

Incorporating Human Values in Technological Innovation: A Value Sensitive Design Approach for Smartwatches

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Abstract

This study uses Value-Sensitive Design (VSD) to explore user values related to smartwatches. As the popularity of smartwatches increases, and to build responsible and ethical solutions, it is critical to reflect on what values are most important to people and how those values can be reflected in the design of the technology. Overall, the study includes three interrelated parts: a conceptual, an empirical, and a technical investigation. The three-part approach followed is the typical VSD approach. The conceptual investigation consists of identifying key values for users, the empirical investigation consists of interviews and analysis based on the identified values, and the technical investigation consists of creating prototypes and testing those prototypes in collaboration with users.

The findings of this study provide insight for research and practice. First, we identified in the literature values that are commonly listed as important (security, privacy, transparency, sustainability, performance and reliability, control, trust, and human welfare) and investigated their significance for smartwatch users identifying the ones that are perceived as most important for them. Secondly, we integrated the values identified within prototypes and assessed these designs with users. We refined the prototype designs using user feedback ending up with a proof of concept that can be adopted by the industry. Overall, the study shows a lack of knowledge about risks amongst users and how adding layers of transparency within technology can help users make more informed choices about their privacy and security.

Overall, the thesis takes a human-centered approach to explore the ethical issues and user experience concerns that emerge with smartwatch technologies. By focusing on the needs, perspectives, and priorities of smartwatch users themselves, this research provides design recommendations that are sensitive to values and consider user preferences. The findings from this study contribute to a growing area of research on smartwatches and wearable technologies. They offer researchers and industry practitioners key insights into the complex challenges posed by these increasingly ubiquitous devices. The recommendations provided can help guide future work that takes a human-centered view toward building smartwatch devices and related smartwatch management applications designed for both usefulness and human well-being.

Keywords: Value-Sensitive Design, Smartwatch, Prototype, Security, Privacy, Transparency, Sustainability, Reliability, Control, Trust, Human Welfare

Table of Contents

1	INTRODUCTION	8
	1.1 Motivation.....	8
	1.2 Research questions.....	9
	1.3 Thesis structure	9
2	VALUE SENSITIVE DESIGN	10
3	RESEARCH APPROACH	12
	3.1 Overview.....	12
	3.2 Conceptual investigation	13
	3.3 Empirical Investigation.....	14
	3.3.1 Study participants	14
	3.3.2 Interviews	16
	3.3.3 Data analysis.....	16
	3.4 Technical Investigation.....	16
	3.4.1 Prototyping a value-sensitive smartwatch.....	16
	3.4.2 Method for usability evaluation and improvement	18
4	RESULTS	19
	4.1 Identified User Values	19
	4.1.1 Smartwatch usage and deciding factors	20
	4.1.2 Security.....	20
	4.1.3 Privacy.....	21
	4.1.4 Transparency	22
	4.1.5 Sustainability	23
	4.1.6 Performance and reliability	24
	4.1.7 Control.....	24
	4.1.8 Trust.....	25
	4.1.9 Human Welfare	26
	4.1.10 Forming design requirements.....	27
	4.2 Design choices - Prototyping.....	30
	4.2.1 Security.....	31
	4.2.2 Privacy.....	33
	4.2.3 Transparency	35
	4.2.4 Sustainability	37
	4.2.5 Performance and reliability	38
	4.2.6 Control.....	38
	4.2.7 Trust.....	40
	4.2.8 Human welfare	41
	4.3 Evaluation and Improvement.....	41
	4.3.1 Users´ evaluation of the prototype - walkthrough.....	41
	4.3.1.1 Feedback for the Smartwatch Design	42

4.3.1.2	Feedback for the App Design	43
4.3.1.3	Suggestions for Improvement from the walkthrough	46
4.3.2	Iteration of the prototype	47
4.3.3	Users' evaluation of the second version of the prototype - walkthrough.....	48
5	DISCUSSION	50
5.1	Importance and perception of security in smartwatches.....	50
5.2	Balancing privacy concerns in smartwatches	51
5.3	Transparency's impact on user decision making.....	52
5.4	Considerations of sustainability in smartwatch usage	52
5.5	Performance and reliability as the primary value	53
5.6	The significance of control in smartwatch usage	54
5.7	Trust in smartwatch brands and certifications	55
5.8	The impact of human welfare in smartwatches	55
5.9	Implications for research and practice	56
5.10	Limitations and future work	57
6	CONCLUSION	59
7	REFERENCES.....	60

List of Figures

Figure 1 : Our VSD process overview.....	12
Figure 2 : Prototype iteration (Carr & Verner, 1997).....	17
Figure 3 : AwareWatch logo	30
Figure 4 : App welcome screen	31
Figure 5: AwareWatch home screen	31
Figure 6 : AwareWatch settings page.....	32
Figure 7 : AwareWatch lock icon.....	32
Figure 8 : AwareWatch lock screen	32
Figure 9 : App settings page (security).....	33
Figure 10 : App security page	33
Figure 11 : AwareWatch gps icon	34
Figure 12 : AwareWatch gps toggle	34
Figure 13 : AwareWatch data sharing toggle	34
Figure 14 : App preferences page.....	35
Figure 15 : App registration options.....	35
Figure 16 : AwareWatch workout page.....	36
Figure 17 : AwareWatch active workout page	36
Figure 18 : App workout page	36
Figure 19 : App your watch page	37
Figure 20 : App ecological footprint page.....	37
Figure 21 : AwareWatch battery saving mode toggle	38
Figure 22 : AwareWatch settings page guidance	38
Figure 23 : AwareWatch “Are you sure?” pop-up	39
Figure 24 : AwareWatch preferences tab	39
Figure 25 : App health page	40
Figure 26 : App alerts page.....	40
Figure 27 : AwareWatch quick-access menu button.....	47
Figure 28 : AwareWatch edit quick-access menu	47
Figure 29 : App how the data is used	48
Figure 30 : App our guide to data security	48

List of Tables

Table 1 : Interviewed users.....	15
Table 2 : User distribution	15
Table 3 : User value importance.....	19
Table 4 : Table of objectives	27

1 INTRODUCTION

1.1 Motivation

While smartwatches offer many useful functions, they also introduce new difficulties and ethical complexities. This thesis attempts to address these challenges through a user-focused lens that puts human interests and values first. The goal is to advance knowledge in this emerging field and support the development of smartwatches that satisfy practical needs while also upholding ethical principles. By looking at smartwatches through the eyes of ordinary users, this work aims for solutions that navigate both technical opportunities and moral responsibilities. The motivation of this study stems from the realization that human values must come first, for users and producers of technology. Examining the values and ethical considerations included in the design and usage of technology is crucial as it becomes more and more pervasive in our everyday lives. By utilizing Value Sensitive Design (VSD), as explained by Friedman et al. (2013) this study aims to answer the demand for a stronger emphasis on the human values in the design of technology.

Incorporating values in technological innovation is very important because technology plays a major role in our daily lives. People are highly dependent on technology for communication, information access, and task management. Therefore, it's essential that individuals reflect on the values of the devices and applications they are using to ensure that they align with their own personal values and ethical standards. We decided to focus on smartwatches because we see ethical issues related to them and a lack of focus on the risks of using them by the users. A key ethical issue is privacy, where the whole industry is based around selling personal and sensitive information like biometric data or geolocation data (Foster & Torous, 2019). Another ethical issue is the potential of discrimination, and profiling through the leakage of this data (Wang, 2017), which need to be considered and limited as much as possible.

We believe the producers of technology need to be more aware of their responsibility to consider the impact their devices and applications have on human values. Companies must recognize the potential their technology has to influence human values. By recognizing this and including human values in their design and governing processes, companies can contribute to the development of more responsible technologies that are worthy of trust (MiT Technology Review Insights, 2023; Vassilakopoulou et al., 2022).

There are risks associated with technology use, particularly in the context of smart devices, which is also a motivation for this study. There are major concerns regarding privacy and security that have emerged alongside the rapid growth in the usage of smart

devices. By understanding these risks, and how they can impact the users, the design of new technology can mitigate these risks and the concerns of users.

This study aims to bring insights that can be useful for practice and for the actual design of technology investigating what values are important to users specifically focusing on smartwatches. The study also aims to contribute to research that takes a VSD approach by problematizing the prioritization of values by different users. We think that the findings of our thesis are interesting and can also have implications for further research and practice. It is important that individuals have awareness of the technology they use and knowledge of the underlying values embedded in its design.

1.2 Research questions

A key to performing a valuable study is to have a clear purpose. The research performed for this thesis is guided by the following overarching research question (RQ):

RQ: How can a Value Sensitive Design (VSD) approach be employed to effectively incorporate human values in the design of smartwatches?

To answer this question, we employed two supporting questions that help us answer our research question.

SQ1: Which values are most important to users regarding smartwatches?

SQ2: What options and features can be offered to users in line with their values in order to create a value-sensitive smartwatch?

To answer these questions, we conducted a qualitative study with users to identify their most important values and shape those values into features for a prototype.

1.3 Thesis structure

The thesis is structured based on the requirements for Master theses defined by UiA. First, the theoretical background is explained providing context to the VSD approach explaining what it is and why we are using it. After the background is explained, the methods used for each investigation are outlined in the research approach section. The research approach is split into a conceptual investigation, an empirical investigation, and a technical investigation as proposed by VSD. Then we present the findings from the different investigations, which include the findings from the initial interview, the prototype creation, the walkthrough interview, the prototype iteration, and its evaluation. The findings are critically evaluated against our research purpose and prior literature in the discussion section. Finally, there is a conclusion to summarize the key findings and learnings from this study.

2 VALUE SENSITIVE DESIGN

Value-Sensitive Design (VSD) is the approach we used in this thesis to identify, and analyze the values of users and inform the design choices for the smartwatches (Friedman et al., 2017). Friedman and colleagues defined VSD as a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process (Friedman et al., 2013).

The term “value” is at the center of this method, which usually means the economic worth of something, but in this context, the definition is broadened to mean “what a group of people consider important in life” (Friedman et al., 2013). To account for the relevant values and mitigate the impact of biases ingrained in technical artifacts (van den Hoven, 2017), VSD deploys an iterative tripartite method which includes a conceptual investigation, an empirical investigation, and a technical investigation (Friedman et al., 2013).

The first part of the tripartite approach is the conceptual investigation which uses analysis and theory to identify the core issues (Friedman et al., 2013). Through the conceptual investigation, values are initially identified to develop an understanding of the environment the team will be developing in (Friedman et al., 2013). As Friedman et al. (2013) points out, a conceptual investigation is not enough to fully understand the context of the environment where the technical artifact will be used, which calls for an empirical investigation into the contexts at hand. Empirical investigations use both qualitative and quantitative methods, like interviews, surveys, observations, and more, to understand aspects such as users’ appreciation of individual values, value trade-offs, and value considerations (Friedman et al., 2013). The last part of the tripartite methodology that VSD offers is the technical investigation. The technical investigation concerns how the technology and the technical solutions can best represent the values identified in the conceptual and empirical investigations (Friedman et al., 2013).

To get an understanding of how to use VSD in our project we explored papers that report on the use of VSD for smart applications or devices. For instance, Harbers and Neerinx (2017) described the design of a virtual assistant for work harmonization in teams using VSD explaining that it is important to address humans values such as trust, security, and privacy during the design process of information systems in general (Harbers & Neerinx, 2017). They identified three objectives with their design: provide operators insight into their own workload, provide support for helping each other, and preserve privacy. The objectives also describe the values they explicitly accounted for throughout the design. Additionally, the functions of the objectives were described, and their associated effects. With this, scenarios were created to show how the values are integrated into the design. A prototype was also created and tested with professionals; all

three objectives were well received. Strikwerda et al. (2022) explored the identification of moral values in the design of health services aimed at disease prevention. This study used VSD to create a preventive health check app. Relevant values were discovered with an analysis of legislation, policy documents, and literature. A series of workshops were conducted with e.g., moral dialogue to add more context-specific definitions of the values. The outcome of these workshops was validated with feedback from students. Chen et al. (2022) used VSD to evaluate a current industrial recommender system, exploring how practitioners and users recognize different values. The study included interviews that resulted in five key values: recommendation quality (including accuracy, diversity, and novelty), privacy, transparency, fairness, and trustworthiness. A summary of values seen from the practitioner's side and the user's side was created, to see differences between them.

Overall, these prior studies emphasize the importance of incorporating human values into the design process of smart applications and devices. Using VSD enables designers to consider values from the early stages of the design process, resulting in products that better align with the users' needs, values, and preferences.

3 RESEARCH APPROACH

In this section, the research approach is explained. The research approach follows the tripartite VSD methodology.

3.1 Overview

This study was performed in a sequence of steps including a literature review, interviews, data analysis, prototyping, and walkthroughs. These steps were performed in order to follow the VSD tripartite method which includes a conceptual investigation (for which we performed a literature review), an empirical investigation (via interviews and analysis), and a technical investigation (via prototyping and walkthroughs). The study started by examining the existing literature regarding VSD and user values in relation to smart technology. Once this step was completed, we developed an initial understanding of the most relevant values that were used to form interview questions for the empirical investigation. After the interviews were completed, the gathered data was analyzed and interpreted to create design requirements for the prototype. When the design requirements were formed, we developed a prototype in Figma. Once the prototype was developed and the values from the users were represented, the prototype was evaluated by a subgroup of the same users via a walkthrough of the system. After the walkthrough was completed, the responses and suggestions of the users were analyzed and synthesized, and the prototype was iterated upon. The changes to the prototype were then brought back to users to receive feedback. The process is illustrated in (Figure 1) below. In the paragraphs following, the steps will be described in more detail.

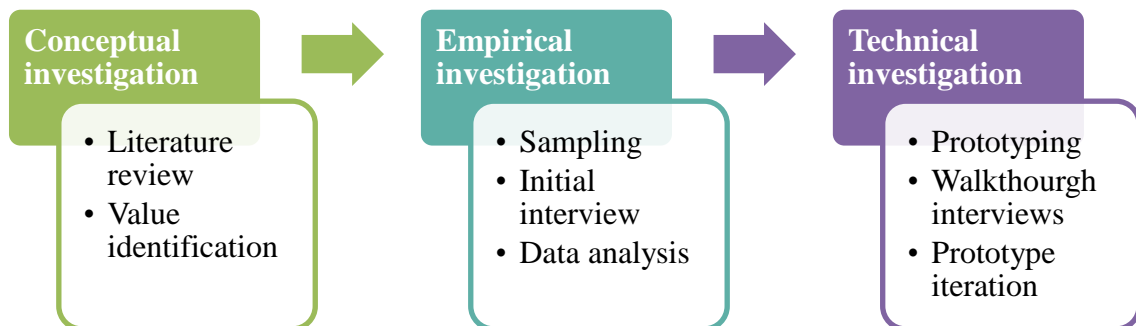


Figure 1 : Our VSD process overview

3.2 Conceptual investigation

As a first step for our study, we reviewed related literature to understand previous work in the field. A thorough literature review helps identify research gaps and inform the development of the study. To conduct the review, we searched for VSD-related research publications and applied inclusion and exclusion criteria to select a focused set of relevant and high-quality sources. The following paragraph outlines the process used to conduct the literature review.

A Scopus search for "value sensitive design" retrieves approximately 3000 documents and limiting the search to only articles with that phrase as a keyword yields around 400 articles. To select articles from this pool that are relevant to our study, we applied criteria aiming to ensure relevance and quality. The first criterion we considered was the publication year. We wanted to make sure we had up-to-date articles, only including articles published as of 2016. The second criterion concerned the document type. To ensure quality we only included journal articles, conference papers, and book chapters. These papers typically undergo peer review and multiple edits, which helps ensure their quality. The third criterion we focused on was the subject area. The papers need to pertain relevance to our field, and therefore only articles from the computer science and social science fields were included. Finally, we only wanted articles that had one or more keywords we defined, which we synthesized by reading a few VSD articles. These keywords were: value-sensitive design, security, privacy, transparency, performance, reliability, control, trust, smart device, and smartwatch. Over two separate searches, we ended up with 104 articles which we whittled down to 16 articles in our screening process. This process consisted of the following steps: exclude by title, exclude by abstract, and lastly exclude articles by reading the whole paper.

We used the 16 articles we found and conducted backward reference searches and added relevant articles to our list. We also got recommended articles from our supervisor, which were added later. Additionally, we found it necessary to include articles from Friedman as he is the pioneer of the VSD space, and Umbrello who has interesting research about VSD.

The first part of the conceptual investigation is to identify key values that apply to the technology we will be investigating. Through a literature review, eight values were identified and used in the qualitative study. The four first values were extracted from Friedman et al. (2013), where they list 13 values related to technology. The values of privacy, human welfare, trust, and environmental sustainability were considered to be important in this study (Friedman et al., 2013). The next three values were gathered from Umbrello (2019), where he studies important values related to AI. Transparency, security, and control are essential values related to AI, which could also be applied to smart technology. The last value is reliability which was found in a study by Maathuis et al. (2020) where a web-based quality-of-life instrument designed for people with mental illnesses was made.

A decision to combine reliability and performance into one value was made, as they often overlap.

In system development, user involvement has been a key part of understanding the context in which the technology is used (Kujala, 2003). Friedman et al. (2017) created a survey of VSD methods to identify, elicit, represent, and analyze the values of users. These methods have undergone a substantial amount of use in projects that deploy the VSD methodology, and should be seen as core methods to engage users (Friedman et al., 2017). The most relevant methods from this survey for this study are the user analysis, to identify relevant users, value-oriented semi-structured interviews to elicit views about values, and the value-oriented prototype, to visualize the results from the interviews (Friedman et al., 2017).

3.3 Empirical Investigation

The methods deployed in this project are based on the work by Friedman and colleagues (Friedman et al., 2017). The methodological core includes value-oriented interviews and the value-oriented prototype (Friedman et al., 2017).

3.3.1 Study participants

For our study, we recruited participants that use smartwatches. The participants are between the ages of 20-57 years old, however, the participants in the 20-30 years range are the majority. This relates to the fact that currently, more young people tend to use smartwatches. Some of the study participants are relatives or friends, but most of them were not known before, as they had at least one level of separation. It was important for this study to contain people in different lines of work, as different circumstances can have an effect on the values they deem important, which is why a deliberate effort was made to represent different groups.

Table 1 below provides a comprehensive overview of the interviewed smartwatch users, and Table 2 shows the distribution. The interview group consisted of 21 individuals, 11 men and 10 women, where the age ranged from 20 to 57 years. In terms of the smartwatch brand they use, Garmin was the most popular, followed by Apple Watch, and some also used Fitbit or Polar.

Table 1 : Interviewed users

<i>ID</i>	<i>Gender</i>	<i>Age</i>	<i>Education/work</i>	<i>Smartwatch</i>
U01	F	25	Student	Fitbit
U02	M	57	Finance	Polar
U03	M	46	Finance	Garmin
U04	M	26	Finance	Garmin
U05	M	24	Student	Apple Watch
U06	F	30	Finance	Fitbit
U07	M	52	Finance	Polar
U08	F	24	Finance	Apple Watch
U09	F	25	Student	Garmin
U10	M	24	Student	Garmin
U11	F	42	Undefined	Garmin
U12	M	32	Finance	Garmin
U13	M	47	Finance	Garmin
U14	F	29	Consultant	Garmin
U15	F	25	Marketing	Fitbit
U16	M	25	Student	Apple Watch
U17	F	20	Student	Apple Watch
U18	F	25	Student	Apple Watch
U19	M	20	Student	Garmin
U20	F	28	Social worker	Apple Watch
U21	M	29	Social worker	Polar

Table 2 : User distribution

<i>Gender</i>	<i>Amount</i>
Female	10
Male	11
<i>Age</i>	<i>Amount</i>
18-29	14
30-39	2
40+	5
<i>Education/work</i>	<i>Amount</i>
Student	8
Finance	8
Consultant	1
Undefined	1
Marketing	1
Social worker	2
<i>Smartwatch</i>	<i>Amount</i>
Fitbit	3
Polar	3
Garmin	9
Apple Watch	6

3.3.2 Interviews

The interview structure for the first interview, as Friedman et al. (2017) recommended, was a value-oriented semi-structured interview. The first part of the interview was to survey their general use of the smartwatch. In the second part of the interview, the interviewees were asked directly about eight values that were identified in the literature search. They were asked if they found the individual values to be important to them, if they could see some current issues relating to the values, and if there was room for discussion about why they prioritized some values higher than others. In the end, they were asked to list the most important values to them. Giving insight into the values that are most important to them can shape the design requirements for the prototype.

As mentioned, the interviews were semi-structured and loosely followed the interview guide. This was to make room for follow-up questions and discussions surrounding the questions and related topics.

3.3.3 Data analysis

The recordings from the interviews were transcribed and key points from each interview were put into a structured Excel sheet that categorized the answers to the values. This made it easy to get an overview of the data for each value and discover patterns. Additionally, to ensure accuracy and consistency in the transcriptions, we both used the same transcription service (Microsoft's transcription software built-in in both Teams and Word Online) and reviewed each transcript carefully for errors, and edited where it was necessary.

To get an overview of the users' values before creating the prototype, we created a set of objectives with associated functions and effects, which are connected to the identified values. We took inspiration from parts of the Situated Cognitive Engineering approach used by Harbers and Neerincx (2017). In practice the objective is what we want to solve/the problem, the function is how the objective can be solved, and the effect is the wanted outcome of the solution.

3.4 Technical Investigation

3.4.1 Prototyping a value-sensitive smartwatch

Different types of prototypes exist to fulfill different purposes in a project (Carr & Verner, 1997). Among the four main prototype types is the "prototype proper", which is used to clarify user needs in a controlled environment (Carr & Verner, 1997). The other types of

prototypes are a presentation prototype, a breadboard prototype, and a pilot system prototype (Carr & Verner, 1997). It could be argued that the prototype which will be used in this project is a mixture of a presentation prototype, which aims to present the feasibility of a product to perspective users, and the aforementioned “prototype proper” (Carr & Verner, 1997). The other two types are not relevant for this project as they deal with issues that arise closer to the release of the product.

The reasoning behind creating a prototype is to elicit and represent values in a system. Prototypes can be used to validate design requirements and can be used to create alternative solutions for the system (Suranto, 2015). By creating a visual representation of the product for the users, they can test the usability of the prototype and deliver feedback which can be used to create additional design requirements for future iterations (Suranto, 2015). Below is a representation of the cycle of development that will be used for this project.

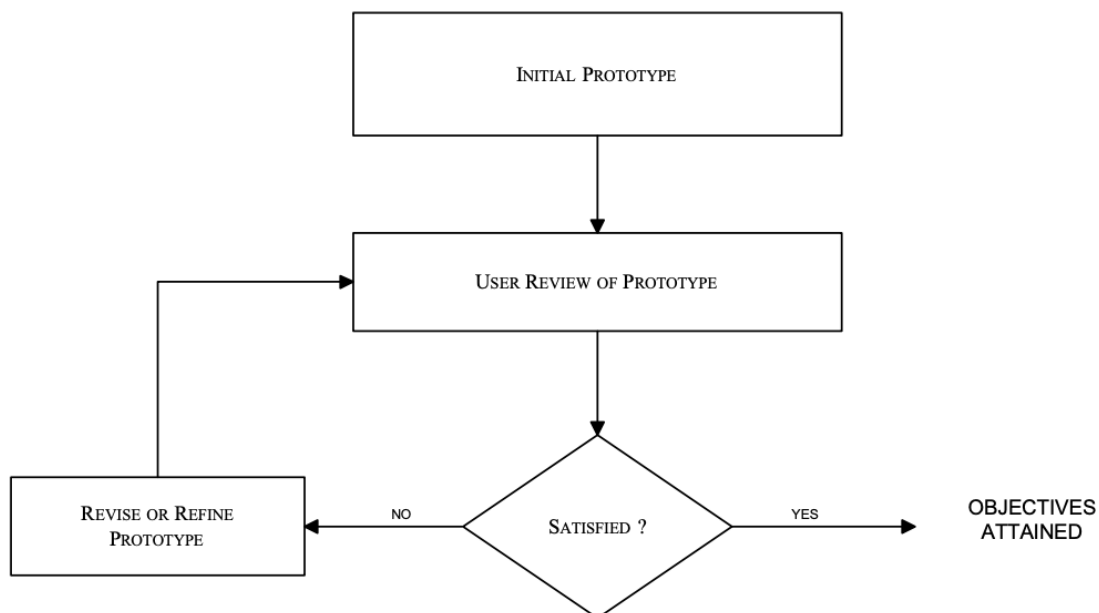


Figure 2 : Prototype iteration (Carr & Verner, 1997)

Another decision to be made about the prototype is the fidelity of it. The two types to choose from are low-fidelity prototypes and high-fidelity prototypes which have different benefits and drawbacks. Low-fidelity prototypes are quick and easy to create, and more examples of the same page can be created to give the users choices in the desired solutions (Suranto, 2015). Low-fidelity only show approximate solutions and often ignore important design decisions, which could make the prototypes less useful (Suranto, 2015). Alternatively, high-fidelity prototypes resemble the finished product and are often created through software tools (Suranto, 2015). This will make the prototype represent the values more accurately and allows users to explore key functionalities in the system (Suranto, 2015), which can elicit some feedback and further elaboration of their values. The

downside of choosing a high-fidelity prototype is that it demands more of the developers and requires more time. Despite the few disadvantages of a high-fidelity prototype, this project will use a high-fidelity prototype to elicit and represent the values of the users, as the functions that are proposed require more nuance than a sketch can provide.

3.4.2 Method for usability evaluation and improvement

Following the creation of the prototype, a second round of interviews was conducted to gather feedback and get an idea of the users' perception of the smartwatch prototype. 12 users that participated in the initial interview were chosen to take part in this follow-up interview, to see if they felt that the values they expressed had been represented in the prototype. The interview consisted of a use-case scenario which the interviewees were presented with and a cognitive walkthrough of the prototype. This approach was informed by established practices in usability testing and cognitive walkthroughs (Blackmon et al., 2002; Carter, 2007). Throughout the walkthrough, the interviewees were asked specific questions about the inclusions and exclusions of certain functions. They were also asked about how they felt about features, and if it supported some of their underlying values. The purpose of this interview was to test the interviewees with specific functions and illustrations by visualizing their values and eliciting their reactions. By giving users a visual representation, we hoped to receive clearer feedback on value-sensitive functions. This way, the prototype can be iterated upon an additional time to represent users' values.

After reviewing the results from the second interview, the prototype was revisited and adjusted in line with the interviewees' recommendations. Subsequently, the third and final interview was conducted with four of the users that took part in the first and second interviews to confirm that the adjustments made had the effect they wanted. This final interview served as confirmation, to ensure that the modifications made addressed the users' concerns and aligned with their values. The insight gained from the usability testing, cognitive walkthroughs, and iterative interviews was an important part of making sure the prototype reflects users' values (Carter, 2007).

4 RESULTS

In this chapter, we present the results from the study that aimed to elicit user values for the design of a smartwatch prototype. We present the results of the interviews, focusing on the values identified by the participants and their prioritization, and then shape design requirements based on the results. After that, we describe how and why features of the prototype were developed, as well as the iterations upon it following the second interview. Finally, we present the results of the final evaluation interview.

4.1 Identified User Values

The table below summarizes the findings from the initial interview round with the users. It shows the importance of the values we presented to the users and the number of users who rated each value as important, not important, or conditionally important.

Table 3 : User value importance

<i>Value</i>	<i>Important</i>	<i>Not Important</i>	<i>Conditional</i>
<i>Performance</i>	20	0	1
<i>Control</i>	13	7	1
<i>Welfare</i>	12	6	3
<i>Sustainability</i>	8	10	3
<i>Security</i>	7	12	2
<i>Privacy</i>	5	15	1
<i>Trust</i>	5	9	7
<i>Transparency</i>	4	17	0

The findings suggest that users find performance to be by far the most important value in smartwatches. Welfare and control were also considered important, but to a lesser extent, and trust was important to many, but under certain circumstances. On the contrary, sustainability, privacy, and security were not prioritized values for most users, and transparency was the least important value. Conditionally important values refer to sentiments that could not be placed in important or not important, as the condition for the value's importance was obscure. These values were not weighted heavily for the purposes of this study.

4.1.1 *Smartwatch usage and deciding factors*

Before delving into users' values, we wanted to gain an understanding of how they used their smartwatches, and what factors were important to them when choosing a smartwatch. We discovered that the primary use of smartwatches among the users was for tracking steps, training, and monitoring health.

"I use it primarily for training. It also has some health monitoring functions that provide some reassurance. It can detect things like heart rate or pulse and other similar things at night, which is helpful." (U08)

The functionality of the watch emerged as a crucial factor for users when selecting a smartwatch. However, it is worth mentioning that some users received their smartwatch as a gift, and therefore did not have a clear answer as to why they chose a particular model.

"I got my watch from my father, so what factors are most important is a bit difficult to say, but functionality is the most important thing for the training sessions I'm going to do." (U04)

By gathering this information about the users' smartwatch usage and deciding factors, we were able to develop an understanding of their experiences with smartwatches.

4.1.2 *Security*

Users' knowledge of and concerns about the security of their smartwatches vary, and these concerns may also be influenced by factors including their level of trust in the brand, the type of sensitive information stored on the watch, and the potential dangers related to how you use a smartwatch. In our study, we sought to understand whether users valued security to be important to them.

Security was not seen as an important value by more than half of the people interviewed. When questioned about the importance of security, some stated they had not thought about it before. Some said they had nothing to hide, and others felt that it was not important because they expected their smartwatch to be secure.

"I don't really think too much about it, at least not in relation to my smartwatch." (U02)

"No, there's nothing secret there, so it doesn't matter to me." (U09)

"I expect that it's secure, but at the same time the information that is stored on my watch is limited." (U06)

However, some users did consider security to be an important value. Specifically, they were concerned about malicious actors getting access to sensitive information, such as their location and health data. One user explained the following:

“The only reason I think security is important is really because of weight. I don’t want it to suddenly be posted on Facebook, for example.” (U01)

Similarly, User 11 would consider security important because of the sensitive data on the watch.

“If there were other things on my watch, which are a little more health related. Then it may well be that I think security could be important.” (U11)

Another user pointed out that security was crucial as smartwatches can be used as a payment device. Security is critical to prevent fraudulent use of the user’s payment information.

“I know that on some watches, you can link it so that you can pay with the watch in stores and such. If this is registered, security is important.” (U10)

The findings suggest that while many participants did not consider security to be an important value, some did recognize the importance of protecting their sensitive information such as health and payment information.

4.1.3 Privacy

The second value we investigated in our study was privacy. We asked the users about what they thought about privacy related to their smartwatch and if this was an important value to them. The majority of users did not consider privacy as an important value in their smartwatches. Most users felt like they had nothing to hide and did not mind sharing data if it helped improve the functionality of the watch.

“Not important for me, I don’t have anything to hide.” (U03)

“There is no problem for me that they want to use my data. So, it’s not important to me.” (U04)

“It’s not something that is important to me. It’s okay if the purpose is to improve the service.” (U19)

Some users, however, thought that privacy was an important value. They wanted to be in control if their data is being shared or not and with whom. They did not want sensitive data to be shared without their consent.

“I don’t feel the need to share all my information with them. I make sure to always click “no” when prompted to limit the amount of data they can collect.” (U18)

“I like to be asked so that I can make a decision. It’s better than them just lingering in the background collecting data without me being fully aware of them. I prefer to have control over what information I share.” (U12)

The findings suggest that privacy is not important for most smartwatch users. There were two groups identified in this part of the interview, the ones that only perceive the benefits of smartwatches, and another group that perceived great benefits and risks to their privacy. The benefit-oriented group contained mostly males, whereas the risk-oriented group consisted of mostly females. Many users are for the most part willing to share data if it is anonymized and used to improve the watch's services and functionality, but some users value privacy higher and want to have control over their data.

4.1.4 Transparency

The third value we questioned the users about was transparency. This refers to the ability of the user to understand how their smartwatch measures data and uses the data it collects. Transparency was found to be the least important value among the users. The majority of the users stated that it was not important to them, and most stated that they either had not bothered investigating themselves or simply had not thought about how the watch measures data or functions in general before.

“I haven't really thought much about how they calculate things, both steps and kilometers and such.” (U10)

“I haven't really thought about how it does it, so it's not really important. I can't imagine how it could be a problem.” (U16)

One user stated that if the accuracy of the data was important to them, they would value transparency.

“Although I'm not entirely sure how it works if having precise heart rate readings were crucial to me, then I would have made a point to investigate further. However, it's not a priority for me.” (U11)

A select few users considered transparency to be important to them in their smartwatches. They explained that they wanted to have control over and an understanding of how their data is being used and calculated.

“Yes, I've seen some videos on YouTube that show how it measures your pulse. It's not really crucial information to have, but it's still useful in a way. So, in that sense, it's important to know because it ensures that you're getting accurate readings.” (U05)

Overall, transparency does not seem to be a significant value for most smartwatch users. Users seem to prioritize the functionality of the watch and the data it provides rather than how it is measured or calculated.

4.1.5 Sustainability

The next value is sustainability, which concerns how the workers are being taken care of and how environmentally friendly the smartwatch has been produced. The majority of the users did not consider it to be an important value. Some of the users stated that they would care if the media reported negatively about the brand they were using, and in this case, they would have considered other brands the next time they were looking for a smartwatch. For the most part, they were satisfied with their current brand and did not have any complaints about, and possibly awareness, of its sustainability practices.

“It hurts to say it, but no, it’s not important to me.” (U13)

“No, I’m not. It’s not something you think about when you’re buying a watch; you assume that large companies have it under control. If it were revealed that they had performed poorly in this aspect, then one may consider it more the next time when planning on purchasing a similar watch or brand.” (U12)

Of those who found sustainability important, the focus was on the treatment of the workers rather than eco-friendliness. They want the workers to be well taken care of and that they receive fair wages. Still, none of the users had conducted their own research on their smartwatch brand’s sustainability practices before buying. They did not find sustainability important enough to research on their own.

“It’s important that workers are well taken care of, but whether it’s produced in an environmentally friendly manner doesn’t concern me all that much.” (U05)

“It is important, but not important enough to have researched it.” (U17)

“No, I have to be honest and say that I am not very conscious about sustainability. Had news gotten out that there were somehow very bad conditions for the workers, I might have chosen to buy a different watch next time. But it was not something I investigated before I bought it and whether it is sustainable plastic or whatnot.” (U14)

Interestingly, one of the users was studying sustainability, and therefore it has become a very important value for them.

“I didn’t really think about it when I bought it many years ago, but now I would have been more conscious about it since I’ve studied circular economy and sustainability and gained more awareness on the topic in recent years. So now I would have thought about it, but not back then.” (U09)

Sustainability as a value in a smartwatch is not a top concern for the users. While some expressed concern, it was not something they had considered before being asked about it. Of course, they want workers to be treated fairly, but they expect the brand to have this under control.

4.1.6 Performance and reliability

Performance and reliability were considered the most important value among the users. In fact, many of the users chose their smartwatch based on its performance. They use their smartwatches to accurately track their workouts and other physical activities, as well as getting notifications and quick access to different applications.

“Yes, of course, it's important. That is the point of having a smartwatch, that it measures the right speed and the right time.” (U03)

“Yes, the most important thing for me is that the data my smartwatch collects is accurate - distance, pulse, time. That's why I have a smartwatch.” (U19)

Even though performance was very important, some users stated that they have not compared their smartwatches' performance to others. Other users also admitted that they are not using all the functionality the watch has to offer, but they still valued the performance they got out of the smartwatch.

“Yes, it's very important to me. I'm very happy with my smartwatch, but I haven't compared it to any others to see if it's better.” (U18)

“The most important thing is that they show the correct time. The other functions they're more of a nice-to-have. The thing is, I'm not the type of person who likes to read instruction manuals, so it will take me some time to learn all the functions on this watch.” (U02)

When the users were asked about what regarding the smartwatches' performance and reliability were important, the accuracy of measurements and the ability to perform equally well under varying conditions were brought up.

“I've tested my watch under tougher conditions, like in a sauna. It's very important that it's reliable.” (U04)

The users depend on the smartwatches' ability to accurately measure their physical activities such as steps taken, pulse, calories burned and distance. This is what they primarily use their smartwatch for, and that is why it is the most important value.

4.1.7 Control

Most smartwatch users considered control to be an important value in their smartwatch. Control refers to the user's ability to control and interact with their device in a way they want to and not have unexpected actions taken by their smartwatch without their consent. The main reason users found this important was because of control-related issues they have faced before. However, some of the users that had not had any issues with their smartwatches also stated the importance of control, as they do want to prevent issues from happening to them.

“The only thing is, if I’m strength training or doing something else and my hand is in a certain position where I bend my wrist toward the watch, I can accidentally hit some buttons and suddenly start a walk without meaning to.” (U10)

“Yes, it’s a bit important, because it’s connected to my messaging system and many apps, so it’s a bit of a hassle if it suddenly sends a lot of things that I don’t want.” (U16)

One user mentioned that having physical buttons on their smartwatch gave them an increased feeling of control, as they felt more comfortable using these buttons most of the time, and in cases where using the touch screen was difficult.

“Yes, I like physical buttons. I only had touch before and sometimes I accidentally hit something. But my watch now has physical buttons, and I think that’s important.” (U12)

Some users did not consider control important at all. The primary reason for this was that they had yet to encounter any sort of issues when using the watch, and they were not concerned that any issues would arise either.

“Nothing has really happened outside of my control, so it’s not that important to me.” (U17)

Users need to have control over their smartwatches, and this study shows the importance of it and how many take it for granted.

4.1.8 Trust

The value of trust was regarded as not important by most of the users. But interestingly users elaborated on this and indicated that their trust more often is with the brand and not with certifications as we asked about in the interview. The brand of the smartwatch is what is trusted, rather than any specific certification or badges.

“I’ve thought about the water resistance, it’s certified to withstand moisture, but not waterproof. But ultimately, I bought it because of the brand and not the certifications.” (U17)

“I only look at the brand, and when I think about it, I go for reputable brands, which I assume have certifications that I’m not even aware of.” (U21)

Among those who stated that trust was important it was mentioned that to be able to trust technology to use it effectively is important. Some also said they chose one brand over another because of trust, and one also mentioned that certifications can be a differentiator for them when choosing a smartwatch, but not something they would go out of their way to research.

“I do a lot of research beforehand. And that’s why I chose Garmin because I know it is a good watch manufacturer.” (U19)

“If I were in a store and saw several watches side by side, I would be drawn to the one with the most certifications, but if I were looking at just one watch, I don't think I would care about that alone.” (U01)

The findings suggest that trust as a value is not very important to the majority, but it’s still an important factor to keep in mind when choosing a brand.

4.1.9 Human Welfare

Human welfare was important for most of the users in this study, some even claiming it as the single most important value. Smartwatches give these users happiness and motivation, making their training easier and more enjoyable.

“The watch makes it easier to keep track of my own activity. It's something that motivates me to do positive things like going to the gym.” (U04)

“It's motivating, at least when it comes to the workouts. You can see that you're in shape and keep track of your progress with the watch. I think it's fun to see the effect of the training instead of just doing it for the sake of it.” (U08)

“Yes, I use it every day and I am happy with it. I look at it all the time to see the number of steps and use it a lot for training with heart rate and also use it for SMS. So, I would definitely say that it provides well-being.” (U14)

Some users, however, did not consider this value to be important, stating that it does not matter to them.

“No, my relationship to the watch is very relaxed. It's not bothersome, and it doesn't provide anything extra.” (U07)

Other users mentioned that using a smartwatch can be annoying at times, but that does not necessarily mean that they do not value human welfare. A couple of users mentioned that it was annoying to use it to track sleep as they would have to charge it at inopportune times or that the watch would vibrate when they were trying to sleep.

“It was fun to see sleep data and have some kind of control over sleep quality, but at the same time, there were so many times that I was woken up by the watch's vibrations that I stopped using it when I sleep.” (U03)

The human welfare value is highly regarded by most users, and they find value in the smartwatch’s ability to give them happiness, motivation, and help them with their daily routines. Even though some users find this value irrelevant, it should be prioritized highly when creating the design requirements.

4.1.10 Forming design requirements

After all the interviews with the smartwatch users were conducted, we set out to establish how our prototypes can address and reflect the answers we got. To do this, we were inspired by parts of the Situated Cognitive Engineering approach used by Harbers and Neerinx (2017). We wanted to create a comprehensive set of objectives with associated functions and effects that would help us when developing the prototype.

We used the findings from the interviews to create a table with smartwatch design objectives related to each value, including specific functions and effects.

Table 4 : Table of objectives

<i>Value</i>	<i>ID</i>	<i>Objective</i>	<i>Function</i>	<i>Effect</i>
<i>Security</i>	1	People should be able to lock their watch.	The watch should have an easy-to-use lock screen, and visibly locked.	The user has more control over the security of their watch.
	2	People should know when the watch is locked and unlocked.	The watch should have icons that show whether the watch is locked or unlocked easily visible.	The user becomes more aware of the security of their watch.
	3	Cybersecurity protections should protect the user from unwanted attacks.	The company should follow best practices to ensure data integrity and protection of the watch.	The user will not be troubled by the threat of attacks.
	4	The user should have more awareness of security and how they can protect their information.	The app should include a guide that explains how to better protect their information	The user can better protect themselves from attacks.
<i>Privacy</i>	5	People should know when they are being tracked.	The watch should display an icon when they are being tracked.	The user will become aware of when they are being tracked.
	6	People should be able to turn off geolocation easily.	The watch should have an easily accessible icon to turn on/off geolocation.	People can decide when they want to be tracked.

	7	The user should be able to turn off data sharing easily.	The settings in the watch and the app should have an easily accessible button to turn off data sharing.	The user gains more control over what data they share.
	8	The user should be able to control what features they want to enable before registering.	The registration page should have options that can be enabled and disabled to customize their experience.	The user gains control over their privacy without having to deactivate options after they register.
Transparency	9	Users should be able to find out how sleep, pulse, and steps are calculated.	The associated app should have explanations of how the data is calculated.	The user can learn more about the technology they use.
	10	What data is used and how it is used should be explained to the user.	The associated app should have an easily available overview of what data are used and how.	People become more aware of what their data is used for and what they can use.
Sustainability	11	The location where the watch is produced and how the workers are treated should be known by the users before purchase.	The web page where the watch is bought should include an overview of all the major steps in the assembly process.	The user becomes more aware of how the watch is produced.
	12	The carbon footprint of the watch should be accessible to the user.	There should be an overview of the carbon footprint of the watch on the web page.	The user will become more aware of the carbon footprint they have.
Performance & Reliability	13	The battery time should be substantial, without making the watch heavy or big.	The watch should have a page that shows the user what functionality of the watch uses the battery and what amount. There should be a battery eco-mode.	The user will have to charge their watch less often, making it easier to use for longer durations.
	14	The accuracy of the measurements (pulse, sleep, steps) should be as accurate as possible.	The watch should have workout presets for many different activities that use different calculations to give the user the most accurate data.	The user trusts the watch more and has a better experience using it.

Control	15	The watch should get feedback/confirmation about the action that was performed.	The watch should have physical, robust buttons to press, in addition to a touch screen. The watch should give feedback when actions such as starting a workout are performed.	The user feels more in control of the watch.
	16	It should not be easy to accidentally do actions on the watch	If buttons that cause or disable actions are pressed, the user should receive a confirmation screen.	The user feels more in control of the watch.
	17	It should be easy to disable all alerts.	The watch should have an on/off icon/switch that easily disables alerts of all sources.	The user does not get disturbed at inappropriate times and feels more in control.
	18	The user should be able to decide how the watch activates.	There should be settings that allow the user to decide how the watch can activate.	The user feels more in control over the activation of their watch.
Trust	19	The watch should follow best practices and market standards	The watch should provide access to certifications.	The user feels they can trust the watch and the company
	20	The watch should show evidence of quality assurance	The watch should be reviewed by known professionals or audit organizations. These reviews should be displayed on the web page	The user feels they can trust the watch and the company
Human Welfare	21	The watch should motivate the user	The watch should give feedback when you have reached your goals and when you break records	The user gets motivated by the feedback the watch gives
	22	The watch should be able to motivate the user towards goals.	The associated app should have the option to input daily or weekly goals and remind the user semi-frequently about what they need to do.	The user feels motivated and pushed towards achieving their goals.

A smartwatch that satisfies these objectives can meet the needs of users that have specific value concerns but also strengthen the awareness of users that are not already sensitized to some of the values.

4.2 Design choices - Prototyping

All the values that were discussed in the first interview need to be covered in the design of the prototypes. The least important values also need some representation to test the users with practical features, rather than theoretical questions only. In this way, if there are differences between the values expressed when encountering an actual prototype compared to the values in the abstract initial interview, these will be uncovered and can be represented in future iterations. The smartwatch covers in varying degrees the values of security, privacy, performance and reliability, control, trust, and human welfare. Additionally, transparency and sustainability are represented in the app, along with all other values that were identified in the conceptual investigation.

This design was guided by the objectives that were formed through the identification and elicitation of values in the initial interview. The first step was to create a basic template for the prototypes to shape the style and design. The watch needed a name that reflected the value-sensitive nature of the device, and to create this name ChatGPT was consulted to come up with potential names. After workshopping a few names and logos, we eventually settled on AwareWatch, as this did not infringe on any copyrights (Figure 3).



Figure 3 : AwareWatch logo

We created a baseline for developing a presentable prototype, and the app used the same colors to unify the prototypes. Figure 4 & Figure 5 were the first screens designed for the app and the watch, as it will be the first thing that the users see.

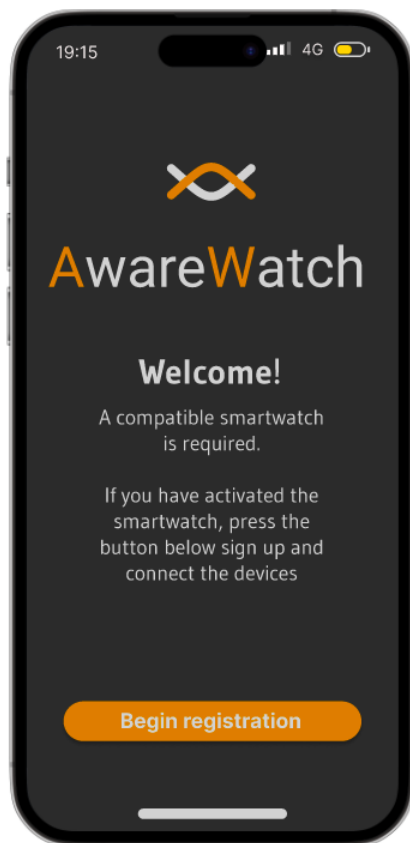


Figure 4 : App welcome screen



Figure 5: AwareWatch home screen

After the landing screens shown above were designed, the design requirements that were shaped by the initial interview could be considered and implemented. In the following sections, the first iteration of the prototype will be shown, and will also outline how the eight core values are represented in the prototype.

4.2.1 Security

The first security measure that was implemented was a lock option on the watch (Obj 1). This would enable the user to lock the device and need a pin code to unlock the watch the next time it was opened. This security measure needed to be weighed against accessibility, which is why the watch only locked itself if a button on the quick-access menu was pressed (Figure 6). If the watch automatically went into sleep mode or the lock button on the side of the watch was pressed it would not prompt an unlock screen when activated again (Figure 8). Another feature that was added in this section was a lock icon on the home screen to show if it was locked or not (Obj 2) (Figure 7).



Figure 6 : AwareWatch settings page



Figure 7 : AwareWatch lock icon



Figure 8 : AwareWatch lock screen

The security features on the app were all implemented in the security settings (Figure 9). On this page, the user can change their password and enable two-factor authentication, which is standard for any app. The feature that was unique to this app, was a guide to information security (Figure 10). The idea behind this page was to explore whether the user was interested in becoming more aware of the security and integrity of their data (Obj 4). Therefore, this button/page was included to question the users' disinterest in security when they performed the walkthrough in the second interview.

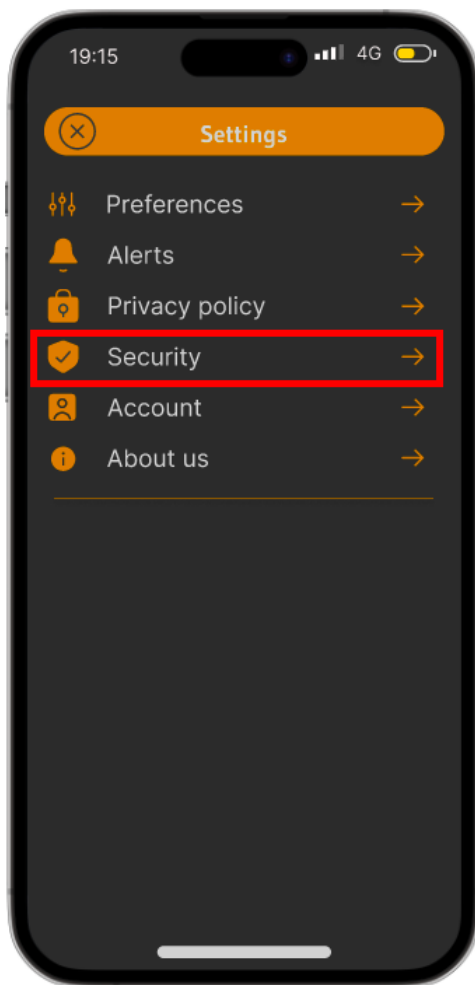


Figure 9 : App settings page (security)

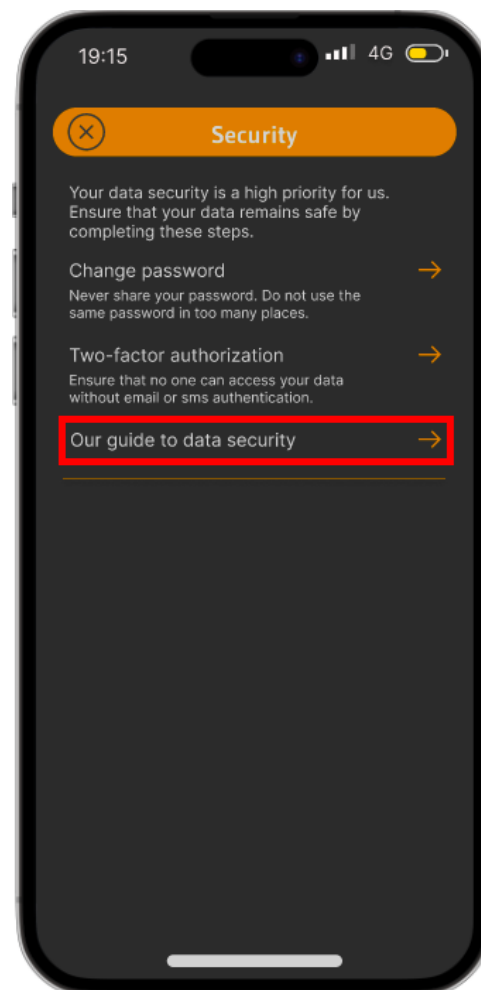


Figure 10 : App security page

4.2.2 Privacy

Based on the first interview of the users, a few design requirements were formulated to represent the value of privacy in the watch and the app. The two design requirements that were formulated relate to privacy and privacy awareness in the prototype of the watch. The first design requirement expressed that the user needs to know when they are being tracked and when their location services are activated (Obj 5). The solution that was implemented to fit this design requirement was an icon that is displayed on every page and symbolizes that location services are activated (Figure 11). The second design requirement is related to the accessibility of enabling and disabling the location services (Obj 6). The solution to this was to have a quick-access menu, which was located at the top of the settings page. In this quick-access menu, the location services button could be included (Figure 12) in addition to other frequently used buttons. An additional privacy-related feature was added to the watch, which is the easily accessible button that enables and disables data sharing with the company (Obj 7, Figure 13).



Figure 11 : AwareWatch
gps icon



Figure 12 : AwareWatch
gps toggle



Figure 13 : AwareWatch
data sharing toggle

The first design requirement that was made in relation to the app was that users should be able to find out how the data is used through a resource on the app. This was solved by including a page that details what data is collected and used, and how it benefits the company and the user (Figure 14). This feature would be below the settings that relate to the sharing of data, to give context to the options. This feature represents both awareness around privacy, but also transparency, to give a level of insight to the user. The second design requirement that was formulated to represent privacy, was the inclusion of pre-registration settings (Figure 15). These settings were there to adjust your level of privacy before registering as a user, to further promote privacy in the prototype (Obj 8). This feature also relates to the value of control, as it empowers the user to make decisions before registering.

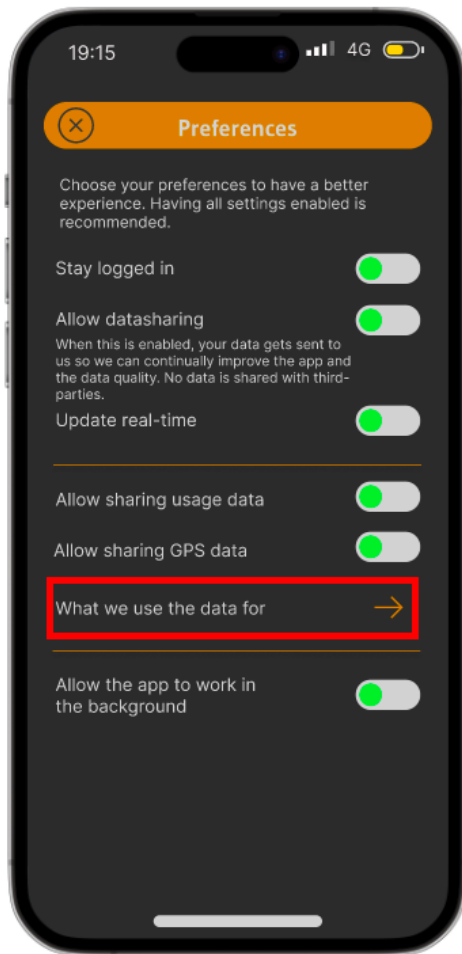


Figure 14 : App preferences page

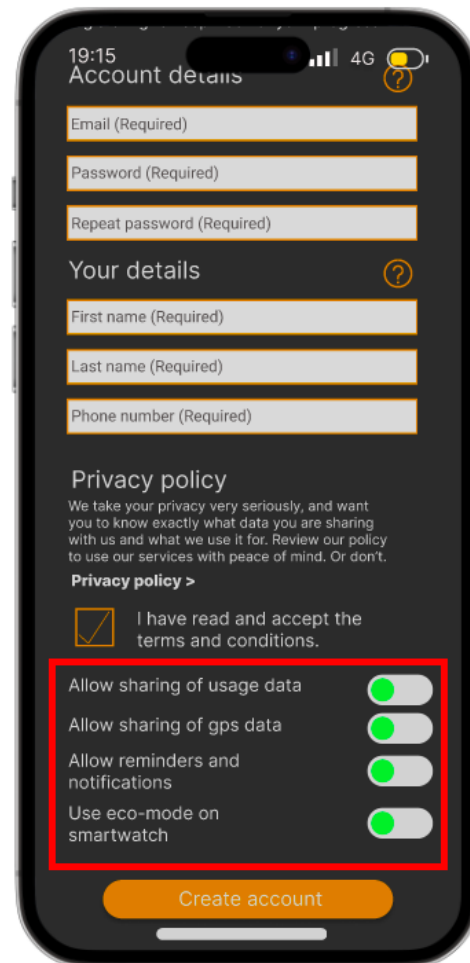


Figure 15 : App registration options

4.2.3 Transparency

Transparency was considered the least important value in the first round of interviews, which is why there are few design requirements for representing this value. The one design requirement that was shaped by the interviews was the inclusion of accessing previous workouts to track their progression. Most users that were interviewed expressed that they mostly use the watch for working out, so the watch needed to have a page where workouts could be started and stopped (Figure 16 & Figure 17). The page where previous workouts could be viewed needed to be in the app (Figure 18), as it would be difficult to display all the data from previous workouts on a small screen. The page for this was made, but pages for the individual workouts were not made, as it went beyond the scope of this paper. The last thing that was considered in relation to transparency was the inclusion of the “What the data is used for” page, which is mentioned above as it relates to privacy as well (Obj 10, Figure 14).



Figure 16 : AwareWatch workout page



Figure 17 : AwareWatch active workout page

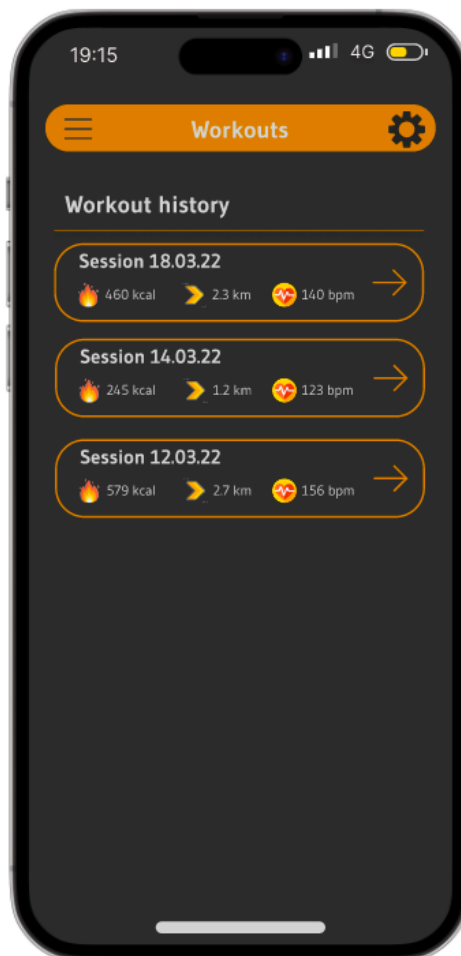


Figure 18 : App workout page

4.2.4 Sustainability

Sustainability was not as important as other values according to the interviewees. Therefore, the prototype did not include many functions that represent these values, and the scenario did not include any mentions of where the watch would be produced, how it would be produced, or who would make it. We included one function in the app that tests the findings from the interview and explores whether sustainability needs to be represented in the app. The function that was included to represent this, was on a page called “Your watch” (Figure 19) and outlined the carbon footprint that the watch had (Obj 12, Figure 20). These numbers were only rough estimates, as the purpose was only to explore whether they would appreciate the inclusion of this page.

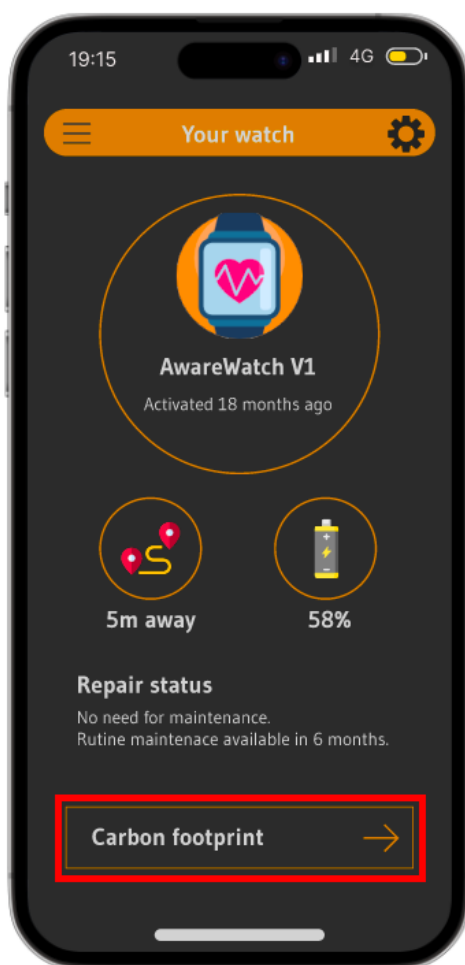


Figure 19 : App your watch page

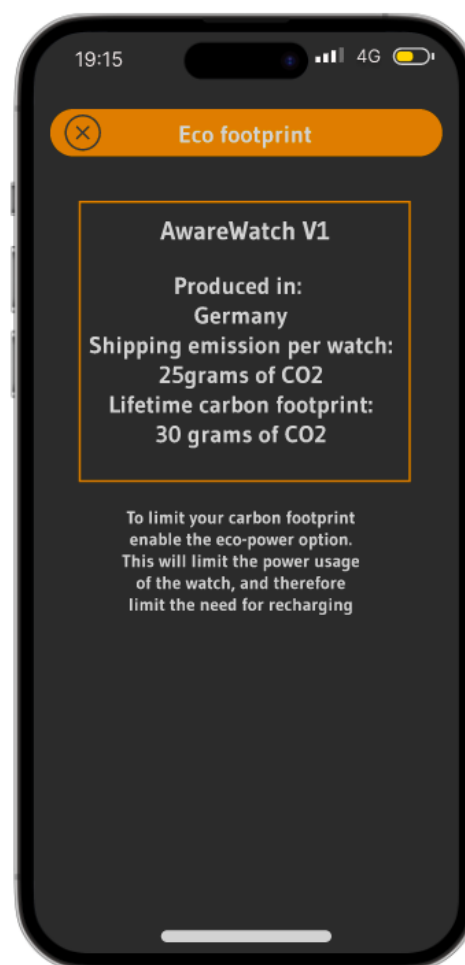


Figure 20 : App ecological footprint page

4.2.5 Performance and reliability

Performance and reliability were considered the most important values for the users, but creating features in the prototype to represent this value was a challenge. The two design requirements that were created for this value could not be effectively shown by using the prototype, so they needed to be explained in the scenario. The first of those was the extension of the battery lifetime. The solution to this demand was to include a button in the quick-access menu which enabled battery saving mode (Obj 13, Figure 21). This mode would disable several functions in the watch but extend the battery duration. The second design requirement expressed the need for accurate measurements of distance, pulse, and sleep data. This was not possible to implement in a prototype, so it was explained in the scenario. Since performance and reliability were highly appreciated by the users, the prototype needed to have an effective solution to the user interface, where little to no effort was wasted trying to find the different functions of the watch and app. As mentioned in 4.2.2, the solution to this was to introduce a quick-access menu. This would allow users to find the most relevant functions by swiping down on the watch (Figure 22). The front page of the watch and the app needed to have the most relevant information on display, while not oversaturating the user with things to look at.



Figure 21 : AwareWatch battery saving mode toggle



Figure 22 : AwareWatch settings page guidance

4.2.6 Control

It is important for users to feel that they are in control of the smartwatch. As mentioned in section 4.2.2, the settings page has an easily available button where you can turn off

data sharing, as well as Bluetooth, alerts, and other important functions through the quick-access menu. Through the interviews, some users mentioned that the watch would stop the current workout automatically. To counteract this, a redundancy screen was added to the workout (Figure 23) to make sure that the workout was not ended without consent from the user (Obj 16). A second objective that was formed after the initial interview was the need for a way to choose how the watch activates (Obj 18). The solution that was made to solve this objective was to have a preferences menu where they can choose what ways they want the watch to activate and deactivate as shown in Figure 24.

Users also mentioned that they liked to have physical buttons as well as a navigational touchscreen. Physical buttons cannot be implemented in a web-based prototype, so this was explained in the scenario. The watch would have two multi-functional buttons. The first button was to go back to the previous page, or if pressed down for 1-2 seconds it would lock the screen. This button also serves as an on/off button if held down for 5 seconds. The other button's function is to accept various pop-ups that appear on the watch, and if pressed when there is no pop-up it would navigate the user straight to the workout page.



Figure 23 : AwareWatch “Are you sure?” Figure 24 : AwareWatch preferences tab pop-up

A feature that was added to the app to represent control was the option to set your own goals. This feature was developed because the users that were interviewed expressed some negativity about alerts appearing too regularly. Therefore, the idea was to not send alerts until the user had set their own goals on the health page (Figure 25). Further control over the alerts was given to the user, through the alerts settings (Obj 17, Figure 26), although this is common practice in the industry.

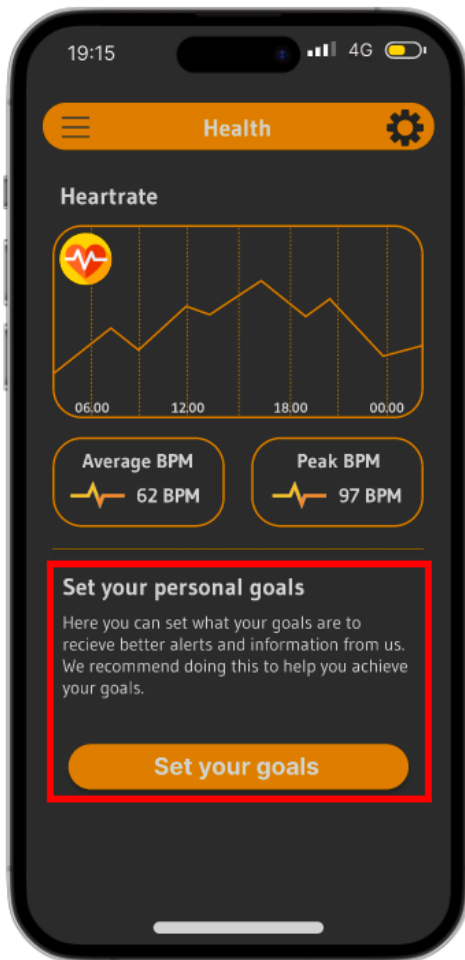


Figure 25 : App health page

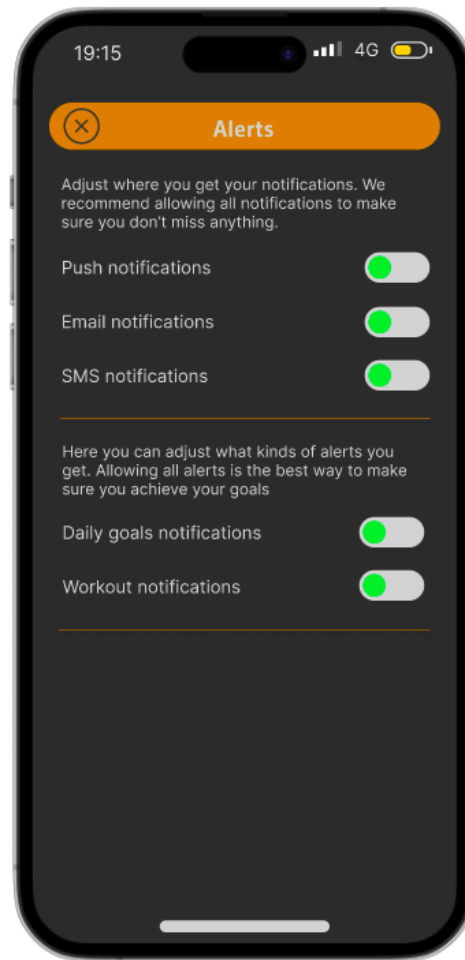


Figure 26 : App alerts page

4.2.7 Trust

During the first interview with the users, they were questioned about certifications, to which they expressed their disinterest in the availability of seeing certifications. These responses led us to move away from incorporating this value into the design of the prototype. To achieve trust in AwareWatch they either need to have positive past experiences with them or others that can vouch for the company. Receiving certifications and advertising those was the idea that was included in the scenario, to test users on the importance of trust and how trust is gained. Certifications are not something that can be incorporated into the design of the prototype, only if we wanted to publicly display those certifications on an informative page in the app. However, building trust through the transparency of the device is possible. Heightening and representing the values presented above can help to build a positive repertoire with the user and encourage them to buy products from the company in the future, which will be uncovered through the walkthrough.

4.2.8 *Human welfare*

Human welfare, which in this case can be motivation, encouragement, or joy, is important to a majority of users and therefore needs sufficient representation. To incorporate this into the design, the goal is to motivate and encourage the user towards their goals. As mentioned in 4.2.6, the users can set their own goals on the health page. By doing this, the user agrees to receive alerts to push them towards their goals as encouragement and motivation (Obj 2 & 22). Another design requirement was to keep track of their personal bests and notify the user when they surpassed their records. Examples of these are calories burned, distance traveled, steps taken, and length of workout. Giving the user something to feel joyous about after a workout can help to motivate them for the next workout or workday.

The functions that are considered core functionalities for a smartwatch were not developed fully, as the purpose of this paper is to create new solutions, and many of these represent human welfare.

4.3 Evaluation and Improvement

In this section, we will describe how the walkthrough interview was conducted, what we found out through this interview, how that information was processed to create another iteration of the prototype, and how the third and final interview went.

4.3.1 *Users' evaluation of the prototype - walkthrough*

For the second interview, we wanted to test the prototype we developed on users and decided to create a guided walkthrough. In addition to the walkthrough, we created a scenario that the user had to envision, so all values could be asked about.

“You will now test a smartwatch that is about to be released on the market, along with an accompanying app. We do not have a physical watch to present, so you will have to imagine a smartwatch that is like an Apple watch, with physical buttons on the side. There are two buttons on the side, one that locks the watch after it is pressed and held a few seconds and goes back to the previous page if it is pressed once. The second button is to accept choices that the watch gives to you, or pausing a workout if a workout is active. In addition to these buttons, the screen will have touch enabled to navigate through the watch. The app that can connect to the app is used for registration and various settings for the app and watch.

We are about to guide you through the watch and the app, and will be questioned about some of the features, so do not hesitate to speak your mind or ask questions.

The goal is to figure out how you feel about certain functions and design choices, and not to put much weight on the visual design of the prototype.”

This was the introductory text that we prompted the interviewees with. After this was read to them, they were guided through the prototypes and asked questions about certain features. They were first walked through the prototype for the watch and then walked through the app. The interviews were not recorded, which means we do not have direct quotes from the interviews, however, the sentiments of the users and their opinions about features were documented.

The goal of this interview was to elicit more information about their values and test the results we gathered in the first interview in a more practical setting.

4.3.1.1 Feedback for the Smartwatch Design

The user was shown the quick-access menu on the watch (Figure 6) and asked:

What do think about an optional lock button that prompts you to enter a pin code the next time you try to open it?

This security option received mixed responses. Some of the users said that it was unnecessary for them and that it would create an obstacle for their use of the watch. A small majority of them said that it was not something they would use frequently, but it is a nice option to have in terms of security. A few of them said that this was a nice option to have, so they could walk away from the watch without worrying that someone else could get access to their watch.

The next feature they were shown was also in the quick-access menu (Figure 12), and were asked:

What do you think about the accessibility of turning on/off the GPS functions on your watch? Is this something you would use? And do you like that it displays whether the GPS is on/off on every page?

This question deals with privacy, through the option to turn off tracking services, and transparency, through the visual indications that tracking services are on/off. The responses were split about this, where around half of the users did not care if the GPS was easily accessible to toggle, and half of the responses were positive about having this option to turn it off and positive about knowing that the GPS is on or off on every page. One user noted that this was a necessary option for them as they work in healthcare, and the places they visit are considered sensitive information.

They were shown another button in the quick-access menu that deals with alerts.

Do you think that turning off alerts is easy enough with this button or would you like to have a physical switch on the side of the watch to mute alerts as well?

This feature deals with performance and reliability, and the responses were almost unanimous. The majority said that the button in the quick-access menu is enough because it is so easily accessible. One user said that they prefer physical buttons in general and that having a physical switch, like the mute switch on an iPhone, could give the user confirmation that alerts are off without having to activate the watch.

The next feature the users were shown was the eco-power option in the quick-access menu (Figure 21).

What do you think about having an option to enable an option which depletes the battery slower, but disables other features to accomplish this? Would you use this option? And would you like a page where you can see what draws the most power?

The button is related to the value of performance and reliability, and the option to see what draws power deals with transparency. All the users expressed that the option of eco-power mode was a very positive addition. Half of the users struggled to have enough battery throughout the day, which meant that they had to take it off and charge it at work, which defeats the purpose of their use. One of the users also valued how easy it was to enable the option in the quick-access menu. The option of seeing what features/apps use the most power on their watch was also well received. Some of the users said that this is something that they would be curious about, so having the option to view this information would be beneficial to them.

The next feature they were shown was the workout page (Figure 17) and the redundancy measure (Figure 23) put in place to make sure they do not accidentally stop their workout.

What do you think of the workout page of the watch? Does it have enough information on display? Would you feel in control of your watch with this workout function?

This is a core function of the watch and deals with the value of performance and reliability, and the redundancy measure deals with the value of control. According to the users we interviewed, the workout page was fine, but with a few issues. One user said that it needed specific programs based on what they were training, like cycling, outdoor running, indoor running, swimming etc. Another issue that one user mentioned is the ability to access and continue previous workouts in case they had taken a long break. The redundancy measure that was put in place did not elicit much of a reaction, as they felt it was natural to have available. However, one of the users said that they would disable this if they could.

4.3.1.2 Feedback for the App Design

After these questions had been discussed with the users, we started to walk them through the prototype for the app. First, they were shown the welcome page (Figure 4), which led

them straight to the registration page, where they were asked to evaluate the new features (Figure 14).

If you browse through this registration and see settings that you can adjust before registering, would you feel more in control of your privacy? Do you appreciate this addition or is it unnecessary?

This feature covers the values of privacy, control, and transparency. The response from the users to this question was unanimously positive. Some of the users explained how this would make them feel in control and more comfortable with the app, and in turn, build trust between them and the brand. Another user mentioned that this is not a possibility that they had considered, and it would make them more aware of their privacy. A couple of users mentioned that they appreciated this because they do not usually browse through the settings after registering, and often just accept choices that are given to them to access the app faster.

Next, they were tested with a controversial feature in the app about the sustainability overview (Figure 20).

If you enter the “Your Watch” page, you can see a page at the bottom, where you have an overview of the sustainability of the watch. Is this something that you appreciate?

This question that deals with sustainability and transparency received mixed responses. Half of the users explained that this was unnecessary and irrelevant to them, while the other half explained that there is a heightened focus on sustainability these days, so the inclusion of this feature could satisfy their curiosity in a way, but it was not something that they felt was necessary. One user explained that this is something that they would brag about to others about, and maybe visit once themselves to become more informed, but that it served no purpose after that. This is the response that we expected based on the initial interview responses. There was little to no change between the theoretical and practical implications of this value.

Next, they were questioned about a page that deals with alerts and personal goals (Figure 25):

If you navigate to the “My Health” page, you’ll see that there is an option to set your own goals. If you set your own goals, you will receive notifications frequently to push you towards those goals, but if you do not set your own goals, you will not receive any notifications. Do you feel that setting your own goals would help you stay motivated? What do you think about the solution of not receiving notifications unless you set your own goals?

This is a feature that represents human welfare and control. Most of the users felt that this feature was a nice addition, as they like to be able to set their own goals. Some users said that they would not set their own goals, as they did not need reminders to walk or

work out. A few of the users said that they would set their goals if it was possible to adjust the frequency of alerts.

Then the users were guided to the workout overview, where they were asked:

If you navigate to the “Workout” page, you’ll see an overview of previous workouts you have completed with the watch. Does this provide you with the information you would like, and does it give you control? Or are there other apps you would rather use?

This question about a core function of the app represents control. Most of the users explained that it did feel like they were in control, but they mostly used Strava to track their progress. Their familiarity and dependence on Strava create a barrier for adoption of this feature. A user explained that integration of Strava in this app would make it more usable for them. Another user explained that this app would benefit from having anonymized competitions or competitions between friends. This would be a motivational factor for them, which would represent human welfare.

After discussing the workout page, they were guided through the settings of the app (Figure 9 & Figure 10).

Now you can navigate to the settings and access the security settings. You can see that there are a few things you can do on this page, but there is also a guide here that would give you a few tips on how to better protect your data. Is this something that you would access and read, or would you ignore it? Do you like the inclusion of such a guide?

This guide represents the values of security and transparency. The guide had not been created, so the users were asked if they were interested in accessing it. Some of the users said that they would ignore it, while others said that they appreciated having the option of becoming more aware. However, the users that said that they would ignore the security guide did not have anything against the inclusion of this feature. One notable comment from one of the users said that whether they would read it or not would depend on how the page was structured and formulated.

After exiting the security settings, they were asked about another feature in the settings, which was the “What we use the data for” page (Figure 14).

You can navigate through the different settings pages, and then lastly enter “Preferences”. Do you feel that there are enough settings here to feel in control over the app? And what do you think about an informational page about what we use the data for?

The settings represent privacy and control, while the “What we use the data for” page represents the value of transparency. Most users said that there was a sufficient amount of options to choose from. Some users elaborated and explained how they appreciated the simplicity of the settings, and that usually, they would have to dig through a lot of pages to find what they were looking for. In response to the “What we use the data for” page

they were mostly positive, with a few users being indifferent. The users wanted to know more about this and explained that an explanation of why data is collected, what data is collected, and how the data is being used could be a difference maker for whether they enabled data sharing or not. One of the users added that they always refuse to share data when prompted with this question, but this information could inform them and make them enable data sharing.

This was the end of the walkthrough, but they were then prompted with hypothetical questions that cover the value of trust.

Let's imagine that you are in a store, and the purpose of your visit is to buy a smartwatch. You see familiar brands like a Apple Watch, FitBit, Samsung Watch, and a Garmin watch, but you also see another watch that you have not heard of called AwareWatch. The watch has several certifications about security, privacy, and sustainability. Would these certifications affect your choice? Or would you choose what you have already heard of?

This question required the users to reflect on how they choose what to buy. Almost every user answered that the trust that they had already built with other brands would outweigh any certifications that AwareWatch could display. In this question, we could interpret that trust was very important to them as a value, but that certifications did not cause or affect that trust, rather that it was a continuous relationship with a brand that they had built over time. One user explained that they would choose this watch, but only after the walkthrough and not because of the certifications.

4.3.1.3 Suggestions for Improvement from the walkthrough

Through the walkthrough, the users suggested various features that would help elevate this prototype. The first suggestion that arose from a few users was the inclusion of a friend function. This would allow the users to compete with friends and view their progress. Along the same line, was the suggestion of integrating Strava into this app, which is what most users use to share their results with friends. Another suggestion, which would represent human welfare, is the inclusion of anonymized competitions. The user would have the option of seeing where they rank in terms of all users. The problem with this feature is that it could have the opposite effect of discouraging users if they rank among the bottom percentage. One user suggested having an optional competition that would display the top 10 users of the week in terms of distance walked, number of workouts, and other leaderboards.

When asked about the security guide and the “what we use the data for” page in the settings, they suggested that we make those pages, to show what they would include, as their interest was dependent on what those pages showed.

One user explained that the background lighting of the watch was essential, as people over 50 have trouble reading without it. This is a feature that cannot be implemented as

we do not have a physical model, but a concern that should be considered to represent the value of performance and reliability.

The last thing that was suggested related to the quick-access menu, was the option to decide what buttons are available there. As the demand of the users varies, the quick-access menu should also have the possibility of adapting to the user.

4.3.2 Iteration of the prototype

A key part of developing the prototype is to test it with users and use their feedback to iterate upon it. The suggestions that were mentioned in 4.3.1.3, were used to form a few points of improvement for the prototype. Figures 28-31 were all developed after the walkthrough, as these were suggestions given by the users. To improve the watch prototype, we used the suggestion about an adaptable quick-access menu. This page included a checklist where the user could enable and disable the buttons that they wanted in this menu. This option was placed in the preferences settings on the watch as shown in Figure 27.



Figure 27 : AwareWatch quick-access menu button



Figure 28 : AwareWatch edit quick-access menu

To improve the app, we used the suggestion by the users to develop two pages as shown in Figure 29 and Figure 30. The first page was “How the data is used”, which was created to explain which data is collected, how it is stored, and what the data is used for by AwareWatch. This would give the user a heightened sense of privacy, and more transparency about data collection. The second page for the app was the data security guide, which is a page that lists measures that the user can take to ensure that their information is safe. The inclusion of this page gives the user more control and awareness of their security, if they choose to read it, which will be tested in the third interview.

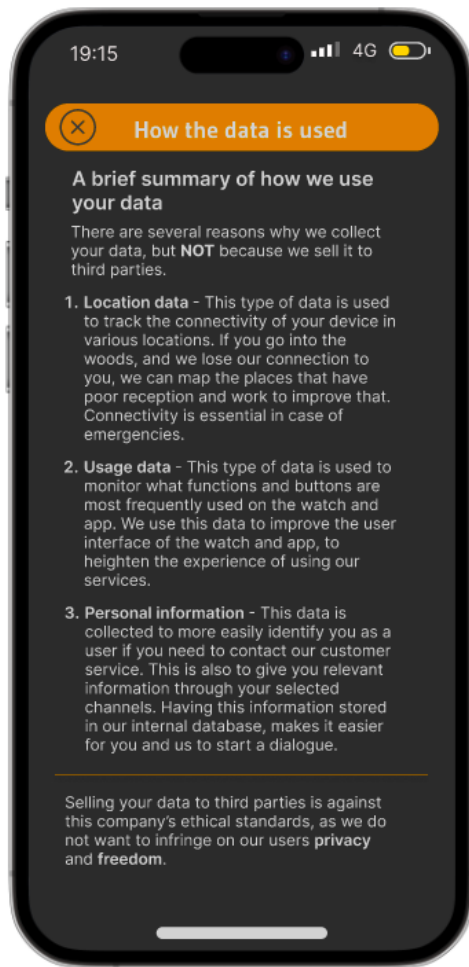


Figure 29 : App how the data is used

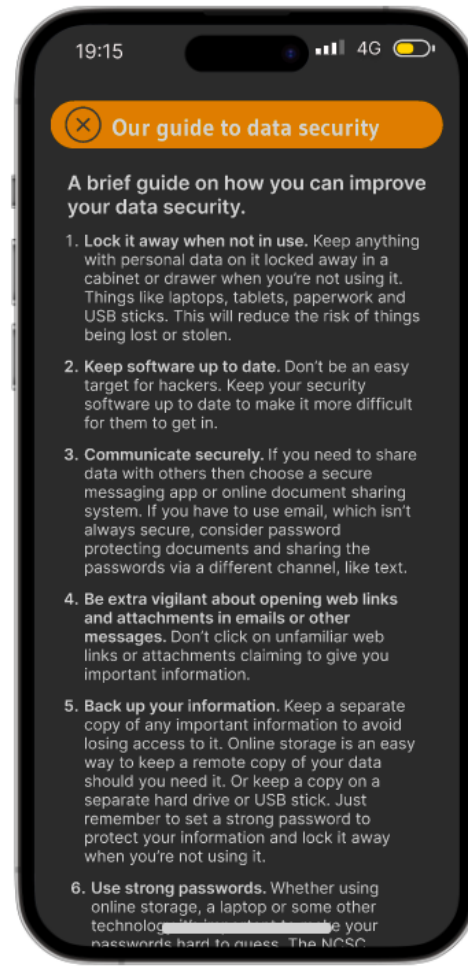


Figure 30 : App our guide to data security

4.3.3 Users' evaluation of the second version of the prototype - walkthrough

The third interview was the next and final step of the process, which existed to test the new iterated features. Ideally, there would be more iterations and tests with users, but due to the limited amount of time, this was the last round. Four of the users that were included in the first and second interviews were interviewed again. The first thing the users were asked about were Figure 27 and Figure 28.

Do you feel more in control of the smartwatch if you can control what is in the quick-access menu? Do you appreciate this feature?

The users responded positively to this feature. They said it was beneficial to choose what they preferred to have easily accessible. One user added that they would like to have a dark mode button on the menu and that it should be possible to have an alarm and a calculator available.

The next feature they were asked about was a page in the app called “What we use the data for” as shown in Figure 29.

Do you like having a page where you can see what your data is used for?

The responses were mixed to this page but mostly positive. Two users said that they would most likely not read it or only read it once, but they felt more secure by having this information easily available. The other two users found the information interesting and loved the inclusion of this page. One user explained how the transparency of what your data is used for makes people more aware of privacy concerns and makes the user feel safer with sharing their data.

Lastly, the users were asked about the security guide as shown in Figure 30.

Do you like the inclusion of a security guide? Does it make you feel more secure?

The users said that they think the page is a nice inclusion, but they would not be interested in reading it more than once. One user said:

“It’s a positive inclusion for those that need it and not a negative inclusion for those who don’t need it” (U20)

Another user said that this can make them feel safer, and it can also make people trust that the company wants people’s data to be secure. This feature, based on the responses from the users, supports transparency, security, and trust.

5 DISCUSSION

In this discussion chapter, we explore the values and considerations associated with the usage of smartwatches, as identified through three interview rounds and analysis and we discuss them against prior literature. By understanding these values and how they should be incorporated into a smartwatch, developers and designers can tailor the smartwatches to meet user expectations and needs. The following sections answer our two supporting research questions about what values are most important to users, and what features can be offered to promote a value-sensitive design.

5.1 Importance and perception of security in smartwatches

During both the interviews and analysis of the findings, it became evident that users' knowledge of and concerns about security in smartwatches vary. While more than half of the users did not believe that security was an important value, others did recognize its importance, especially when considering the sensitive data that can be on a smartwatch, such as location, health data, and payment details. This is aligned with prior literature that identified security issues related to wearable technologies (Ching & Mahinderjit Singh, 2016). Security became significantly more important for users when they began considering the potential exposure of personal information or when their smartwatches are used as a payment method. A recent study by Vhaduri et al. (2022), also pointed to the risks of exposing personal information gathered from health-tracking devices, such as a smartwatch which could pose a threat to the user. Our study highlights the importance of protecting sensitive information, alongside understanding users' perception of security in smartwatches.

In our prototype, we implemented security measures such as a lock screen with a PIN code, visual indication if the watch is locked or not, and password management and two-factor authentication in the app. With these features and the inclusion of a guide to data security, we aimed to raise user security awareness and make the users more considerate towards their own smartwatch security. Many users found these features unnecessary and even mentioned that they could be annoying, while others liked them and would use them.

Considering our research questions, the importance of security as a value for smartwatch users is significant. Users' diverse attitudes towards security need to be recognized, for developers and designers to tailor smartwatch features and options to meet users' expectations and needs. Additionally, providing users with information about the security

of the watch and how they can improve their security can help address misconceptions they may have and strengthen their perception of security.

5.2 Balancing privacy concerns in smartwatches

Through the first interview, we found that most users do not prioritize their privacy due to feeling like they have nothing to hide, whereas a few users preferred to have control over what data they shared. The key issue here is that users do not know what they are consenting to. There is a lack of transparency in the industry about what their data is used for and if it is shared with third parties. As mentioned in Krishna (2020), people think that privacy policies provide them with protections, when it has the opposite effect of giving companies uninformed consent to sell their information. We wanted to add a layer of transparency in the design of the prototype, which is why we included data-sharing settings (along with other settings) on the registration page, as well as a more detailed overview outside of the privacy policy to explain what the different types of data and information are used for. This is to counteract a method in the industry of employing dark patterns that mislead and manipulate users into making decisions against their best interest for the companies gain (Krishna, 2020). We found, through showing these features to the users in the walkthrough interview, that people were positive towards these inclusions. Most users stated that having access to these critical settings before registering gave the users more control over what they share. Often these settings would have to be adjusted after registering which was a burden for them. Another user stated that the overview of how the data is used can have a disarming effect on the issue of data sharing, which meant they would be more open to sharing data. A few users mentioned that these features in conjunction would heighten their trust in the company. This is an interesting find, as there was a discrepancy between what they answered in the first interview and their responses in the walkthrough interview, which meant that privacy was a more important value than we initially thought.

A key part of smartwatches is the information collected for the user. This biometric and positional data is collected for the user's benefit but also heightens the privacy risks for the user. In a study conducted by Kang and Jung in 2021, they identify three distinct groups of users that perceive privacy differently. One group perceived major benefits and major risks, another perceived major benefits without major risks (benefit-oriented group), and the last group includes users that are neutral to the benefits and risks (Kang & Jung, 2021). Kang and Jung (2021) found that the benefit-oriented group contained mostly males, that are highly educated and young. This is aligned with our findings as well, as the users that stated that they do not concern themselves with the value of privacy in smartwatches were mostly highly educated men.

5.3 Transparency's impact on user decision making

Transparency, as a value, was perceived as the least important among the users interviewed. Most of the users either lack interest or consideration regarding how their smartwatch uses their data and measures it. However, a few users highlighted the importance of accurate data readings and wanted to have control over how their data is utilized. The prototype had limited design requirements created due to the users' low emphasis on transparency, but we included a page where the users can access their previous workouts, given the users' overall focus on fitness activities. Additionally, as described in 5.2, options for and descriptions of data sharing in the smartwatch were implemented, serving both transparency and privacy concerns. Betzing et al. (2019) underlines that although EU GDPR gives users the right to all their personal data by law, the process of getting this data is often over-engineered. They also found that, when related to data sharing and collection, increasing transparency had little to no impact on consent decisions. This might suggest prejudice, that users are not impacted by increased privacy. But could also indicate that users are making more informed decisions, those who previously declined might be convinced to accept, or those who previously accepted feel more inclined to decline given the information.

While the value of transparency was less prioritized by users, it remains an important consideration to build user trust and enhance the user's ability to make informed decisions. This was highlighted by our study, as users became more positive towards the concept of transparency when they were shown the prototype. Considering this, with supporting literature from Betzing et al. (2019), transparency is much more important than we initially thought as it strengthens the user's awareness of their privacy, makes the user feel more in control of their data, and increases user trust.

5.4 Considerations of sustainability in smartwatch usage

Sustainability and eco-friendliness are becoming more relevant issues in the world, as people want the planet to become hospitable for future generations. In the first interview, the users were asked about their feelings toward the ethical practices of the industry and the carbon footprint of the producers of smartwatches. The responses from the users indicated that this value was not significantly important to them. A few users said that it would be nice to know that the watches were made sustainably, but it was not something that factored into the purchasing process. Despite the deprioritization of this value from the users, this needed to be tested with a visual representation in the prototype, which was done with an informational page that displays how and where the watch was produced, and a function that tracks how much carbon emission was released by shipping the product and the lifetime carbon emission by using the smartwatch. The responses to this page were consistent with the responses given in the first interview. Most users said they had

no interest in this function, and a few users said that they would visit this page once and forget about it. We can extract from this that sustainability is not a critical value for smartwatch users. Sustainability is an ethical issue, and even if the features that we implemented were not received well, ethical considerations should be taken into account when designing technology, to support societal norms by working with ethical specialists and the users themselves (Shilton & Anderson, 2017). There is prior experience with technology designs that explicitly promote sustainability values such as the mobile phone Fairphone (van de Poel, 2021) which has been quite successful in the market, and this is something that can be also transferred to smartwatch design.

5.5 Performance and reliability as the primary value

Performance and reliability are key values that influence the users' satisfaction and overall experience when using their smartwatches. In this study, this value emerged as the most important one for the users.

Being able to utilize the smartwatch's full functionality was brought up as a challenge by some users. There seems to be a lack of awareness or understanding of all the features that are packed into a smartwatch, which can result in underutilization. For the users to familiarize themselves with the smartwatch should not be a hassle or overly time-consuming task. The smartwatch should help to users in maximize the potential of their smartwatches intuitively and interactively.

Battery time was frequently brought up by the users as a crucial factor in how usable the smartwatch is. Many users struggled to even have enough battery to last a whole day. For users to be able to utilize their smartwatches how they want the battery usage needs to be optimized. Providing users with an overview of battery usage enhances transparency and makes the users able to efficiently manage their battery consumption, seeing what functionality of the watch uses the most battery. This, alongside an easily accessible eco-mode, could lead to users experiencing longer battery life in their smartwatches.

The users perceived performance relates to how well the smartwatch's performance meets their expectations. What users expect of their smartwatches varies. User experience, ease of use, and user-specific needs all influence perceived performance and reliability. Actual and perceived performance can be enhanced by improvements made based on user feedback. The reliability of the data was not tested in this study, as it did not have any usable functions, but Maathuis et al. (2020) highlighted that through testing the data given, the reliability and trustworthiness of the system can be heightened, showing a link between the values of transparency, trust, and reliability.

5.6 The significance of control in smartwatch usage

Having control over your smartwatch is crucial, and through the first interview, we discovered that the user group considers control important. One user said that they always feel in control, which is why they do not consider it important. The value of control needed sufficient representation in our prototypes to fulfill the user requirements. The first control-oriented feature that was created for the smartwatch was a quick-access menu which gave the user easily accessible options to enable or disable, which initially included a Bluetooth button, a mute button, a geolocation button, an eco-power button, a brightness button, and a lock button. The users were positive about this inclusion, but through the walkthrough interview, it became clear that different users have different needs, which led us to further develop this function into a customizable quick-access menu. In this second iteration, the user could choose which functions to have accessible in the menu, depending on what they needed to access frequently. In the third interview, they were shown this feature and were positive towards this inclusion.

The users were divided when it came to physical buttons, where some felt less in control when they had physical buttons, and others felt the buttons are prone to be accidentally pressed during workouts. Because the prototypes were developed in a web-based program, physical buttons could not be represented, but they were included in the scenario. The users were positive towards the physical buttons, and some users also wanted a physical switch on the side to turn off notifications, as this heightened their sense of control. The inclusion of physical buttons gives users more options to control their watch, which some users are less likely to use, but others can draw benefits from.

Another feature in the app which represents control is the redundancy of asking “Are you sure?” when stopping a workout. This was made in response to a control issue that a user was having where workouts would occasionally be stopped accidentally. When the users were questioned about this solution, they were either indifferent or negative towards it and wanted an option to disable this feature. This inclusion did not have a positive impact on the user, which is why different solutions are required to solve this issue. This shows that an increase in control can limit accessibility and ease of use, which can cause a value tension with human welfare.

A feature that has been mentioned in terms of transparency and privacy is the inclusion of settings before registration. The walkthrough interview showed that users were positive towards this and that it gives them more control and awareness. The ability to customize their experience before signing up makes them feel more secure in the app they are using.

Users value control highly, but they have differences in how they perceive control in a smartwatch. Customizing the smartwatch is a beneficial addition to heightening their experience of control, both in terms of software and hardware.

5.7 Trust in smartwatch brands and certifications

Trust is a crucial value that influences users' perception and adoption of smartwatches. Being able to trust the smartwatch was important for users, but not in the way presented in the questions.

It became clear that certifications are not important for most of the users, and that brand trust is what is important for them. The reputation of the brand, alongside other users' recommendations, was primarily what made them choose their smartwatch. While certifications could be a differentiator in some cases, users rely more on brand trust and user experience when going through a purchasing process.

When studying the value of transparency, it became apparent that it plays a role in building customer trust, which is also supported by Chen et al. (2022). Transparency regarding data collection, usage, and sharing enhances user trust. As discussed in 5.2; transparency can have a disarming effect on the user, building trust, and making it more likely for the users to accept data sharing. As mentioned in 5.1, the inclusion of a security guide was also beneficial for increasing the trust in the brand, as it showed good intentions from the company.

5.8 The impact of human welfare in smartwatches

To represent human welfare in technology is no easy task, as people become motivated and happy by different means. Through the first interview, we found that human welfare in smartwatches is important for some users, whereas others see the smartwatch merely as a tool. Since most users said that they exclusively use the smartwatch for training and tracking their progress, the most obvious representation of human welfare in a smartwatch is motivation. Alerts, positive feedback, and displays of progress are different features that can help motivate users to achieve their goals. A feature that was included in the app prototype was the possibility of setting their goals. By setting their goals they would get occasional alerts to push them towards those goals. If the user did not set any goals, they would not get any reminders or alerts that pushed them towards activities. The reasoning behind this is the responses from the first interview, where the most active users saw alerts as a nuisance, and others appreciated reminders to be more active. This solution will allow users to customize their experience to have their desired level of motivation from the watch and app. When the users were shown this in the walkthrough, they were positive or indifferent, as the users that need motivation will get it. However, some users said that it would be a nice addition to adjust the frequency of alerts, as some users want to have this function active, but do not need alerts to motivate them. We can say that human welfare is an important value for smartwatches, with the most important part being the possibility of customizing parts of the smartwatch and app.

A suggestion we received through the walkthrough interview to make users more motivated was the inclusion of competitions. One competition would be anonymized, where you could enter, and it would show how well you had done in comparison to other users during a week or a month. Another competition, which was also voluntary, was a top 10 ranking, where the most active users would be displayed on a leaderboard. We believe that this would motivate the most active users, however, could demotivate and alienate the users that did not perform as well. Therefore, we cannot decisively say if this is a positive or negative feature as more research is needed since the risk of demotivating users is too high, and therefore the competitions were not included in the design.

5.9 Implications for research and practice

The findings of this study have significant implications for both research and practice in the field of smartwatch technology. It is important that researchers and practitioners understand these implications for them to be able to build upon existing knowledge and utilize the insights gained by this study to push research further and elevate user experiences. Throughout this study's lifecycle, we have found several implications, and in this section, we will discuss these.

The varying perceptions of security and varying needs and preferences regarding privacy indicate that user-centric design principles should be prioritized. Doing this would help align the smartwatch with the user, as well as make them more aware of the importance security and privacy has. Alongside this, transparency around data sharing, usage, and collection has the potential for significant positive effects, while not initially valued by users in this study, it can help build trust with the users and make them feel more in control of their smartwatch and their privacy. A running theme we found throughout the data collection process was that many of the users had a lack of awareness and knowledge regarding their own smartwatch. The smartwatches and associated apps should provide users with information about privacy and security. By educating users about potential risks and strengthening their awareness they will be better suited to make informed decisions.

As for performance, there is a need for increased focus on optimizing battery life to meet user expectations and make them able to use the functionality they want. Most users complain about short battery time for their smartwatches, which makes them charge multiple times per day. Alleviating this barrier for adoption can have positive effects on the users.

To encourage users to be environmentally conscious, sustainability features can be incorporated as well as providing information about the production of the smartwatch. However, these features need to be different from the way our prototype incorporated them, since we received negative and indifferent feedback on this feature.

The accessibility of our smartwatch prototype was well received by the users, customizable features, and interfaces, such as the quick-access menu and physical buttons should be added to smartwatches to enhance user control and satisfaction.

5.10 Limitations and future work

In this section, we outline the limitations of this study as well as what should be researched further.

The people that interact with the technology are considered direct stakeholders, and those who can be impacted by the technology without interacting with it are indirect stakeholders, and in VSD, both of these groups must be accounted for in the design process (Umbrello, 2018), which makes it a more ethically grounded approach (Friedman et al., 2013). This paper could not cover all the direct and indirect stakeholders, due to time and resource restrictions. This can be considered a limitation of this work, but also an opportunity for future work, expanding the study to cover the perspectives of diverse stakeholders including technology companies and investors. Another limitation of the study is that in the prototyping rounds, we were not able to include a high-fidelity prototype on an actual smartwatch. This would have helped users to test the suggested design in a more natural way. This was not possible, as developing a physical prototype would require a significant investment in both time and money and was considered beyond the scope of this master thesis.

VSD also heavily relies on the perspective of the interviewees, which ultimately is subjective and is influenced by their individual experiences and biases. It is crucial to think critically about what values the users in this study find important. What a user finds important is influenced by a variety of factors, including but not limited to: time, context, and personal preference. What seems to have been much less recognized in VSD is that values themselves may be subject to change during the lifetime of a product as pointed out by van de Poel (2021). It is possible to distinguish between value changes that primarily occur due to social developments and value changes that are induced by technology (van de Poel, 2021) and this research aims to contribute to inducing some positive value changes by raising awareness through technology. Prior research has also shown that it is important to find ways to empower users and at the same time orient and sensitize them, striking a balance between dynamic/adaptive and static/predefined options in the user interfaces (Vassilakopoulou et al., 2019). This is an interesting area for further research.

Although Friedman et al. (2013) and Umbrello (2019) highlighted human welfare and control as important values in VSD, we found little to no supporting literature in the context of smart devices. This study is reliant on our opinions and reflections on how and what should be implemented, which can be affected by our biases. How the values are represented in our features can be poor representations, which in turn can make the user

undervalue the importance of the value. We have aimed to mitigate this risk by performing several iterations with the users. We encourage other researchers to use our study as a basis for further research with diverse user groups to expand and potentially validate the insights from this work. Another key aspect of the technical investigation is to examine the value trade-offs that can occur in the solutions, as features cannot always support multiple values (Friedman et al., 2013). This is something we would have invested more time in if we had the opportunity. The investigation of tensions and trade-offs should be researched further.

While our prototype's transparency was positively received, its impact on user decision-making regarding data sharing remains unclear. Though transparency enables informed choices, we cannot determine if it will increase or decrease consent for data collection. Transparency may lead users to make more privacy-protective decisions due to better information, but it could also have little impact if other factors drive adoption and sharing behaviors. Further research is needed to understand how transparency shapes consent in the context of smartwatches, as Betzing et al. (2019) note.

6 CONCLUSION

This study employed the VSD framework to create a smartwatch prototype and companion app exploring ways to incorporate human values into design. This study provides a proof of concept for how Value Sensitive Design can incorporate users into the design process to support human values through design features. Communicating with users and testing prototypes revealed values, features, and solutions that better align smartwatch design with users' needs and wants. This VSD approach holds promise for developing more human-centered smartwatch technologies.

The findings of this study provide insight for research and practice. First, we identified in the literature values that are commonly listed as important (security, privacy, transparency, sustainability, performance and reliability, control, trust, and human welfare) and investigated their significance for smartwatch users identifying the ones that are perceived as most important for them. Secondly, we integrated the values identified within prototypes and assessed these designs with users. We refined the prototype designs using user feedback ending up with a proof of concept that can be adopted by the industry. Overall, the study shows a lack of knowledge about risks amongst users and how adding layers of transparency within technology can help users make more informed choices about their privacy and security. By focusing on the needs, perspectives, and priorities of smartwatch users themselves, this research provides design recommendations that are sensitive to values and consider user preferences. The findings from this study contribute to a growing area of research on smartwatches and wearable technologies. They offer researchers and industry practitioners key insights into the complex challenges posed by these increasingly ubiquitous devices. The recommendations provided can help guide future work that takes a human-centered view toward building smartwatch devices and related smartwatch management applications designed for both usefulness and human well-being.

7 REFERENCES

- Betzing, J., Tietz, M., Brocke, J. v., & Becker, J. (2019). The impact of transparency on mobile privacy decision making. *Electronic Markets*, 30. <https://doi.org/10.1007/s12525-019-00332-3>
- Blackmon, M., Polson, P., Kitajima, M., & Lewis, C. (2002). *Cognitive walkthrough for the Web* (Vol. 4). <https://doi.org/10.1145/503376.503459>
- Carr, M., & Verner, J. (1997). Prototyping and software development approaches. *Department of Information Systems, City University of Hong Kong, Hong Kong*, 319-338.
- Carter, P. (2007). Liberating usability testing. *Interactions*, 14, 18-22. <https://doi.org/10.1145/1229863.1229864>
- Chen, Z., Piao, J., Lan, X., Cao, H., Gao, C., Lu, Z., & Li, Y. (2022). Practitioners Versus Users: A Value-Sensitive Evaluation of Current Industrial Recommender System Design [Article]. *Proceedings of the ACM on Human-Computer Interaction*, 6(CSCW2), Article 533. <https://doi.org/10.1145/3555646>
- Ching, K., & Mahinderjit Singh, M. (2016). Wearable Technology Devices Security and Privacy Vulnerability Analysis. *International Journal of Network Security & Its Applications*, 8, 19-30. <https://doi.org/10.5121/ijnsa.2016.8302>
- Foster, K. R., & Torous, J. (2019). The opportunity and obstacles for smartwatches and wearable sensors. *IEEE pulse*, 10(1), 22-25.
- Friedman, B., Hendry, D. G., & Borning, A. (2017). A Survey of Value Sensitive Design Methods. *Foundations and Trends® in Human-Computer Interaction*, 11(2), 63-125. <https://doi.org/10.1561/11000000015>
- Friedman, B., Kahn, P. H., Borning, A., & Hultgren, A. (2013). Value Sensitive Design and Information Systems. In N. Doorn, D. Schuurbiens, I. van de Poel, & M. E. Gorman (Eds.), *Early engagement and new technologies: Opening up the laboratory* (pp. 55-95). Springer Netherlands. https://doi.org/10.1007/978-94-007-7844-3_4
- Harbers, M., & Neerinx, M. A. (2017). Value sensitive design of a virtual assistant for workload harmonization in teams [Article]. *Cognition, Technology and Work*, 19(2-3), 329-343. <https://doi.org/10.1007/s10111-017-0408-4>
- Kang, H., & Jung, E. H. (2021). The smart wearables-privacy paradox: A cluster analysis of smartwatch users. *Behaviour & Information Technology*, 40(16), 1755-1768. <https://doi.org/10.1080/0144929X.2020.1778787>
- Krishna, A. (2020). Privacy is a concern: An introduction to the dialogue on privacy.
- Kujala, S. (2003). User involvement: A review of the benefits and challenges. *Behaviour & Information Technology*, 22(1), 1-16. <https://doi.org/10.1080/01449290301782>
- MiT Technology Review Insights. (2023). The state of responsible technology. *MiT Technology Review*.
- Maathuis, I., Niezen, M., Buitenweg, D., Bongers, I. L., & van Nieuwenhuizen, C. (2020). Exploring Human Values in the Design of a Web-Based QoL-Instrument for People with Mental Health Problems: A Value Sensitive Design Approach [Article]. *Science and Engineering Ethics*, 26(2), 871-898. <https://doi.org/10.1007/s11948-019-00142-y>

- Shilton, K., & Anderson, S. (2017). Blended, not bossy: Ethics roles, responsibilities and expertise in design [Article]. *Interacting with Computers*, 29(1), 71-79. <https://doi.org/10.1093/iwc/iww002>
- Strikwerda, L., van Steenbergen, M., van Gorp, A., Timmers, C., & van Grondelle, J. (2022). The value sensitive design of a preventive health check app [Article]. *Ethics and Information Technology*, 24(3), Article 38. <https://doi.org/10.1007/s10676-022-09662-x>
- Suranto, B. (2015). Software prototypes: Enhancing the quality of requirements engineering process. 2015 International Symposium on Technology Management and Emerging Technologies (ISTMET),
- Umbrello, S. (2018). The moral psychology of value sensitive design: the methodological issues of moral intuitions for responsible innovation [Article]. *Journal of Responsible Innovation*, 5(2), 186-200. <https://doi.org/10.1080/23299460.2018.1457401>
- Umbrello, S. (2019). Beneficial Artificial Intelligence Coordination by Means of a Value Sensitive Design Approach. *Big Data and Cognitive Computing*, 3(1).
- van de Poel, I. (2021). Design for value change [Article]. *Ethics and Information Technology*, 23(1), 27-31. <https://doi.org/10.1007/s10676-018-9461-9>
- van den Hoven, J. (2017). Ethics for the Digital Age: Where Are the Moral Specs? Value Sensitive Design and Responsible Innovation. In.
- Vassilakopoulou, P., Grisot, M., & Aanestad, M. (2019). Between personal and common: the design of hybrid information spaces. *Computer Supported Cooperative Work (CSCW)*, 28, 1011-1038.
- Vassilakopoulou, P., Parmiggiani, E., Shollo, A., & Grisot, M. (2022). Responsible AI: Concepts, critical perspectives and an Information Systems research agenda. *Scandinavian Journal of Information Systems*, 34(2), 3.
- Vhaduri, S., Dibbo, S. V., & Chen, C. Y. (2022). Predicting A User's Demographic Identity from Leaked Samples of Health-Tracking Wearables and Understanding Associated Risks. 10th IEEE International Conference on Healthcare Informatics, ICHI 2022,
- Wang, I. (2017). Using Smartwatches to Improve Health and Wellness.