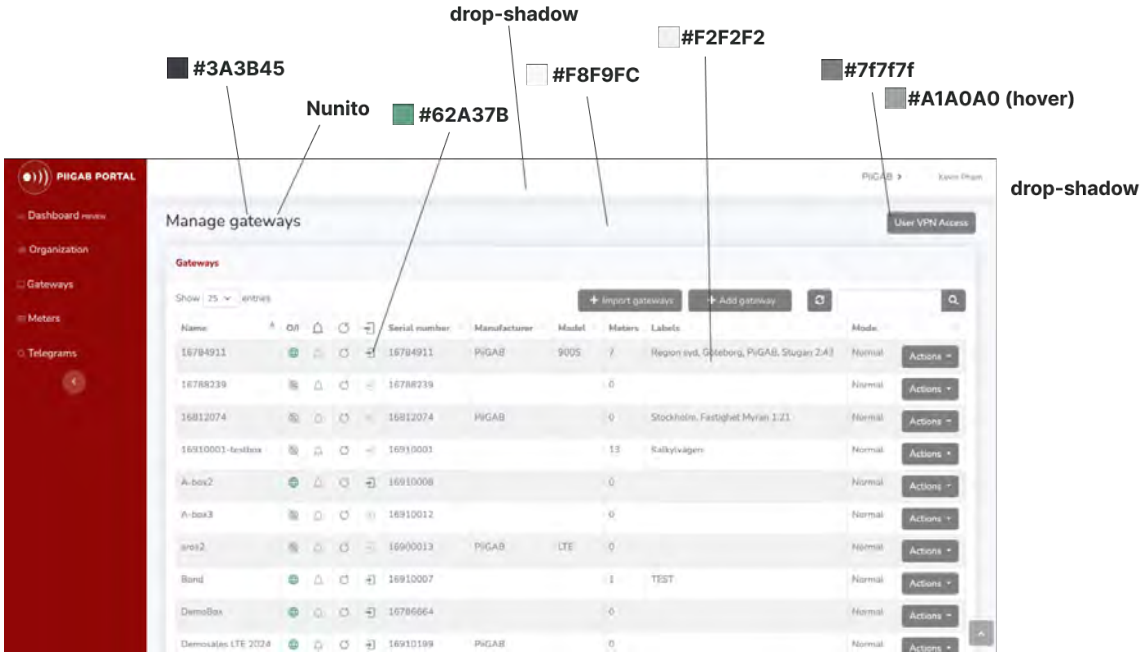


Figure 5.14: Design analysis of PiiGAB portal website interface

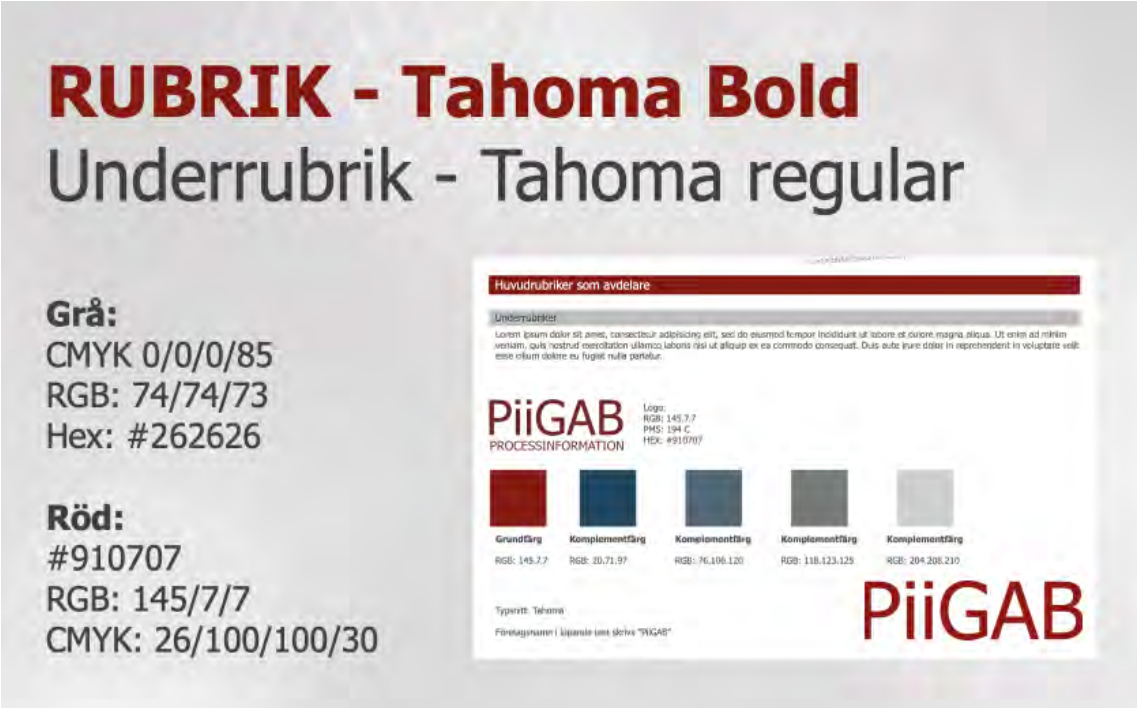


Figure 5.15: PiiGAB's established design identity

rather than exploring alternative solutions. Hence, my ideation approach aims to push individuals beyond this comfort zone by emphasizing practical techniques, such as utilizing whiteboards. Through this process, I aim to cultivate a culture of creative problem-solving that yields innovative solutions. The methodology was selected based on past experiences and the effective outcomes.

5.2.2.1 Crazy 6's and Sketching

A simplified version of the Crazy 8's method, known as the Crazy 6's, was utilized to brainstorm a new layout for the homepage of the web interface. Unlike the original Crazy 8's, which involves generating 8 ideas within 60 seconds each, the Crazy 6's involved generating 6 ideas. This approach aimed to foster diverse perspectives and encourage thinking outside the box. The session included 4 participants, including myself as the designer and the sole individual familiar with the Crazy 8's methodology.

Given my relative newness to the product concept, I initially completed the Crazy 6's alone to provide a fresh perspective before involving other participants. To observe their unique thought processes, I held individual sessions were I acted as a facilitator, offering only time notifications for each idea. To inspire creativity, I also displayed typical layouts of configuration interfaces from devices like modems and IoT devices on a nearby monitor. While providing existing layouts as inspiration may risk guiding participants towards common layouts, it is worth noting that newcomers to the Crazy 8's method often struggle to generate numerous ideas, typically exhausting their creativity after 2-3 sketches.

The goal of the Crazy 6's method was to lay the foundation for a potential new design theme, ensuring consistency and coherence by establishing a structured framework. Additionally, it aimed to surface ideas previously considered by stakeholders at PiiGAB, the company. All generated ideas were then evaluated for similarities and differences, with a focus on aesthetics. The most promising concepts were earmarked for further exploration through sketching which is visualized in Figure 5.16.

The rating system consists of golden stars, which can be either full or half in shape, used to determine the level of value or impact for inspiration during later phases. A fully shaped star represents a concept that requires more attention and shows potential for further refinement, while half-shaped stars indicate potential design elements that can be incorporated into the fully starred concepts. The rating system aided in narrowing down the design layout possibilities, resulting in a combined concept that reflects what is currently believed to be the desired layout. The rating system served as my personal method for evaluating designs and was not shared openly within the company. Therefore, the stars do not indicate a collective vote or represent the preferences of multiple individuals, but rather reflect my own opinions as a designer.

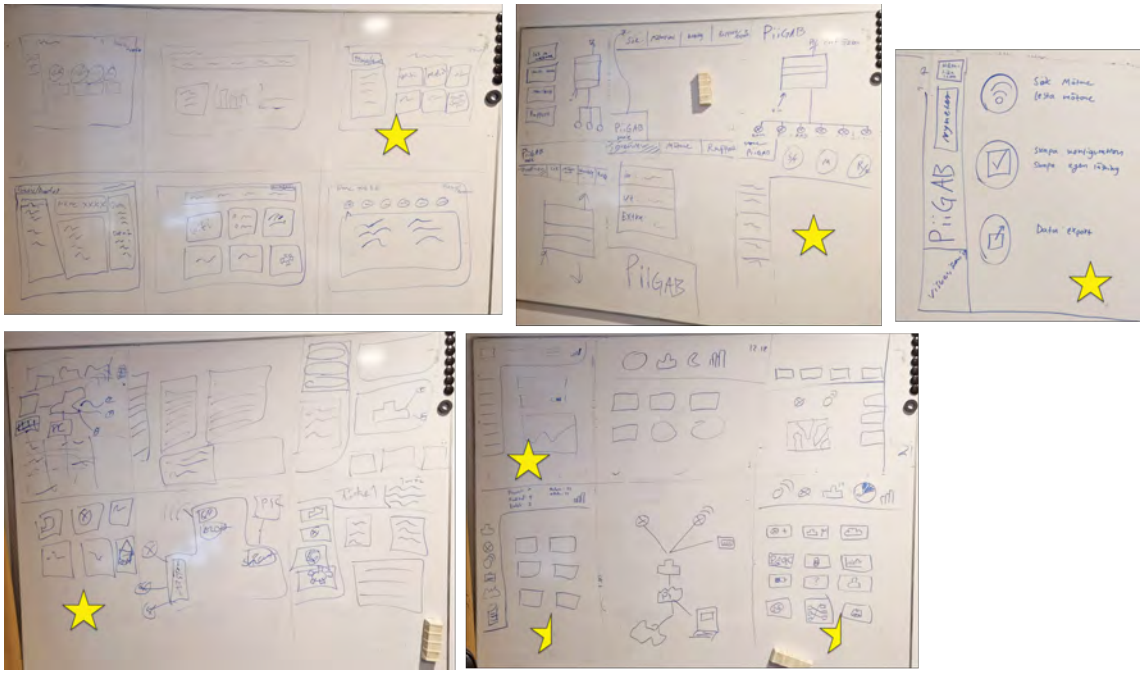


Figure 5.16: Results from Crazy 6's sessions with star ratings

Combining the sketches helped in defining a conceptual structure for the artifact to address. However, at this stage, the design remains open to adjustments and the emergence of new ideas, which will be further explored in subsequent prototype iterations. Since prototyping is about bringing a design to life, the sketching phase is not limited to specific implementations, providing room for creative exploration [10]. The sketch was subsequently translated into digital format using Figma, facil-

itating easier access and allowing for further refinement.

Similar to the star rating system used in the Crazy 6's session, I conducted an evaluation of the "dashboard" within the current web interface to identify data that might be significant for stakeholders. In Figure 5.17, design elements such as labels, data outputs, buttons, headers, and tables are highlighted in green, yellow, and red to indicate what should be kept, revised in a new format, or removed/hidden. Descriptive labels were also provided alongside the highlights to offer refinement suggestions and reinforce the ratings. For instance, the start button in the navigation bar on the left side of Figure 5.17 is marked yellow for refinement, with the attached label proposing a renaming.

Furthermore, the analysis was presented to stakeholders at PiiGAB who could be impacted by the suggested changes, including the support team and developers who require specific tools and data to perform their tasks. The feedback received was mixed: while the support team favored keeping all design elements in one place for easier debugging, there was recognition that removing or refining certain elements could lead to a more intuitive design for all stakeholders.

Additionally, it's important to note that one of the key objectives of the redesign is to decrease the number of support cases resulting from non-intuitive design, indicating that an improved design might render some debugging tools unnecessary. Despite the numerous motivations provided at this stage, it's crucial to remember that many assumptions were made and would need validation by stakeholders during evaluation.

Figure 5.17: Design and feature analysis of gateway's startpage interface

5.2.3 Prototyping

The majority of prototyping was conducted digitally using Figma. The process involved numerous iterations, each building upon the previous design with refinements that ranged from significant conceptual changes to minor adjustments. To maintain a clear record of revisions, each version was labeled as "Mark X," with 'X' representing the version number expressed in Roman numerals. For example, the initial prototype was labeled as Mark I, followed by subsequent iterations such as Mark II and Mark III. This naming convention drew inspiration from Iron Man's system of naming his prototypes.

Based on personal experience, I found that sketching on a whiteboard before digitizing designs proved to be more practical and facilitated the creation of more detailed specifications. Consequently, most layouts, wireframes, and sitemaps were initially conceptualized on a whiteboard to gain a clearer perspective and serve as a reference for digital design in Figma. Figures 5.2 and 5.17 were utilized consistently throughout the prototyping process until all factors were adequately addressed or categorized.

Given that the start page is often the first point of contact for stakeholders and can significantly influence their impressions, it was prioritized as the initial focus for redesign during the prototyping phase. From the ideation stage, it became apparent that there was a need for quick access to data presented in a format that requires minimal cognitive effort to comprehend. Additionally, it was essential to meet the requirements of both the support team and developers by displaying data that benefits both customers and internal stakeholders. Furthermore, there was a consensus that providing quick access to tools, such as an add meter, would streamline navigation and eliminate unnecessary steps. This approach aimed to enhance UX by reducing cognitive load and simplifying navigation.

The sketches were transformed into wireframes using Figma's prototyping tool, enabling designers to program design elements into interactions. This enhanced the prototype's realism, simulating a finished product and streamlining the viewing process without interruption. However, certain interactions, such as click and drag functions and complex navigation steps, required additional design elements. Due to time constraints, only essential interactions for common navigation were programmed based on stakeholder input.

Furthermore, while additional features like search bars, filters, and graphs seemed plausible for future implementation, they were left without interactions due to uncertainty regarding future plans and a lack of usability data. Instead, these features were primarily included for aesthetic purposes, adding variety to the design while maintaining consistency. As the current web interface required a new design a majority of the structural integrity needed to be reconsidered. While moving features such as internet into its own section with multiple configurations several possibilities of displaying data was presented which made the design process much more complex. Therefore, in collaboration with PiiGAB staff, we needed to sketch interaction

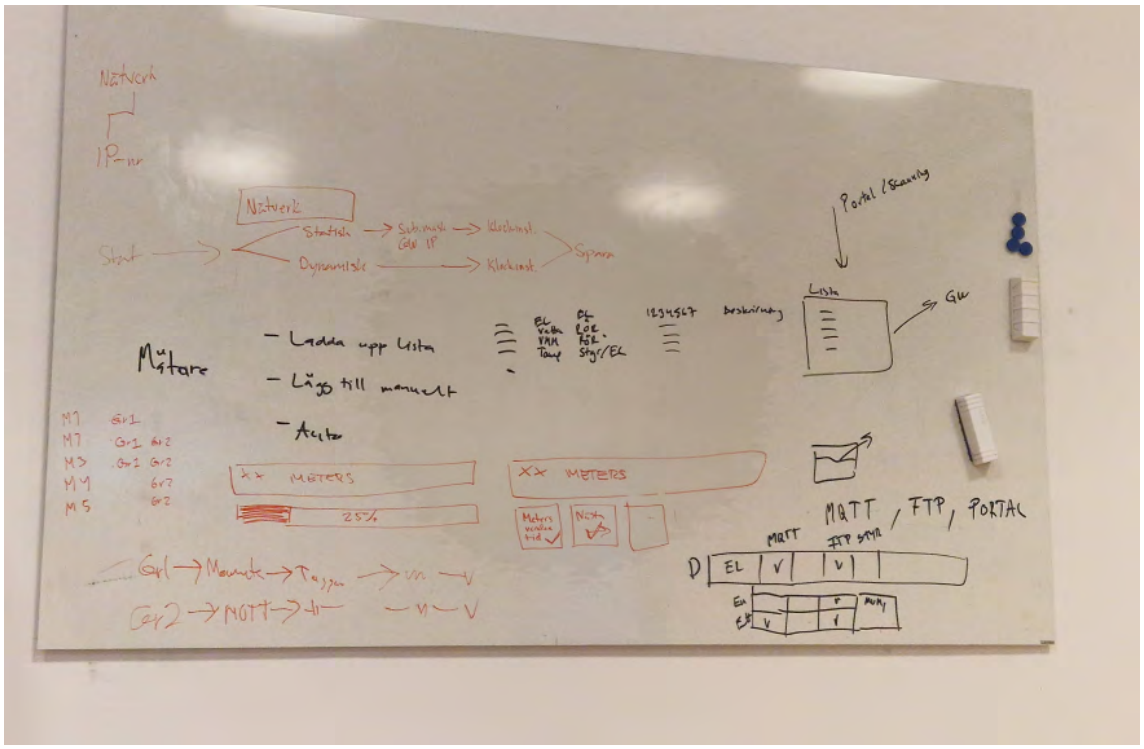


Figure 5.18: Sketch of design ideas on whiteboard

branches and list functions required as visualized in Figure 5.18 as well as design ideas.

5.2.3.1 Co-Design

Given the rapid prototyping approach employed during the process, continual user input and feedback were vital to ensure that the prototypes aligned with stakeholders' needs and requirements. By comparing various versions, it became apparent how stakeholder feedback influenced changes, such as adjustments to colors and sizes of design elements, following my initial designs. Additionally, weekly feedback sessions were conducted with PiiGAB staff, enabling the incorporation of inputs and preferences from external stakeholders, based on past meetings and evolving discussions. This iterative process gradually transitioned into a co-design methodology, emphasizing collaboration and collective input throughout the design iterations. Moreover, I found the rapid prototyping approach beneficial for efficiently producing multiple prototypes. This conclusion is drawn from prior experiences where designing a high-fidelity prototype from scratch, without exploring potential designs, was also not considered significantly important or necessary for achieving meaningful results. In these experiences, the focus was on exploring potential designs and branching out, which was deemed important and meaningful for project success [11].

The initial prototype, visualized in Figure 5.19, seamlessly combines previous sketches with the implementation of PiiGAB's design identity, incorporating profile colors.

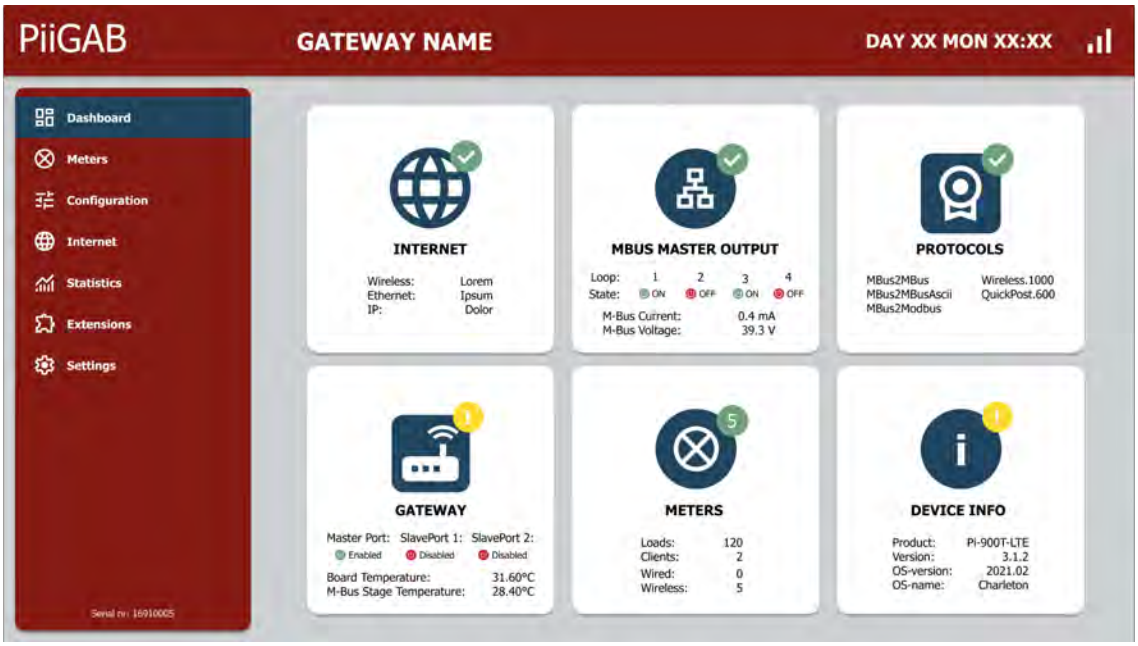


Figure 5.19: Prototype Mark I

This iteration marked a significant improvement from the previous interface, boasting a modern and simplistic aesthetic that provided a solid foundational starting point. The design utilized icons and visual aids effectively, although there is room for improvement in terms of contrast. Personally, I found its appearance to be rather plain, resembling modern configuration systems such as router web interfaces. Nevertheless, Figure 5.19 (Mark I) underwent internal evaluation within the company, leading to the development of Mark II, depicted in Figure 5.20. In this iteration, feedback from the internal evaluation was incorporated by reducing the heavy contrast, primarily by replacing the majority of red elements. A modernized aesthetic was achieved by limiting the use of colors and introducing subtle rounded corners to design elements, aligning with the company's desired aesthetic.

Concurrently with Mark II, Mark III was prototyped to explore visual aids in navigation bars, experimenting with various methods to indicate the user's current page. A comparison between Figure 5.20 and Figure 5.21 reveals a notable difference in the left panel, where the navigation bar displays the current page. This was achieved either by highlighting the entire design element and altering the text color or by adding a thick line on the left. Both methods are commonly integrated into universal applications and interfaces, and I wanted to test their suitability in this prototype.

The decision between Mark II and Mark III was reached unanimously through a vote during a feedback session, allowing staff at PiiGAB to reflect and voice their opinions. Despite discussions revolving around minimalism and modernism, I personally found Mark II to be the more fitting candidate. However, Mark III was favored for its enhanced visual aids, which were deemed necessary compared to the current interface, where such aids are almost nonexistent.

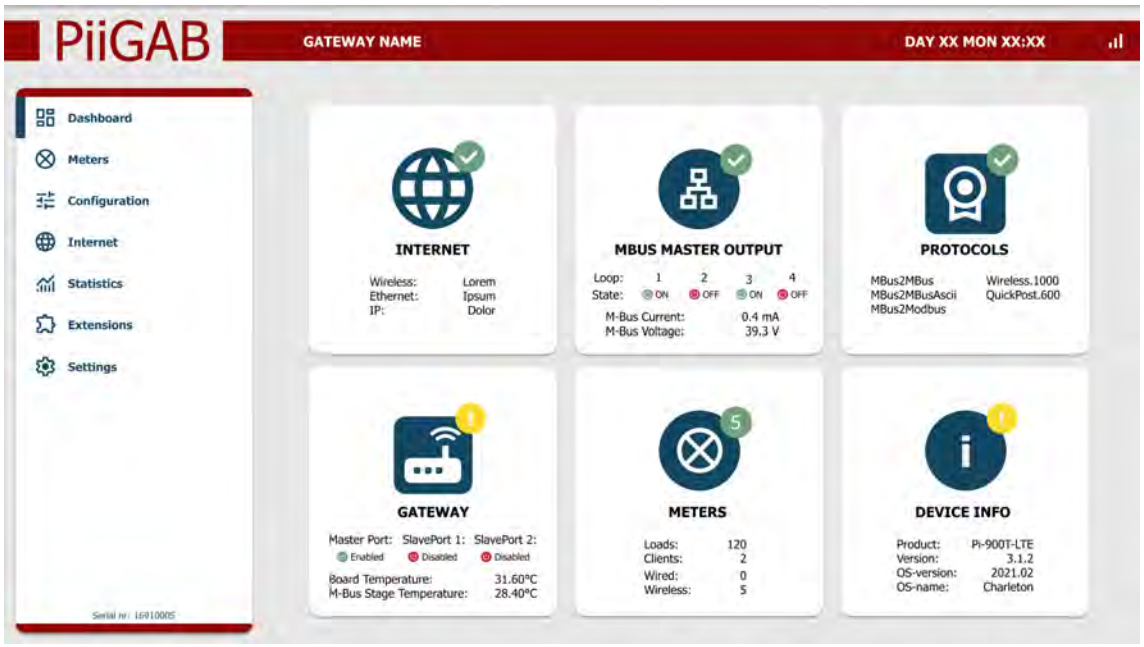


Figure 5.20: Prototype Mark II

In transitioning from Mark III to Mark IV, the dark blue design elements were replaced with grey. To add depth, the white background was subtly darkened with a touch of black, intensifying the saturation to create a base layer for the panels. Mark IV is depicted in Figure 5.22, where the contrast has been further reduced for a minimalist aesthetic. However, I found the contrast to be too low, with the absence of dark blue removing variation and harmony.

Additionally, during testing, a search bar was deemed necessary to enhance UX, serving as a fallback method in case navigation proved to be less intuitive. Furthermore, a notification icon was introduced in the top bar to indicate changes and prompt necessary actions.

After progressing to prototype Mark IV, as shown in Figure 5.23, the interface design adopted a more minimalist approach. This iteration further reduced the presence of red elements and reintroduced squared corners to certain design elements for consistency. Additionally, the search bar was relocated to the top of the interface, extending beyond its previous placement solely within the dashboard. The gateway name was moved to the bottom part of the navigation panel, and the intensity of the color black was decreased to enhance readability.

As development progressed towards the subsequent version, it became evident that the design had attained a high level of fidelity and required no further refinement, especially considering the time needed for implementation through programming. Nevertheless, it remained crucial to have a flawless prototype as a foundation for programming. After discussions with PiiGAB, it was decided to narrow the design scope exclusively to the setup process, necessitating the establishment of a new

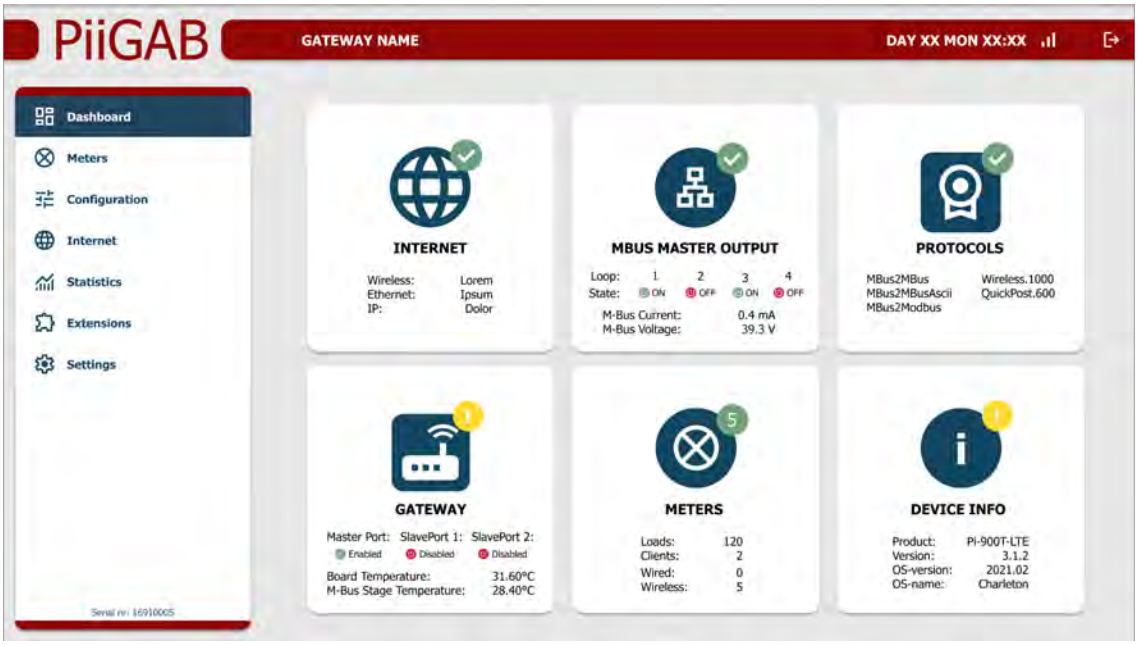


Figure 5.21: Prototype Mark III

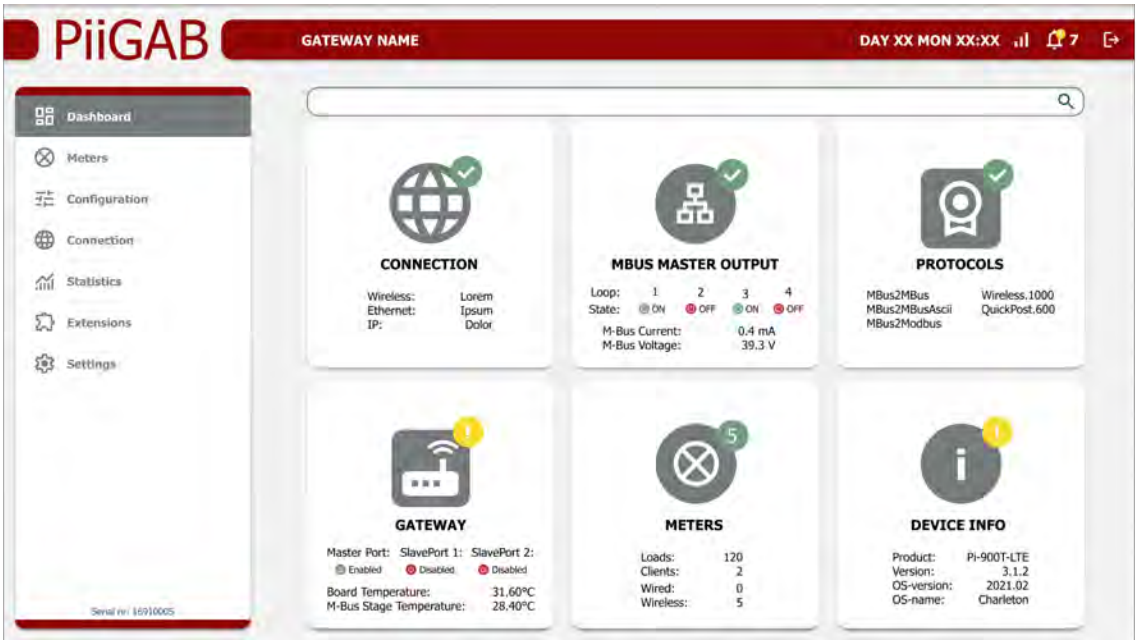


Figure 5.22: Prototype Mark IV

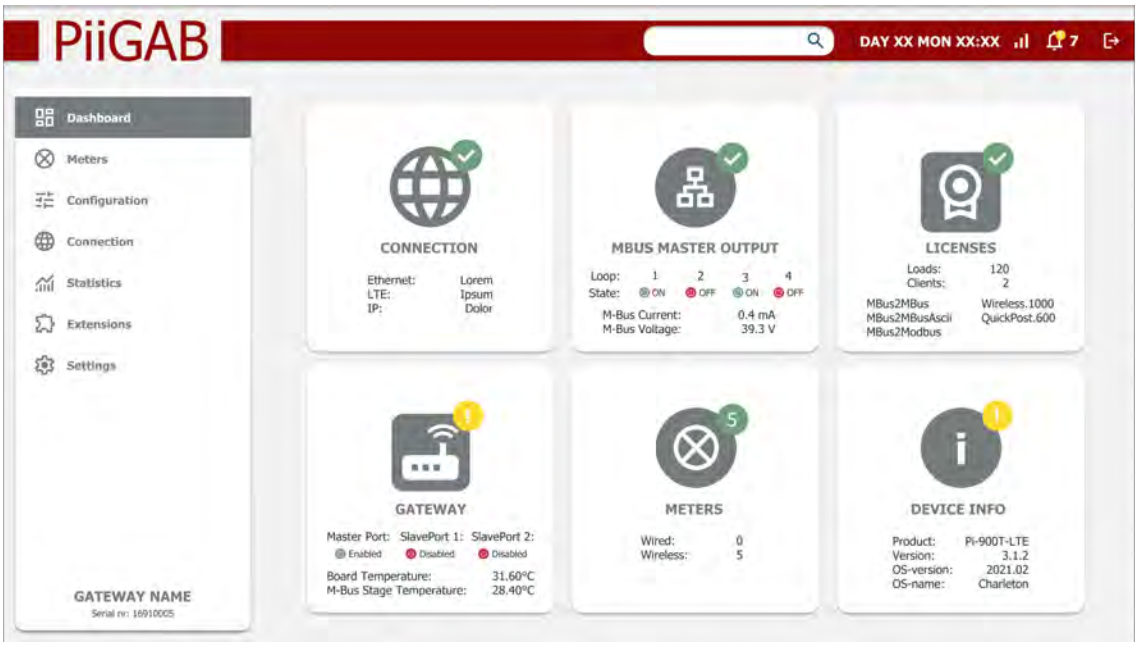


Figure 5.23: Prototype Mark V

structural procedure. Consequently, the scope had to be redefined and restricted to the parameters of the previous version. Additionally, it was agreed that the focus would be solely on design, excluding programming from the project's goals.

Moreover, it was imperative to establish the correct user flow before proceeding with the design to ensure that the features and functionalities were appropriately incorporated. Navigation pages such as Settings, Extensions, Statistics, and Connection were therefore postponed and assigned lower priority in alignment with the newly established direction which can be viewed in Figures 5.24, 5.25, 5.26. Together, we concluded that prioritizing an intuitive design was paramount, necessitating additional time for exploring UX possibilities related to navigation and interaction steps in setting up the gateway.

Many tabs within the pages of the newly designed web interface drew inspiration from the current design, utilizing screenshots as a basis. Since these pages were of lower priority and remained unfinished, an 'UNDER CONSTRUCTION' label was added at the top to inform users testing the prototype of its development status, as depicted in Figure 5.26.

Addressing the absence of visual cues when users interacted with the current interface, I implemented a modal overlay that appears atop the web interface when users configure changes requiring saving, or when data needs to be displayed after actions. This ensures users are always informed of ongoing processes, as the data is layered over the interface, capturing their attention by temporarily disrupting interface harmony.

Depending on user interaction, the modal remains visible until actions are acknowl-

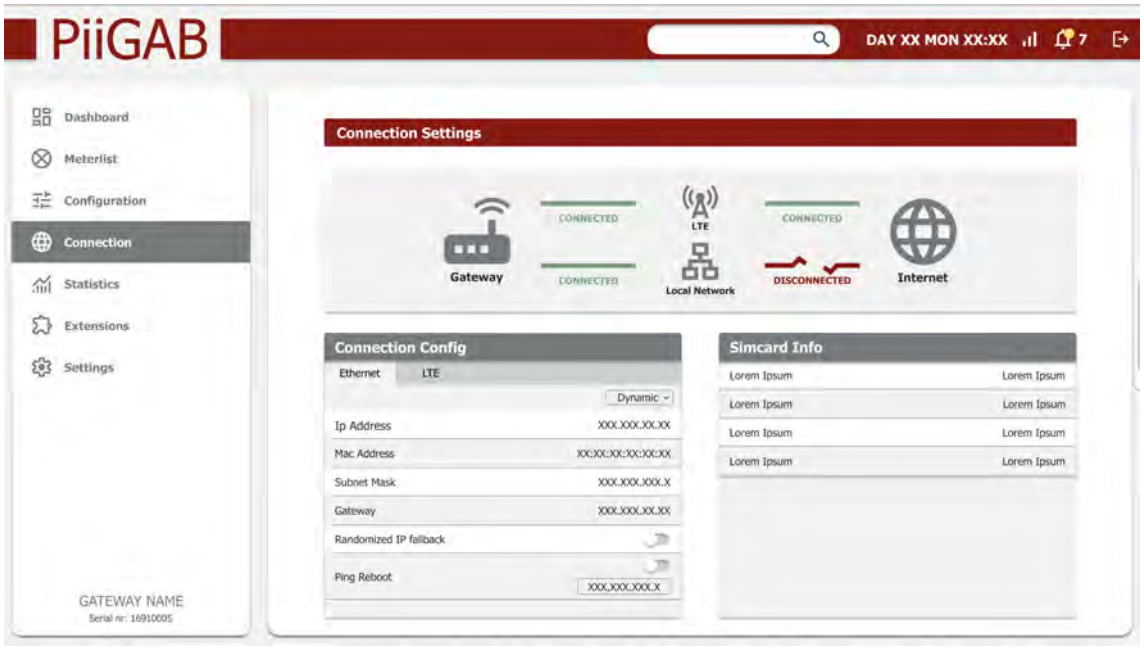


Figure 5.24: Connection page (previously Internet page) of the new web interface

Figure 5.25: Statistics page of the new web interface

Figure 5.26: Settings page with all tabs of the new web interface

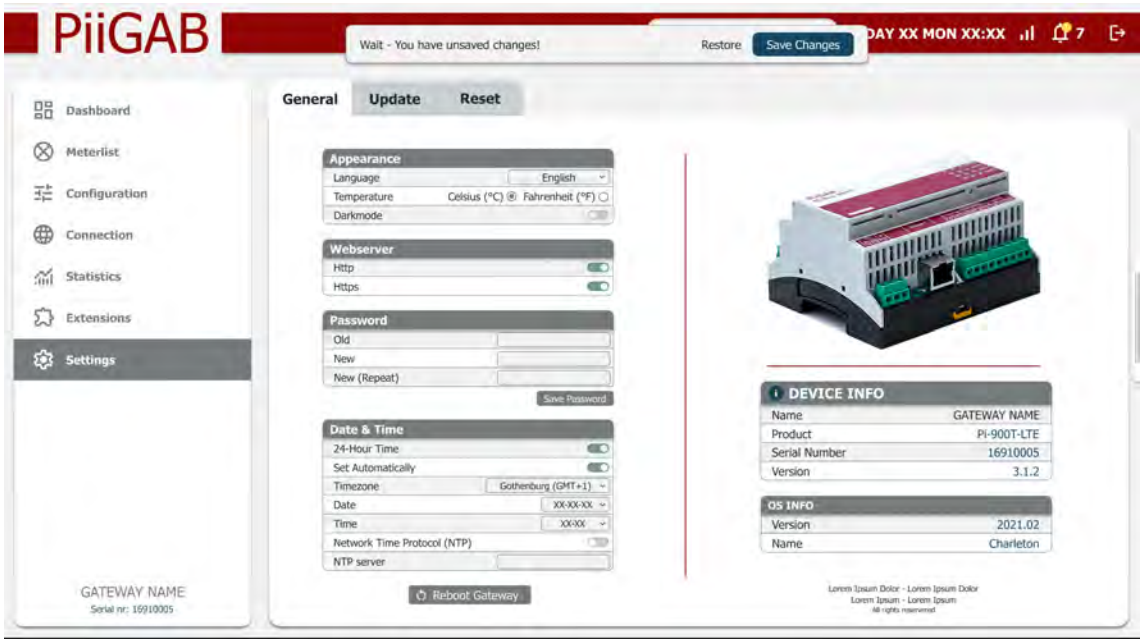


Figure 5.27: Settings page of the new web interface with 'Save Changes' modal

edged, changes are restored, or a predetermined time elapses after users have reviewed the displayed data. Moreover, the modal serves to replace an excess of buttons, reducing clutter and confusion, and instead functions as a general 'save all' feature depicted in Figure 5.27.

Building upon the foundation laid by Mark V, a new dashboard layout was envisioned to optimize interactions and introduce customization tailored to diverse user cases. The process began with rough sketches on a whiteboard, as depicted in Figure 5.28, outlining the design elements. This initial layout evolved into the final design of the prototypes, encompassing a wider array of features compared to the current start page. These additional features will be elaborated upon in subsequent sections.

5.2.4 Evaluation

Given that the company had not done a proper design evaluation with stakeholders before, it was declared by me as the designer as a priotization of utmost importance. Therefore, it was crucial to find real relevant stakeholders whom could reflect and give valuable feedback to the design. The evaluation was planned to be non obstructive observations with minor interference to explain undeveloped interactions due to time constraints.

The study conducted aimed to compare the UX of two web interfaces, in which one is outdated and the other recently designed, by letting participants interact with both one at a time and then answering a questionnaire. By examining the results of the questionnaire, I sought to gain insight into what design elements are considered intuitive and aesthetically satisfying. In return, the stakeholders would

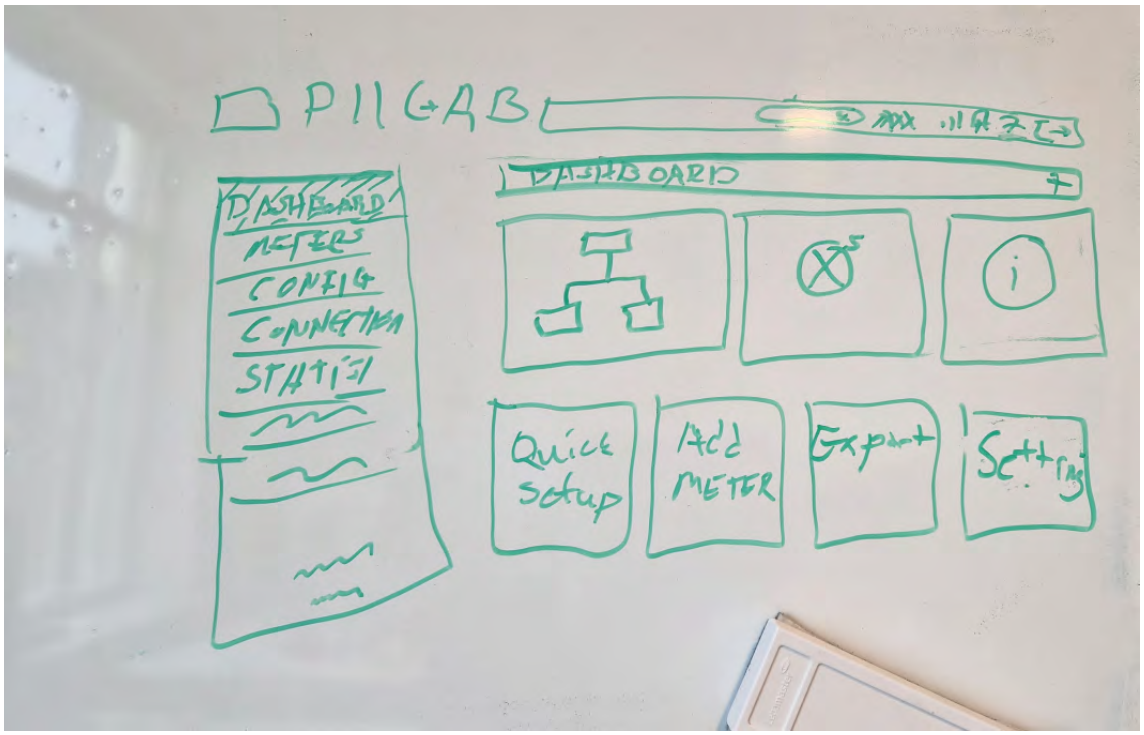


Figure 5.28: Whiteboard sketch of new dashboard from feedback sessions

be thanked for their participation and eventually the chance to somewhat co-design a new interface that is of their advantage and liking in the future.

5.2.4.1 Experiment Hypothesis

The study had three hypotheses that were significant to prove correct or wrong in order to get satisfying results that could contribute to further develop in the next iteration. It was important to receive user input in case the new design was headed in a wrong direction and minimizing the expenses of time and work. The following hypotheses were established to prove in this study:

- Participants will find the newer web interface more intuitive.
- Participants will find the usability of both web interfaces to remain the same.
- Participants will find their needs met when interacting with the new web interface.

5.2.4.2 Participant Profile

As previously mentioned the company had not performed evaluations prior to this project and gathering the correct stakeholders was significantly crucial. In addition, there were general requirements stakeholders needed to fulfill to participate which was the following criterias:

- Should be able to read.
- Have an affiliation to PiiGAB.

- Be familiar with PiiGABs work.
- Have an interest in PiiGAB's products.
- Be somewhat familiar with configuration systems.
- Have a moderate understanding of IT

To emphasize the importance of the participants, Hornbaek [12] mentions the key is to find participants who can bring certain expertise, insights, aspiration, expecations or competencies that is considered important to the study. It is about finding people with the characteristics necessary to adress the research question. It is further reinforced in [24] which mentions the key aspects to look for in participants, Mackenzie emphasizes how researches often assume their results apply to all people, even those who were not tested. It is however possible but requires an additional condition in which the participants are members of the same population whom the results are assumed to hold.

5.2.4.3 Data Collection

The study employed a quantitative approach, aiming to collect summative data from at least ten participants through a questionnaire featuring likert scale questions. I deemed a quantitative method sufficient due to its efficiency and ease of use under time constraints like these. Additionally, two non-mandatory open-ended questions were included to potentially capture qualitative insights, mitigating the risk of bias in the closed-ended questions. Employing a within-subjects design, participants were exposed to both conditions—current web interface and the new Figma prototype—in the same sequence. The sample size aimed for a minimum of 10 participants, predominantly comprising PiiGAB customers. Quantitative data on participants' ratings of the web interfaces were collected for analysis using paired samples T-tests. The study encompassed two conditions: the existing web interface and the proposed Figma prototype. The design study comprises experimental variables categorized into Independent Variables (IV), which represent circumstances manipulated to observe human responses during interaction; Dependent Variables (DV), referring to variables reliant on human actions and measured based on participants' behaviors; and Confounding Variables (CV), representing conditions that change with an IV, potentially influencing the observed relationship. The research question inherently expresses the relationship between these variables [24], as outlined in Table 5.1.

The experimental variables are further defined as the following:

- DV1: The participants will answer on a scale from 1-10 on the overall satisfaction with the design of the web interfaces.
- DV2: The participants will answer on a scale from 1-10 how easy it is to navigate the web interfaces.
- DV3: The participants will answer on a scale from 1-10 how intuitive the design is.
- DV4: The participants will answer on a scale from 1-10 how visually appealing the design is.

Independent Variables	Dependent Variables	Confounding Variables
2 web interfaces	Rating of overall satisfaction Rating of difficulty navigating Rating of how intuitive design Rating of visual appeal Rating of needs and expectations met Rating of consistency of design elements Rating of recommendation	Personal experience of current interface

Table 5.1: Experimental variables making up the design study

- DV5: The participants will answer on a scale from 1-10 how their needs and requirements are met.
- DV6: The participants will answer on a scale from 1-10 how satisfying the consistency of the design elements are.
- DV7: The participants will answer on a scale from 1-10 the likelihood of recommending the web interface to others.

5.2.4.4 Questionnaire

The questionnaire was conducted digitally using Google Forms for its accessibility and seamless integration with Google Spreadsheets for analysis. Given that most of the project documentation was already stored on Google Drive, utilizing Google Forms was a natural choice, ensuring consistency in storage and ease of access for all involved parties. The likert scale questions allowed participants to rate their experience on a scale from 1 to 10, with the endpoints representing extremes such as 'extremely satisfied' or 'extremely dissatisfied.' The questionnaire was divided into two seamless parts, with identical questions presented in different contexts: one for rating the old web interface and the other for rating the new web interface. This division aimed to maintain consistency and minimize bias by ensuring participants focused solely on the interface they were currently interacting with, rather than making direct comparisons between them.

Following the likert scale questions in both parts, an open-ended question was included to gather qualitative data not captured by the quantitative analysis. For instance, in the first part assessing the old interface, participants were encouraged to express any features they felt were missing or in need of improvement. Similarly, the second part provided an opportunity for participants to suggest features and changes, fostering a co-design approach for the second iteration of the interface.

The questionnaire commences with a straightforward demographic inquiry aimed at understanding participants' backgrounds or contexts relevant to the study. The question is as follows: *What stakeholder do you identify yourself as?* with predefined response options including PiiGAB associate, PiiGAB customer, and 'other', accompanied by an open-text field for additional input. The demographic question was purposefully kept short and simple to measure bias if it would be discovered in the participant pool.

In alignment with the dependent variables, the questionnaire comprised the following questions:

Part 1 (old web interface)

- How would you rate your overall satisfaction with the design of the current web interface? (1-10)
- How easy is it to navigate the current web interface? (1-10)
- How intuitive do you find the design? (1-10)
- How visually appealing do you find the design of the current web interface? (1-10)
- How well does the current web interface meet your needs and expectations? (1-10)
- How satisfied are you with the consistency of design elements (e.g., buttons, menus) across different pages of the current web interface? (1-10)
- How likely are you to recommend the current web interface to others? (1-10)
- Is there anything specific that you want to change?

Part 2 (new web interface)

- How would you rate your overall satisfaction with the design of the new web interface? (1-10)
- How easy is it to navigate the new web interface? (1-10)
- How intuitive do you find the design? (1-10)
- How visually appealing do you find the design of the new web interface? (1-10)
- How well does the new web interface meet your needs and expectations? (1-10)
- How satisfied are you with the consistency of design elements (e.g., buttons, menus) across different pages of the new web interface? (1-10)
- How likely are you to recommend the new web interface to others? (1-10)
- Do you have any additional comments or suggestions for improving the web interface?

5.2.4.5 Quantitative analysis

I chose to perform T-Tests for the analysis of this study because they are well-suited to the structure and variables of the research. As described in [23], when participants are tested on each level in experiments, the assignment is within-subjects, also known as repeated measures, as each test condition is repeated for each participant.

Furthermore, T-tests are a statistical method for comparing two groups, providing straightforward results by observing the difference between two treatments, assum-

ing the conditions of normality, equal variance, and independence are met [16]. This analysis method is widely used and highly effective, particularly in design studies comparing the means of two groups. In contrast, ANOVA is typically used when comparing three or more groups [26].

The data collected through Google Forms was transferred to a Google Sheets spreadsheet for analysis. Each question from the survey was subjected to its own T-test, comparing responses between the two experimental conditions. For instance, responses to Question 1 in Part 1 were compared to those in Part 2 using a T-test. Additionally, an overall score was calculated and entered into a T-test to assess the significance of the entire experiment. Furthermore, the results were transformed into bar graphs, which will be showcased in the subsequent chapter. These visual representations offer an initial glimpse into the potential positive changes observed. By utilizing the Google Sheets feature, I simply needed to specify the data range, number of distribution tails, and the type of T-test (paired samples). This straightforward approach facilitated efficient analysis with minimal manual input.

Given the hypotheses were focused on detecting a positive change, I opted for a one-tailed test. This decision was based on the expectation of non-even distribution and the likelihood of extreme values being skewed towards one end of the Likert scale.

The qualitative data obtained from open text questions was not included in the T-tests but was instead utilized for reflective purposes. Since only two participants provided responses to these questions, conducting a qualitative analysis was deemed unnecessary and not particularly time-efficient.

5.3 Second Design Iteration

The second iteration involved further refining the prototype after the previous evaluation process. The primary goal of this evaluation was to obtain approval from stakeholders, ensuring alignment with the project's objectives and direction. While having a high-fidelity prototype early in the process offered advantages, such as clearer visualization of design elements, it also posed risks of bias and resource wastage by committing to features prematurely.

Although changes were internally agreed upon and deemed beneficial for UX within the company, it was essential to solicit feedback from potential stakeholders to ensure the future development and success of the prototype. Figure 5.29 depicts a wizard, a helping feature automating processes, added on request from the company, to enhance user support before users resort to contacting the support team for assistance. The wizard is a universal modal located on the right side of the web interface, consistently available and easily accessible should users encounter difficulties while setting up the gateway. It is designed to incorporate GIFs to optimize the use of limited space, providing visual guidance without relying on text. Moreover, is one of many features implemented in the final prototype Mark VI.

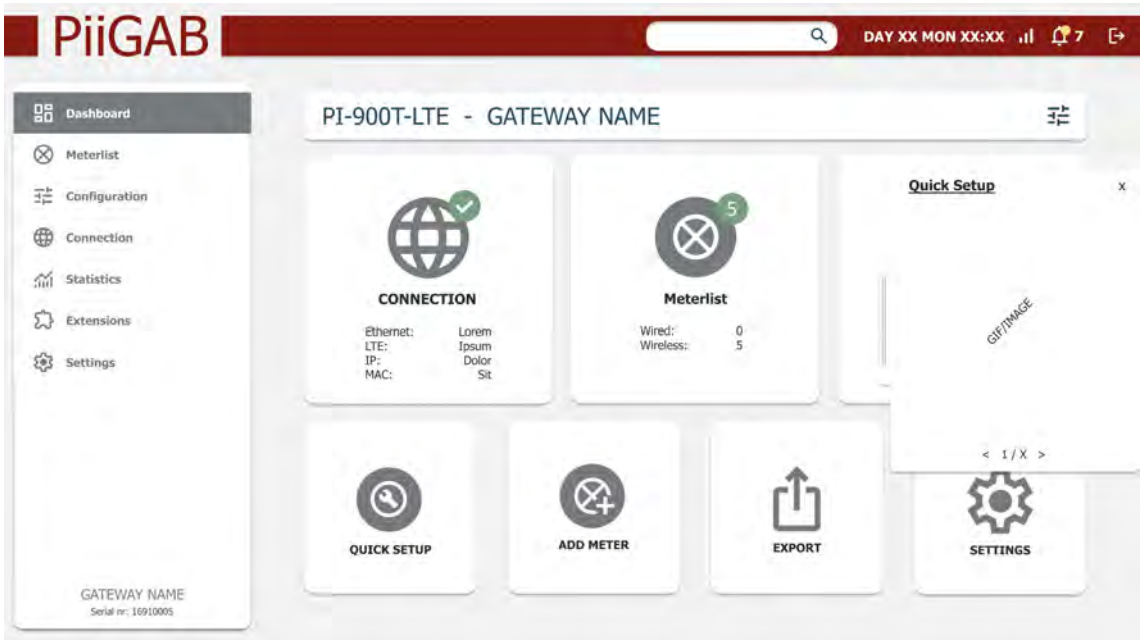


Figure 5.29: Wizard feature of quick setup in new web interface

The second iteration of development concentrated on enhancing the user flow for setting up the gateway. This primarily entailed the addition of meters to the meter list and configuring them to facilitate the acquisition of data from the meters. As a designer with a background in programming, I was cautious about introducing overly complex design elements that might pose implementation challenges, even though programming was now out of scope from my part.

The planned user flow and wireframe for what would become Mark VI is depicted in Figure 5.30, which was later designed. The whiteboard served as a reference, with minor adjustments made to ensure an intuitive and logical approach from the user's perspective. My aim was to categorize features into familiar groupings and minimize navigation between tabs. Achieving this required the implementation of a more complex system, which I hoped users would understand, learn, and navigate without experiencing severe confusion or disorientation.

In conclusion, I carefully structured the design process to develop the user interface for an existing application. Beginning with a thorough pre-study phase to identify stakeholder issues and user needs, I then transitioned to prototyping using tools like Figma. Each iteration was systematically labeled to track revisions, ensuring a user-centered approach guided by co-design methodologies. This iterative refinement aimed to create a seamless and engaging user experience, prioritizing usability and visual appeal.

Figure 5.30: Whiteboard user flow sketch of setup process

6
Results

This chapter presents the results from the evaluation, including a quantitative analysis and paired samples T-tests performed on a questionnaire, followed by the final prototype, Mark VI, developed in the second iteration after feedback. Furthermore, this chapter aims to address the previously established research question, which will be further discussed and evaluated in Chapter 7.

6.1 Evaluation Results

The evaluation conducted during the first iteration aimed to provide results indicating the viability of the design for further development. The following hypotheses were of importance to prove and drive the development forward:

- Participants will find the newer web interface more intuitive.
- Participants will find the usability of both web interfaces to remain the same.
- Participants will find their needs met when interacting with the new web interface.

The T-tests comparing overall scores between both parts yielded an extremely small p-value (close to 0), indicating a significant change and supporting the hypotheses (df = 13). The first part scored 440, while the second part scored 786, as calculated using Google Sheets' built-in T.test function. The design study collected data from a total of 14 participants with diverse backgrounds, including 5 customers, 1 associate, 1 distributor, and 7 design students. The results are depicted in Table 6.1.

The participants' votes and ratings for both web interfaces are depicted in Figures

Question	P-value
Q1: Rating of overall satisfaction	2.97e-5
Q2: Rating of difficulty navigating	1.53e-5
Q3: Rating of how intuitive design	1.78e-6
Q4: Rating of visual appeal	4.15e-5
Q5: Rating of needs and expectations met	1.13e-3
Q6: Rating of consistency of design elements	7.68e-5
Q7: Rating of recommendation	6.23e-6

Table 6.1: P-values from T-tests results on design study questionnaire

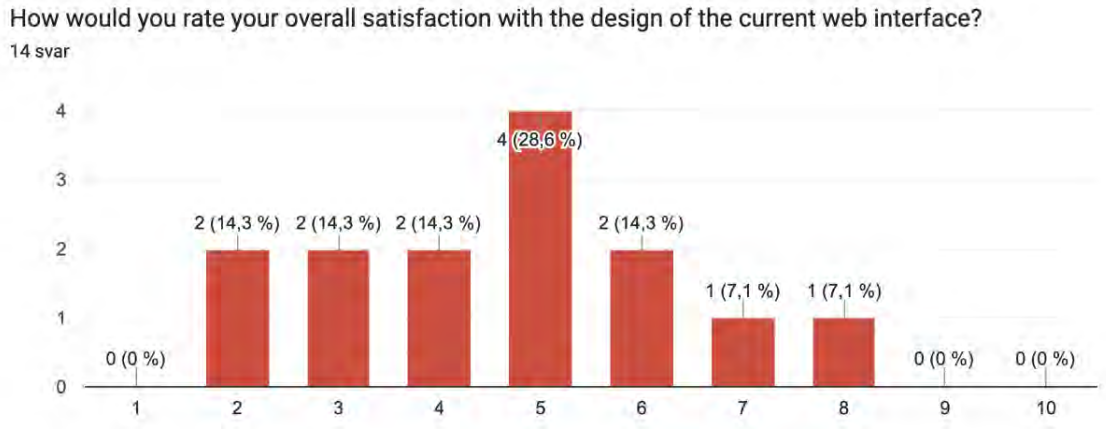


Figure 6.1: Participants rating of overall satisfaction with the current web interface. Mean value: 4.6 Median: 5

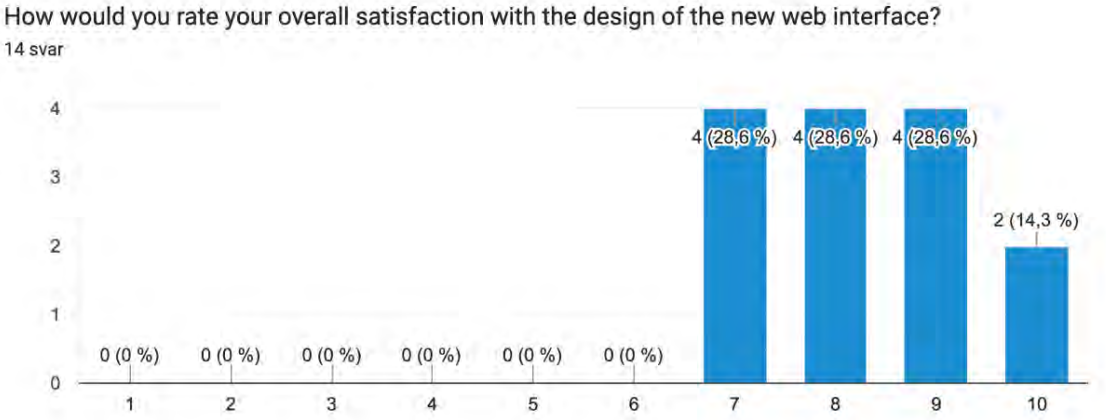


Figure 6.2: Participants rating of overall satisfaction with the new web interface. Mean value: 8.3 Median: 8

6.1, 6.2 and Figures 6.3, 6.4, visually illustrating a higher rating for the new web interface. This visual evidence strongly suggests an improvement in design and potentially a better UX. More detailed results are available in Appendix A.

6.2 Final Prototype

Prototype Mark VI represents the culmination of iterative design efforts, as depicted in Figure 6.5. This final iteration incorporates several enhancements aimed at improving user interaction and customization. Notable features include quick actions for streamlined navigation, personalized customization options on the dashboard, and the integration of a universal wizard to facilitate quick setup processes. Furthermore, the inclusion of a diverse color palette, aligned with the company's design identity, enhances visual appeal while maintaining optimal contrast for improved

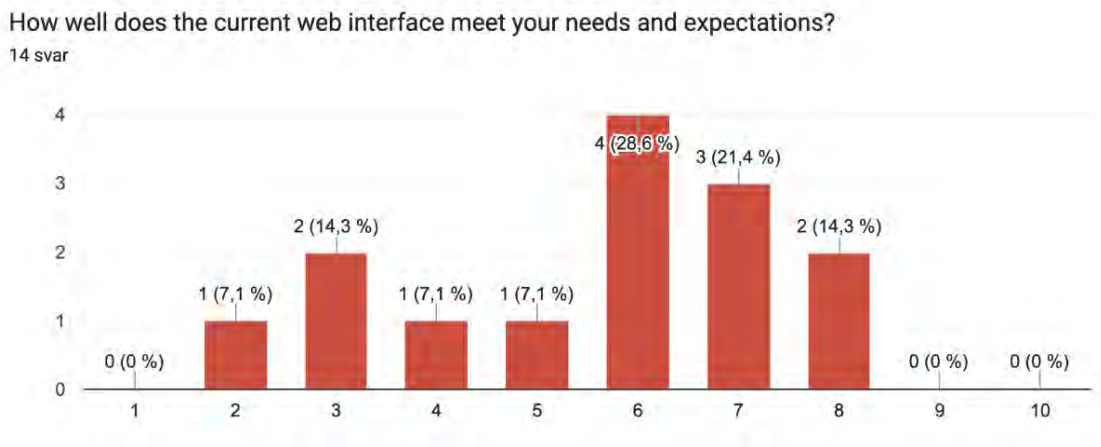


Figure 6.3: Participants rating of needs and expectations met with the current web interface. Mean value: 5.6 Median: 56

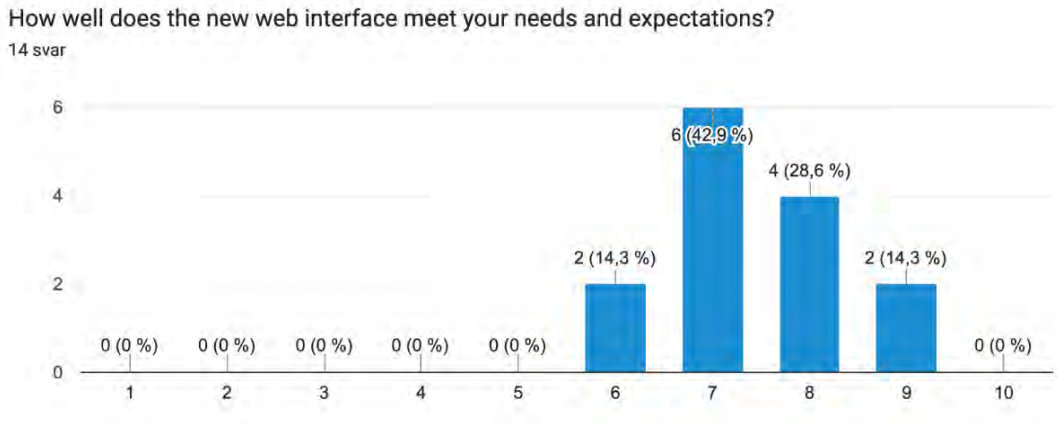


Figure 6.4: Participants rating of needs and expectations met with the new web interface. Mean value: 7.4 Median: 7

usability.

The second design iteration prioritized enhancing the user flow for product setup, resulting in a restructuring and organization of the process into three separate tabs. These tabs feature multiple functions, as depicted in Figures 6.6, 6.8, and 6.9. Additionally, a new intuitive modal for adding meters, designed with visual cues and non-disruptive behavior, is showcased in Figure 6.7.

6.3 Answering the Research Question

At this point, I will revisit the research question that I have proposed in my thesis:

What strategies can enhance the web interface design for a data collection device to accommodate users with varying levels of expertise and improve user experience?

These results demonstrate that the strategies employed, such as incorporating a user-uentered design process, iterative prototyping, and stakeholder feedback, successfully enhanced the web interface design for PiiGAB's data collection device. These strategies effectively accommodated users with varying levels of expertise and significantly improved the overall user experience.

In conclusion, the evaluation data and analysis of the new prototype demonstrate a significant improvement in web interface design for data collection devices. Users reported higher satisfaction levels, improved usability, and better accessibility compared to previous iterations. The findings align closely with the research question, confirming that strategic design enhancements effectively enhance user experience and accommodate users with varying levels of expertise. The prototype successfully addresses specific user needs, such as simplifying tasks and providing clear guidance for both novice and experienced users. Overall, the redesigned web interface represents a successful outcome in achieving its objectives and contributes valuable insights to the advancement of user-centered design practices in this domain.

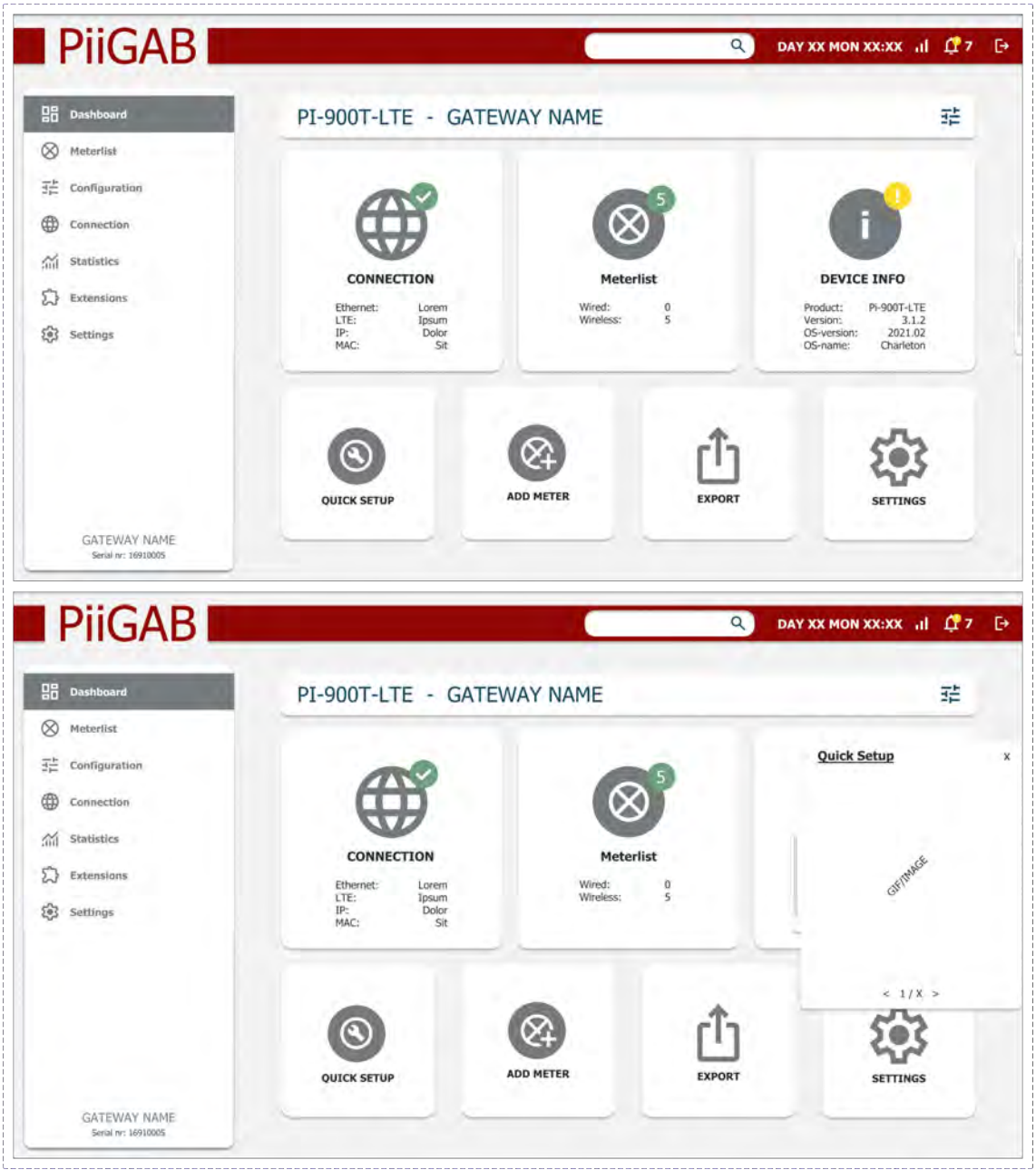


Figure 6.5: Prototype Mark VI dashboard with wizard feature

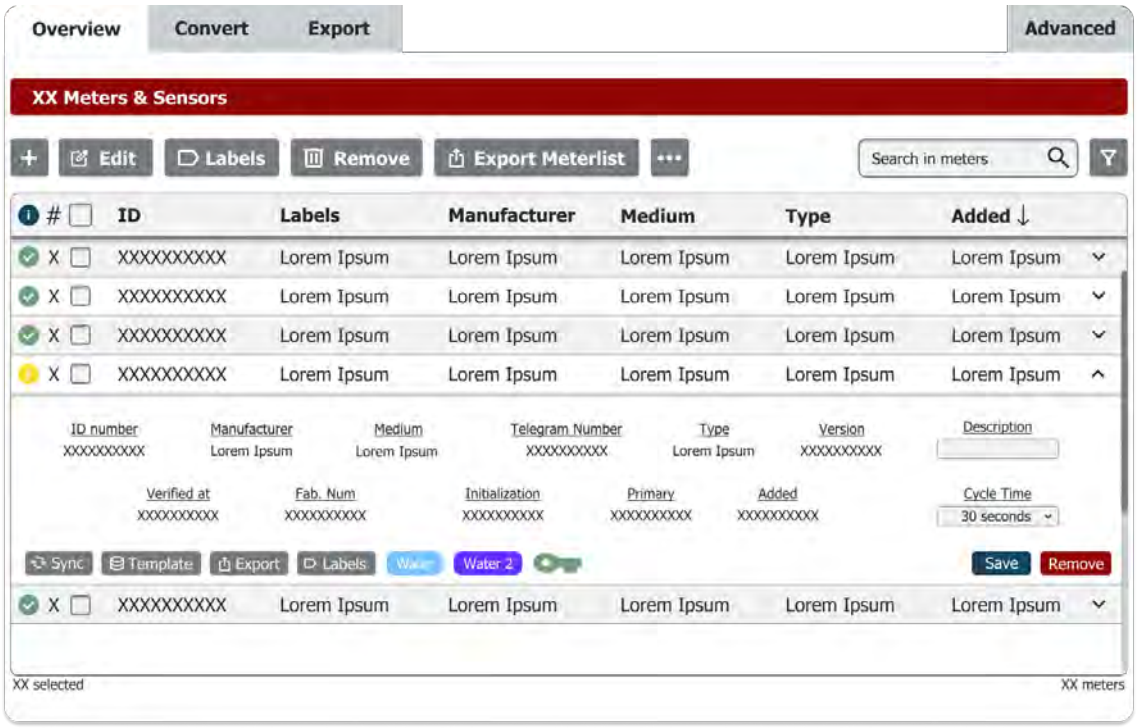


Figure 6.6: Prototype Mark VI meterlist page

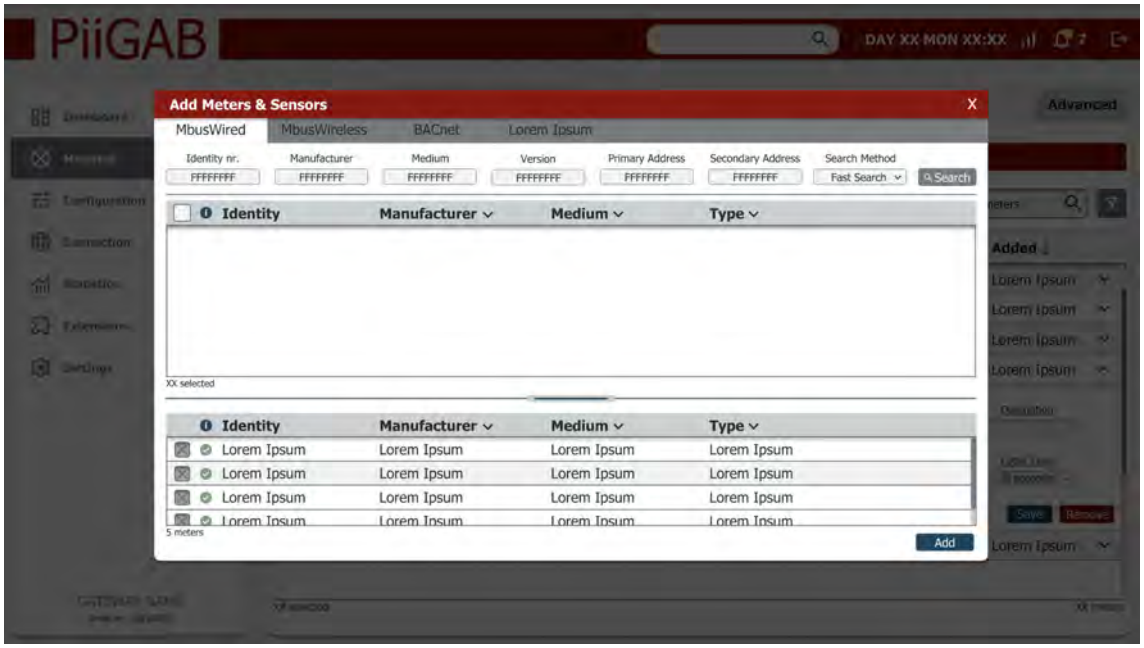


Figure 6.7: Prototype Mark VI meterlist page with add meter modal

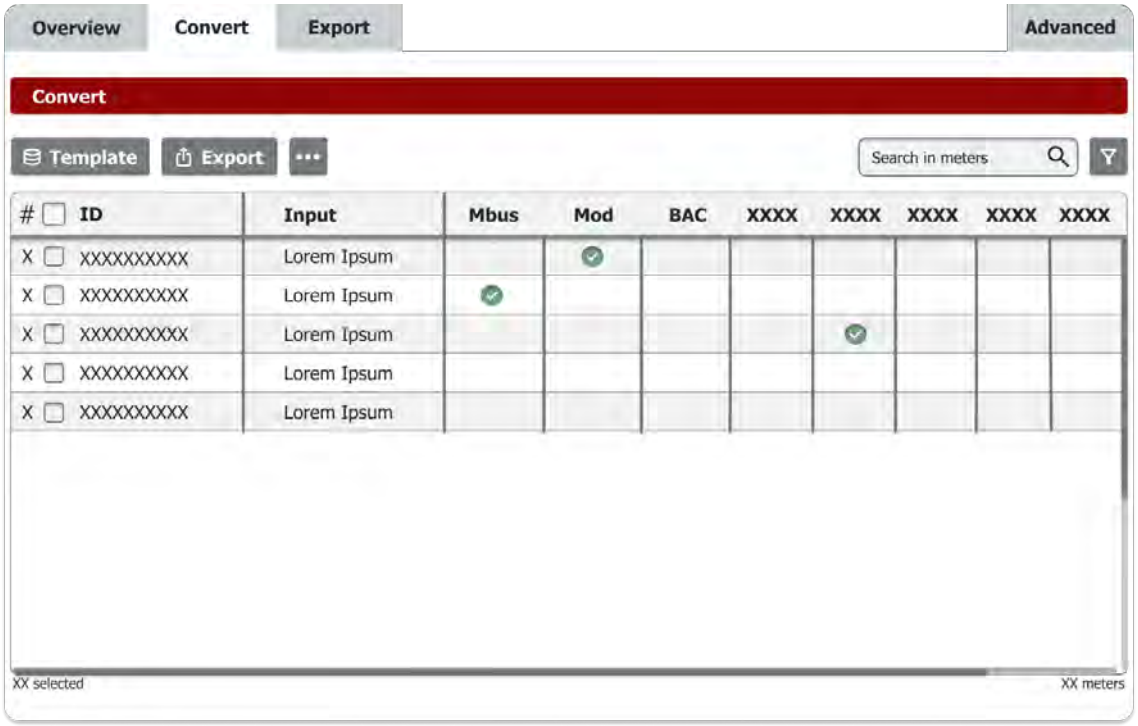


Figure 6.8: Prototype Mark VI meterlist page in convert tab

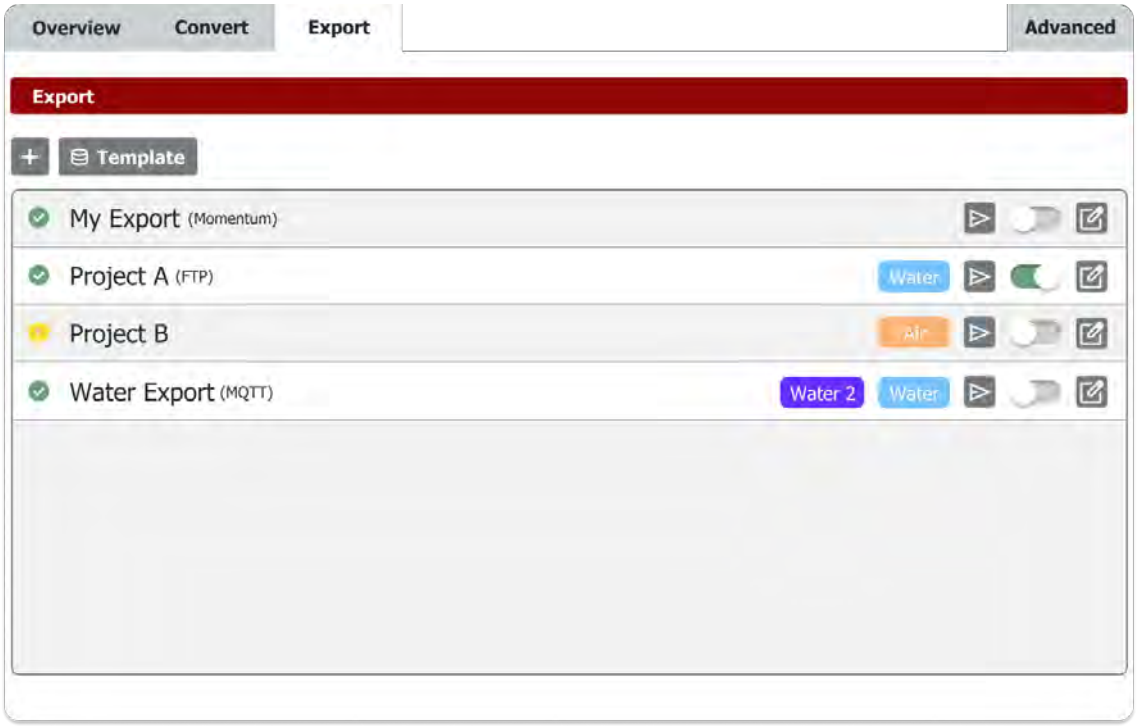


Figure 6.9: Prototype Mark VI meterlist page in export tab

7

Discussion

This chapter will delve into the results presented in the previous chapter, providing further analysis and interpretation of additional data not previously highlighted. Additionally, it will examine the methodology and techniques employed throughout the design process, assessing their validity and suitability in achieving the research objectives. The discussion will focus on dissecting the explorations undertaken to uncover valuable insights relevant to the thesis or research. Moreover, it will include reflections on potential avenues for future research, outlining how to build upon the findings of this study and emphasizing the importance of certain aspects for its success.

7.1 Reflecting on the Design Process

The adoption of the double diamond design process provided a structured framework for navigating the complexities of the design journey. It allowed for a systematic approach while still accommodating flexibility and creativity at each stage.

During the discovery phase, the emphasis was on gaining a deep understanding of the problem space, user needs, and project requirements. This involved extensive research, user observations, and stakeholder consultations. The insights gathered during this phase laid the foundation for subsequent design decisions and shaped the direction of the project. Moving into the definition phase, the focus shifted towards synthesizing the research findings into actionable design principles and project goals. This phase involved refining the project scope, establishing design objectives, and outlining success criteria. Collaborative workshops and brainstorming sessions were instrumental in clarifying project goals and aligning stakeholders' expectations. With a clear understanding of the problem space and project goals, the design process entered the development phase. Here, ideas were generated, prototyped, and iterated upon to explore various design solutions. Rapid prototyping techniques, such as sketching, wireframing, and mockups, enabled quick validation of design concepts and facilitated feedback loops with stakeholders and end-users. Moreover, the adoption of constructive design research principles facilitated an explorative approach to the design process. By viewing the design as a medium for generating knowledge, the focus extended beyond mere problem-solving to include a deeper exploration of design possibilities and their implications. This approach encouraged experimentation, iteration, and reflection, leading to more innovative and insightful design solutions. Finally, the delivery phase focused on refining and finalizing the

design solution for implementation. This involved polishing the prototype, conducting usability testing, and gathering feedback for further refinement. By involving stakeholders throughout the design process, I ensured that the final deliverable met their needs and expectations.

Overall, the double diamond design process, coupled with constructive design research principles, provided a robust framework for navigating the complexities of the design journey. It facilitated collaboration, creativity, and iterative refinement, ultimately leading to the development of a design solution that addressed the identified challenges and met the project objectives.

Reflecting on the design process, I found that the iterative nature of the double diamond approach, combined with the explorative mindset of constructive design research, allowed for continuous learning and improvement throughout the project. Each phase built upon the insights gained from the previous one, resulting in a more informed and refined design solution. Moving forward, I would continue to leverage the principles of both approaches in future projects, recognizing their value in guiding effective and impactful design outcomes.

7.2 Evaluation Results

The analysis of the evaluation results confirmed that the prototype's design is on the right track. Additionally, data not previously discussed in the chapter offered further insight into participants' perceptions of improvements. Despite the T-test results indicating significant changes, the outcomes can also be viewed as enhancements to the UX. UX is inherently subjective, varying among stakeholders and influenced by numerous factors that cannot be replicated in entirety. However, individual aspects contributing to UX, such as usability, performance, feedback, functionality, and visual design, can be examined separately. In the web interface design, I prioritized aesthetics to evoke specific user feelings, acknowledging that the prototype was not a fully functional interface. While functionality was present and users found the product usable, my focus was on addressing gaps in feedback, visual cues, and layout simplicity through design principles and guidelines. These principles provide a structured approach to design but can also be challenged through explorative or creative design approaches tailored to the context. I personally advocate for designers to challenge these principles because it's easy to become complacent designing within established guidelines rather than exploring innovative and unconventional approaches.

However, with questions addressing intuitive design, navigation, visual appeal, and satisfaction, identifying the factors contributing to the improved UX became more apparent. All questions yielded data indicating a positive change, demonstrating that the new web interface statistically outperformed the old one in each corresponding aspect of UX. The ratings for overall satisfaction provided an initial insight into participants' perceived UX, which was further elaborated upon by more

specific feedback regarding their interactions.

Additionally, ratings for meeting needs and expectations were positive for the new web interface, while they remained somewhat neutral for the old interface, as expected, given that the functionality did not change significantly. However, the visual representation of these functionalities was slightly redesigned to better align with expectations, although I assumed that the fundamental needs remained unchanged.

7.3 The Final Design

By comparing the old interface with the new, the results indicate a significant improvement in favor of the new interface. Using the UCD approach, I argue that the web interface has been optimized in several aspects. The key design elements that signify the intuitive and user-friendly enhancements are as follows:

- **Quick Actions for Streamlined Navigation:** The new design introduces quick actions on the dashboard, allowing users to access commonly used features with ease. This improves navigation efficiency and provides quick access to essential functions, enhancing the overall UX.
- **Personalized Customization Options:** The new dashboard features personalized customization options, allowing users to tailor the interface to their preferences. This enhances user engagement and satisfaction by providing a more personalized experience.
- **Universal Wizard for Quick Setup Processes:** A universal wizard guides users through the setup process, making it more intuitive and user-friendly. This streamlines the onboarding process for new users and minimizes the learning curve, resulting in improved usability and satisfaction.
- **Enhanced Visual Appeal:** The new design improves the visual appeal by refining color schemes, typography, and layout consistency. This creates a more visually engaging and cohesive UX, contributing to overall user satisfaction.
- **Improved Usability Features:** The new interface incorporates usability features such as a search bar for enhanced navigation and a notification icon for highlighting changes and prompting actions. These enhancements make the interface more user-friendly and intuitive.

In addition to the previously mentioned design elements, a significant improvement in the new web interface was the implementation of a new categorization system that enhanced the organization and accessibility of features for users. The introduction of three separate tabs for product setup streamlined the user flow and made it easier for users to navigate through different functions and settings. This new categorization system improved the overall organization of the interface, providing users with a clear and structured layout for accessing and managing various features.

By categorizing the product setup process into distinct tabs, users could easily locate and access the specific functions they needed, leading to a more efficient and intu-

itive UX. This system not only simplified navigation but also improved the overall usability of the interface by reducing cognitive load and enhancing user understanding of the system's functionalities.

Based on user evaluations, the new design demonstrated a significant improvement over the old interface. Participants reported higher satisfaction levels, improved usability, and better accessibility, indicating that the design enhancements successfully addressed user needs and preferences. The positive feedback and ratings validate the effectiveness of the design-driven approach in optimizing UX and highlight the importance of prioritizing UCD principles in interface design decisions.

In conclusion, by incorporating these key design elements and focusing on UCD principles, the new web interface not only met but exceeded user expectations, leading to a more satisfying and engaging UX. The iterative design process, stakeholder feedback incorporation, and UCD strategies collectively contributed to the success of the new design in enhancing UX and usability.

7.4 Sustainable Design

PiiGAB's products not only empower users to monitor their water and electricity usage but also exemplify sustainable design principles through the redesigned web interface. In today's society, where sustainability is paramount, the interface serves as a trigger for raising awareness of user behavior in relation to resource consumption. By incorporating sustainable design elements such as a clean and modern aesthetic, intuitive navigation, and visualizations of usage statistics, the interface encourages users to adopt energy-saving practices and environmentally friendly habits [3].

Moreover, the interface promotes reflection and accountability by providing users with insights into the financial implications of their consumption habits. This holistic approach to sustainability goes beyond mere monitoring and extends to educating users about the environmental impact of their actions. By fostering a sense of ownership over resource usage and offering practical tools for reducing consumption, the interface embodies the principles of sustainable living.

In essence, PiiGAB's redesigned web interface not only facilitates the monitoring of resource usage but also instills a deeper understanding of sustainability principles. By integrating sustainable design practices into the interface, PiiGAB not only provides a valuable service to its users but also contributes to a more environmentally conscious society.

7.5 Designing for Inclusion

In terms of ethical considerations and designing for inclusion, I identified several flaws in the design that required attention. Since the company operates internation-

ally, the interface defaults to English, which cannot be changed. While this decision may be practical, it removes the opportunity for individual customization, potentially impacting the personal aspect of the UX. Stakeholders may find comfort in using their preferred language, especially as PiiGAB acquires more foreign customers. For example, languages such as Spanish, German, and French are predominant in certain regions, making English less preferable. In extreme cases, stakeholders may not even use the same alphabet, necessitating immediate attention. Designing for this inclusion would promote cultural diversity and enable the company to expand beyond its current boundaries.

To address this issue, I proposed a new settings feature that allows users to set their preferred language. However, implementing this change may impact the product's performance, as switching languages requires additional memory and financial resources. Nonetheless, I began brainstorming implementation methods to seamlessly integrate this feature if possible.

Additionally, I observed that the interface has a high luminance and is predominantly white, which could be straining for users, particularly those with visual impairments. To mitigate this, I introduced a dark mode feature to reduce brightness and improve accessibility for a wider range of users. Considering color vision deficiency, I recognized the company's color profile, with red as the primary color. Although the low saturation may mitigate the impact on a majority of users, further user testing is needed to confirm this assumption. To address color deficiency, I intentionally designed most buttons with a neutral color, such as blue, from the color profile, enhancing contrast and usability. Moreover, the black text color was replaced with a lighter shade to enhance readability. True black is often considered too dark and can be challenging to read, especially on various devices.

Furthermore, in my effort to improve intuitiveness, we added icons next to features to simplify understanding. For example, the settings page now includes a cogwheel icon next to the text 'Settings.' While icons alone may suffice to indicate functionality in extreme cases, combining them with text ensures consistency and aids users with dyslexia or reading disabilities.

7.6 Limiting the Scope

In contrast to the prototype presented in the previous chapter, the initial scope for the prototype was ambitious but heavily constrained by time limitations and uncertainty surrounding the new structure. Given the company's prioritization of design intuitiveness and the need for a solid foundation for any changes, the project appeared daunting, with numerous aspects requiring attention. Recognizing the challenges, we deemed it too extensive for the available resources. While the design aspect was unaffected, I proceeded cautiously, designing features I deemed feasible for implementation, assuming I would handle the development. Even as the scope evolved, I remained mindful of the potential complexities for fellow developers at

the company.

The delivered prototype, a Figma high-fidelity model, represents a culmination of extensive effort and iteration. Initially intended to balance design across different pages (Dashboard, Meterlist, Connection, etc.), a shift in focus during the second design iteration prioritized the setup process, allocating more resources to the relevant pages.

Conducted in parallel with the company's ongoing projects, the implementation of the prototype (programming) was deemed best to postpone. The workshops highlighted the need for a robust foundation, lacking in the existing framework. My responsibilities extended to selecting a suitable programming framework tailored to the product's requirements, such as limited memory, high performance, and ease of maintenance. However, I concluded, in collaboration with the company, that establishing a comprehensive database of underlying code would be a prerequisite, potentially consuming weeks of resources before this project could progress.

7.7 Future Work

As the thesis approaches its conclusion, I am keenly aware that the research area remains largely unexplored, with much more left to discover. While my contribution to the field represents a foundational step, it only scratches the surface of this vast domain. In this section, I will reflect on my insights and offer recommendations, shedding light on the challenges I encountered and the potential avenues for fruitful exploration. Additionally, I will discuss methodologies that, while not utilized in this study, may offer valuable insights and contribute to more significant research outcomes. Moreover, I hope to convey my vision for the ongoing evolution of the design, as I believe there is still much untapped potential beyond what I have achieved.

7.7.1 Timeplan

As the thesis progressed, I actively documented achievements and tracked the timeline to ensure the relevance of time constraints for future planning. However, as time passed, the Gantt Chart had to be revised severely due to overly optimistic assumptions about the time needed for certain tasks and unexpected illness. Although the progression did not precisely align with the plan depicted in the Gantt Chart in Figure 7.1, I believe it still provided a solid guideline. The need for revision is evident, as the status of each week was not clearly defined. A newer, more relevant Gantt Chart is depicted in Figure 7.2, with all weeks having a defined status.

For future work, I believe the Gantt Chart can offer valuable insights into structuring such projects and estimating task durations under similar conditions. Initially, I aimed to conduct evaluations earlier; however, as I was new to this context and work field, it required more knowledge to become familiar and productive. Nevertheless,

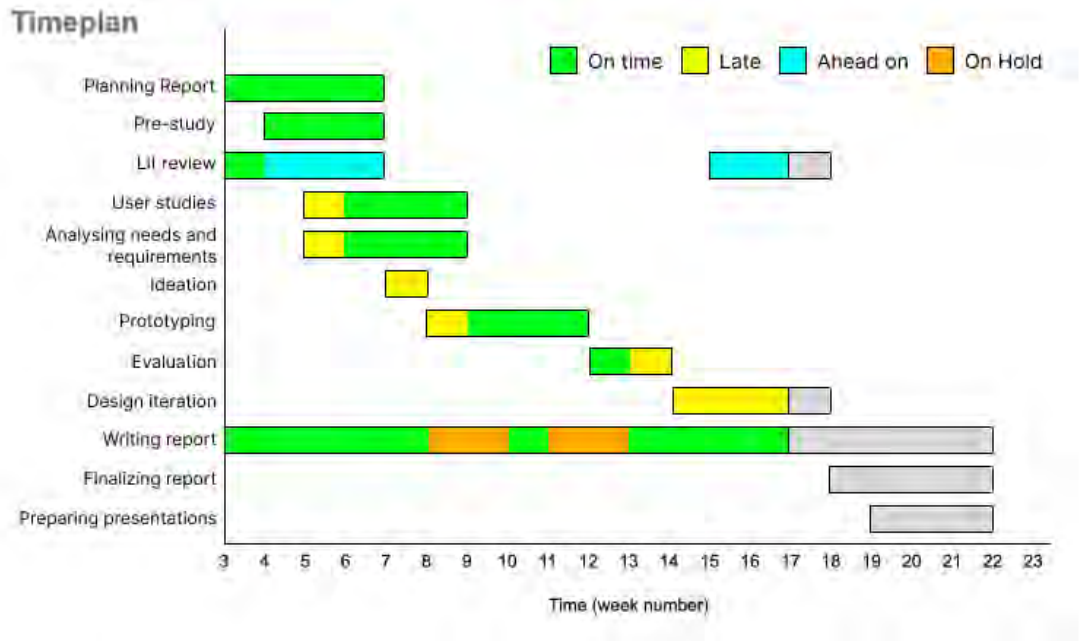


Figure 7.1: Updated Gantt Chart with Status Progression

I believe the old Gantt Chart would be viable for the continuation of this thesis, along with the new Gantt Chart as the starting point. Despite the challenges faced, the Gantt charts can be deemed a partial success, considering the insights acquired and shared as references.

7.7.2 Qualitative Analysis

The evaluation conducted in this thesis involved a quantitative analysis of experimental results to assess the viability of continuing with the design. While the evaluation tested various aspects of UX to identify potential improvements compared to the old web interface, it's important to note that the participants' ratings of the new interface, though positive, may not suffice to draw definitive conclusions for all stakeholders. In future iterations, I would advocate for conducting multiple evaluations. For example, incorporating a design study experiment during the second iteration could offer stronger evidence of improvement and help pinpoint root causes.

The evaluation included both observations and a questionnaire to gather data on participants' perceived ratings of different aspects contributing to UX. While this approach efficiently provided a signal to proceed with designing the prototype, I believe a qualitative analysis would offer deeper insights. However, such an analysis would require additional time and resources.

Drawing from personal experience and insights from the research field, I suggest that a comprehensive evaluation could benefit from a larger participant pool with diverse backgrounds and stakeholders. This would help reduce bias and enable detailed demographic analysis for deeper insights. Additionally, incorporating methodologies

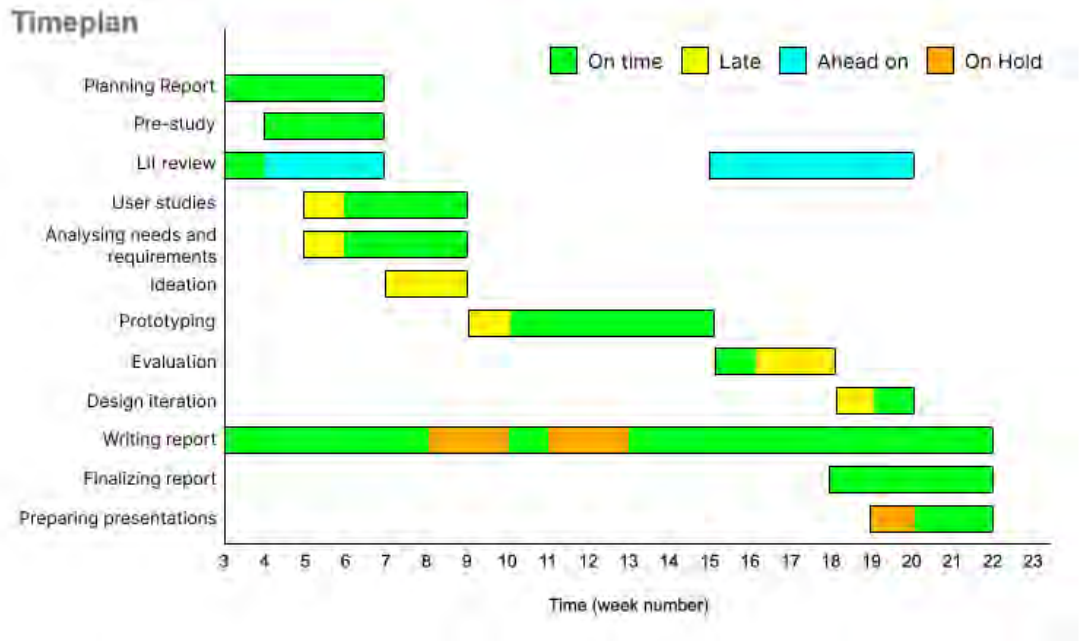


Figure 7.2: Revised Gantt Chart with Updated Progression

such as eye tracking, as demonstrated in studies like [22], could provide valuable insights into participants' learning activities and emotional responses. Furthermore, collecting data on participants' interactions with the mouse or keyboard could offer insights into their adaptational behavior and emotions in response to system feedback. Likewise, linguistic features when the participants verbally reflect on their doings. I firmly believe that integrating cognitive data into the analysis will provide deeper insights and enable to draw more conclusive findings about intuitive design, a priority that the company strongly values. By examining cognitive processes such as attention, memory, and decision-making, we can better understand how users interact with the interface and identify areas for improvement. This approach not only aligns with the company's preferences but also enhances the ability to create user-centric designs that optimize usability and UX.

7.7.3 Programming

As mentioned earlier, the implementation of the prototype through programming was initially intended as the final step. However, due to time constraints and the absence of a foundational basis, this phase was deferred and labeled as future work. Instead, my focus shifted towards creating a high-fidelity prototype solely through design, delivered as an interactive prototype in Figma. This Figma prototype aimed to simulate the interactions of a programmed web interface, providing an optimistic vision of the final product's look and feel.

As I approached the programming stage, I encountered challenges in selecting a suitable framework. While many options were available, they primarily utilized

JavaScript with varying development libraries, each impacting the resources required for development. Given my expertise in JavaScript and my preference for building from basic to advanced functions, I felt equipped to navigate these challenges. Additionally, considerations were made regarding the company's developers' preferences, weighing the benefits of continuing with existing code for easier maintenance against adopting a comprehensive design package with minimal code changes.

Reflecting on the current state of the final prototype, I believe that its implementation should be treated as a separate project. This approach would delineate the theoretical design foundation from the strategic development, facilitating clearer communication and managing the project's scope effectively. As I find it too challenging and burdensome a responsibility to maintain a balance between both aspects, given the significant cognitive load and various factors involved. Moreover, the interface has potential to branch out into smaller subsets of implementation like responsive interface for mobile devices and accessibility adaptation. Therefore, the continuation will not require additional user studies, as this thesis provides the prerequisite theoretical foundation.

8

Conclusion

This study has delved into the realm of User-Centered Design (UCD) principles and their profound impact on the overall user experience in web applications, particularly focusing on configuration systems – a domain that has been relatively underexplored in the context of UCD and established Human-Computer Interaction (HCI) principles.

Through a meticulous examination of existing literature, design studies, and practical implementations, this thesis has aimed to fill a significant gap in current knowledge by deepening our understanding of how user expertise influences the user experience in configuration systems. By combining my background as an interaction designer with expertise in data engineering, I have strived to bridge the gap between designers and programmers, fostering a harmonious integration of their needs and preferences to deliver high-quality products that cater to both stakeholders and end-users.

While the research has focused on the design process of the user interface for an existing application, addressing minor technical aspects related to frontend programming, it has also outlined the limitations and scope of the study. The development of a Minimum Viable Product (MVP) prototype has provided a foundational basis for further iterations and improvements, emphasizing the importance of interaction design methodologies in enhancing user experiences.

The evaluation results have confirmed the positive trajectory of the prototype design, with participants expressing improvements in usability, performance, feedback, functionality, and visual design. By prioritizing aesthetics and user feelings in the web interface design, while also addressing gaps in feedback and layout simplicity, the study has underscored the significance of challenging established design principles to foster innovation and creativity in interface design.

Looking ahead, as the thesis nears its conclusion, I acknowledge that there is still much more to explore in this research area. The future work section outlines potential avenues for further research, methodologies that could offer valuable insights, and the ongoing evolution of design practices. By sharing my insights, recommendations, and reflections, I hope to inspire continued exploration and innovation in the field of Interaction Design & Technologies, paving the way for transformative advancements in user interface design and user experience optimization.

In essence, this thesis represents not just a culmination of research findings but a springboard for future endeavors, signaling the endless possibilities for enhancing user experiences through design-driven approaches in web application interfaces.

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A

Appendix: Questionnaire results

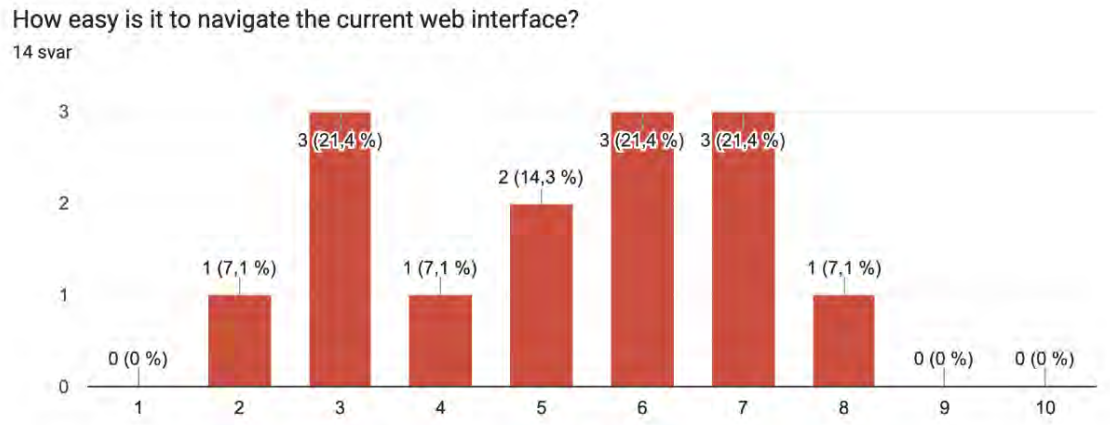

Figure A.1: Participants rating of difficulty navigating the current web interface. Mean value: 4.6 Median: 5

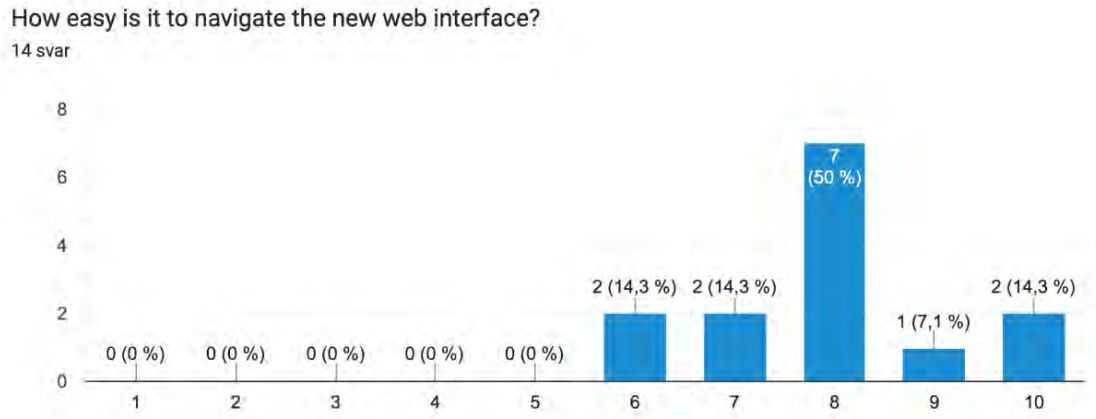

Figure A.2: Participants rating of difficulty navigating the new web interface. Mean value: 7.9 Median: 8

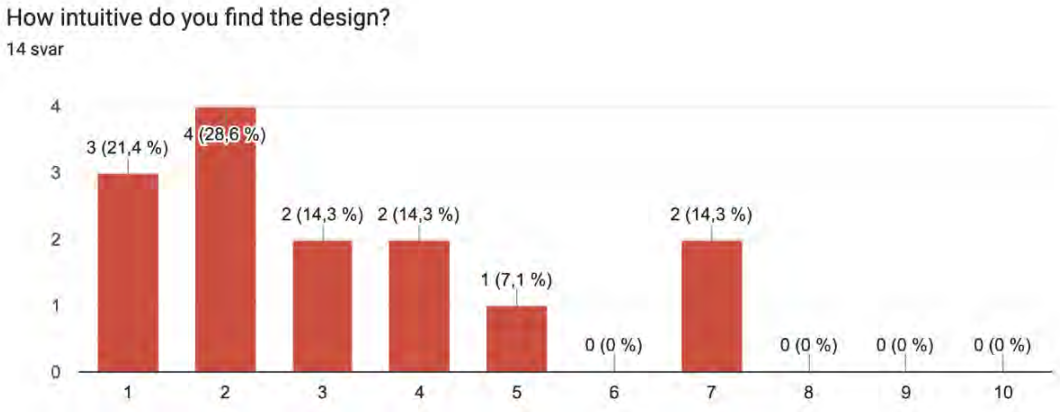

Figure A.3: Participants rating of how intuitive design with the current web interface. Mean value: 3.1 Median: 2.5

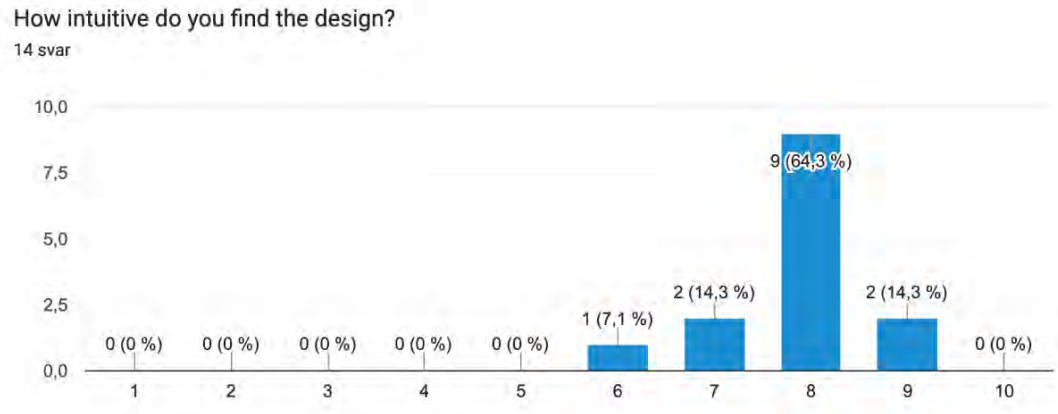

Figure A.4: Participants rating of how intuitive design with the new web interface. Mean value: 7.9 Median: 8

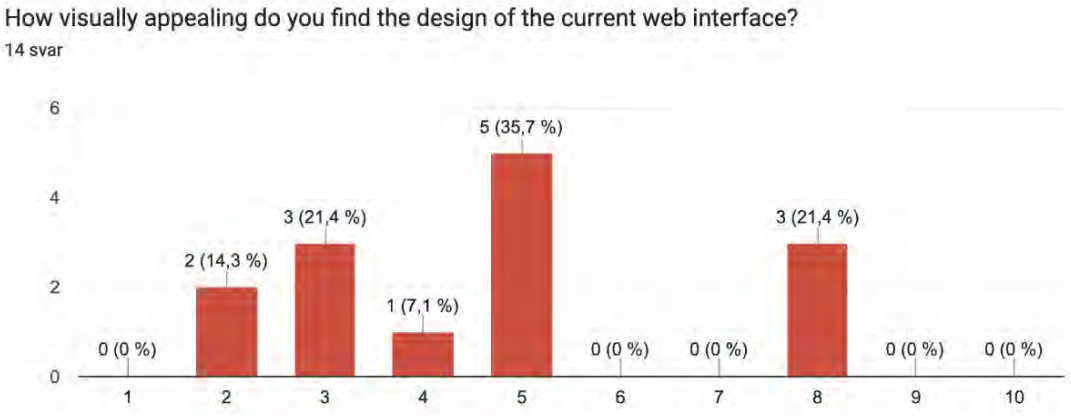

Figure A.5: Participants rating of visual appeal with the current web interface. Mean value: 4.7 Median: 5

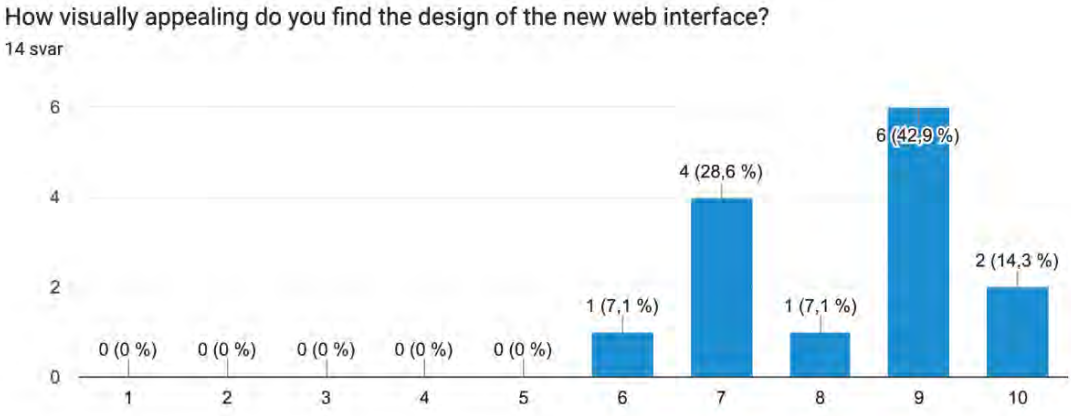

Figure A.6: Participants rating of visual appeal with the new web interface. Mean value: 8.3 Median: 9

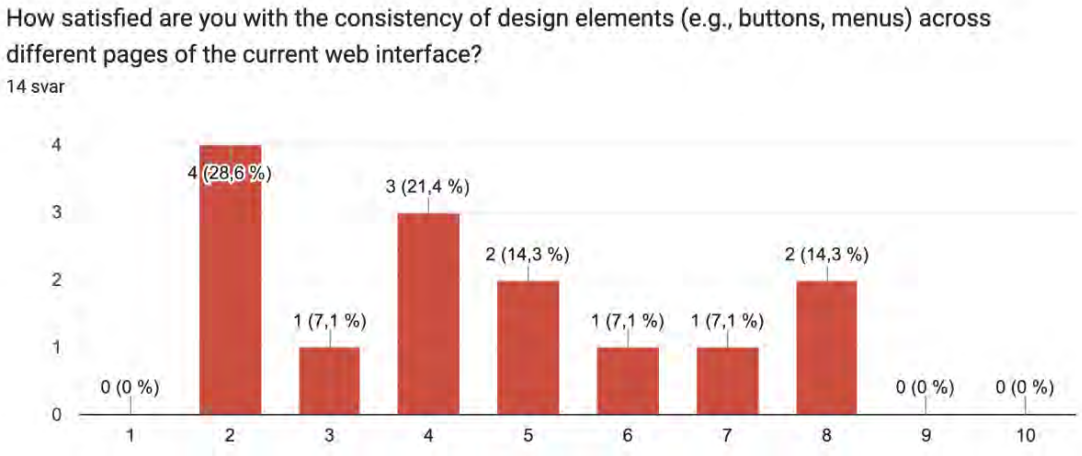

Figure A.7: Participants rating of consistency of design elements with the current web interface. Mean value: 4.4 Median: 4

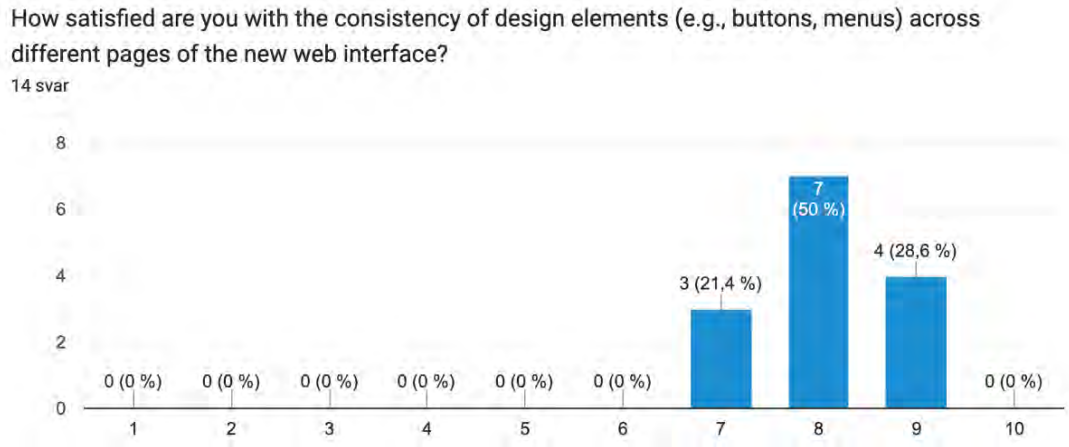

Figure A.8: Participants rating of consistency of design elements with the new web interface. Mean value: 7.4 Median: 7

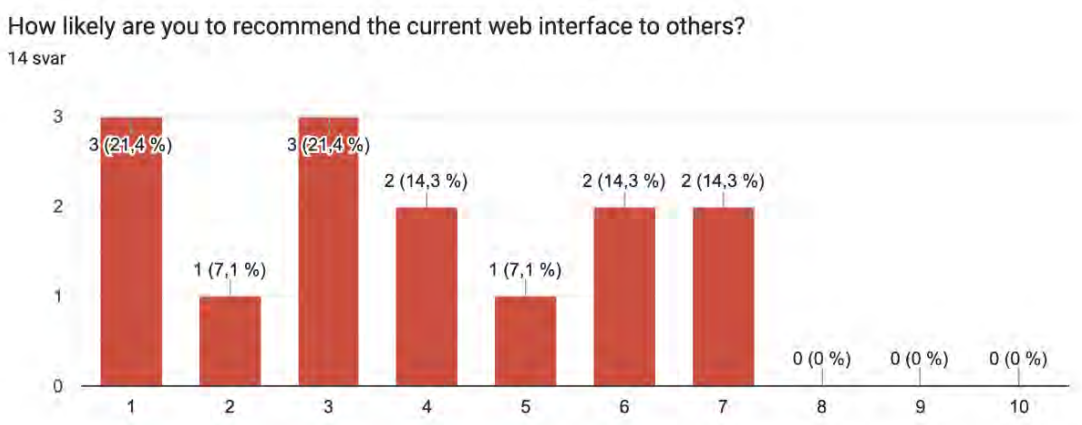

Figure A.9: Participants rating of recommendation with the current web interface. Mean value: 3.8 Median: 3.5

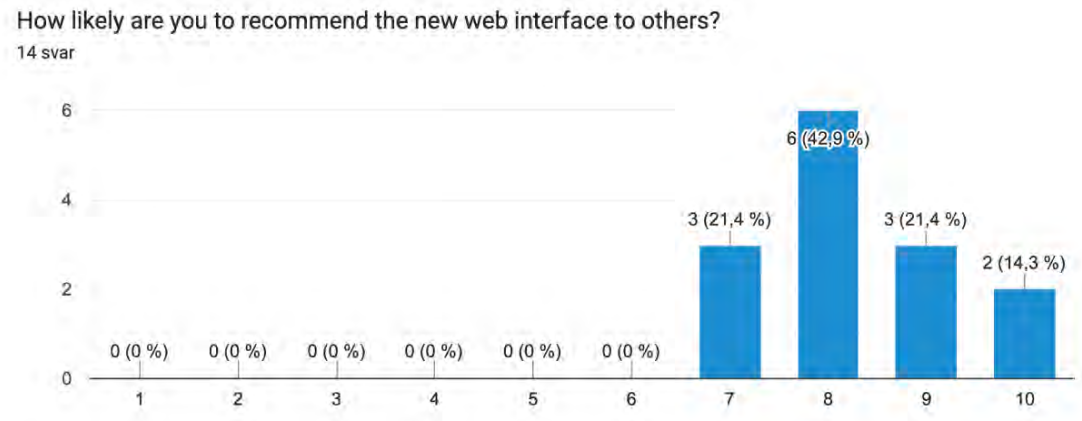

Figure A.10: Participants rating of recommendation with the new web interface. Mean value: 8.1 Median: 8

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