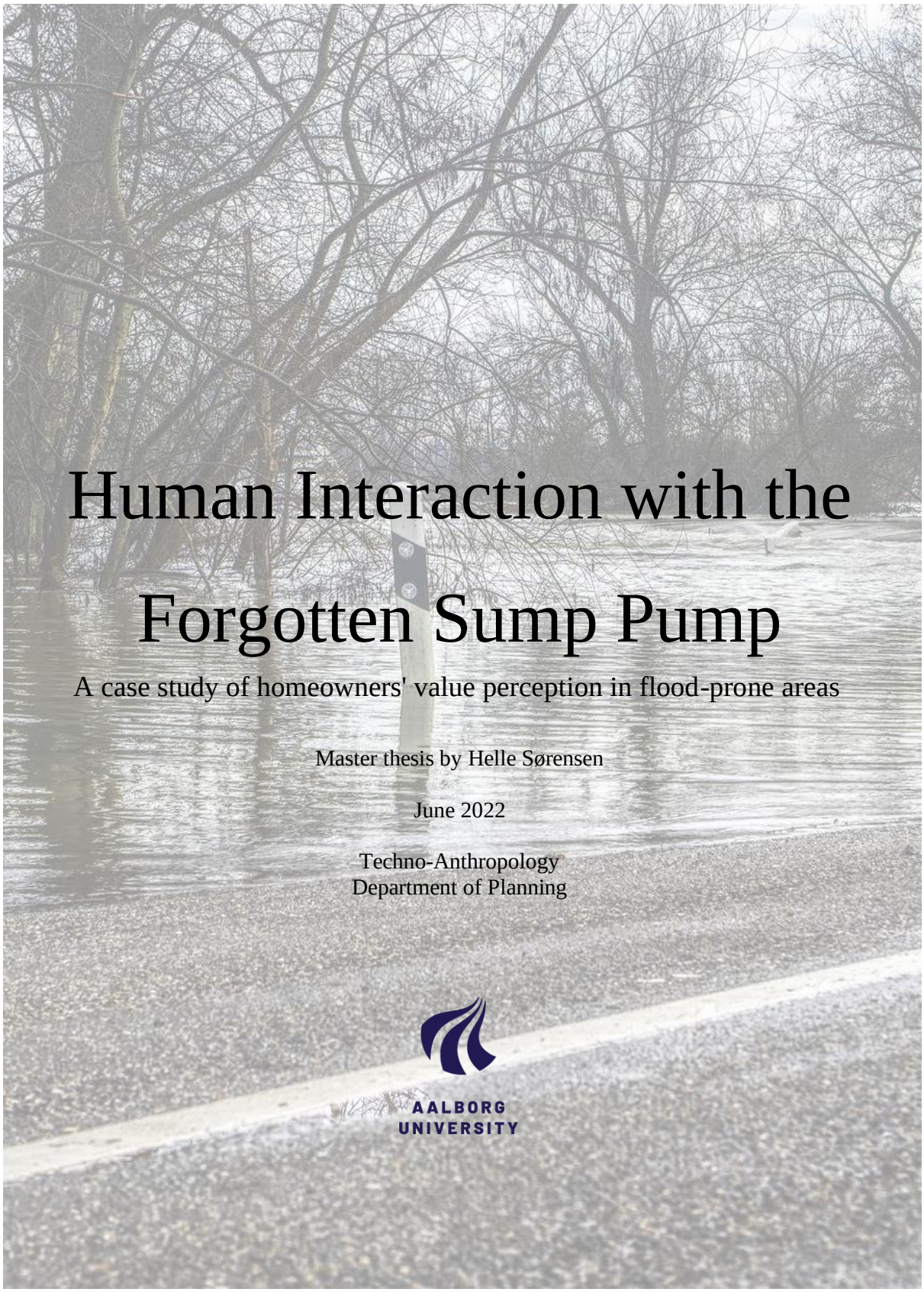

Human Interaction with the Forgotten Sump Pump

A case study of homeowners' value perception in flood-prone areas

Master thesis by Helle Sørensen

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By handing in this document, I confirm that I am responsible for the content of the report.

Table of Content

Abstract

The objective of this thesis and this report is to elucidate homeowners' challenges regarding flooding of houses in flood-prone areas in Denmark and bring forward ideas for technological solutions to address the challenges. Through an ethnographic study, I investigate, what is at stake for the individual and society. I unfold homeowners' values in this specific context through a Value Sensitive Design approach and identify desirable future solutions to accommodate homeowners' concerns, increase their ability to protect their own houses and reach a composed psychological state of mind. The idea for a software solution regarding homeowners' sump pumps was discussed amongst interviewees and with specifically selected values in mind, I investigate why homeowners prefer some solutions as opposed to others. I collaborated with a pump manufacturer on this project, and I have investigated how Value Sensitive Design can have a positive effect on their business opportunities by validating homeowners' desire for a solution that includes a subscription model for service and maintenance of the sump pump. Through this validation, the study has contributed to the further expansion of the idea in the company. I argue that using a techno-anthropological angle enhances the creativity amongst technical developers, due to in-depth insights concerning homeowners' values and their reasons for emphasising some values over others, combined with the diversity these insights brought into the discussions in the collaborative project group.

Introduction

In recent years, climate change has become a part of the public agenda with increasing awareness of the consequences it has on humans in different contexts. Climate changes affect all of us, rising sea levels, increasing temperatures, droughts, and rainfalls and humans are affected in different ways in different areas. In flood-prone areas, the consequences of the increased heavy rainfalls contribute to homeowners' concerns about protecting their property. I will draw a picture of the problem concerning homeowners' challenges, and the way they are affected psychological and investigate viable solutions to accommodate these challenges.

For this project, I have collaborated with a pump manufacturer with remarkable experience in producing pumps of high quality. As the development in this field has expanded, and it becomes increasingly challenging to produce pumps of better quality than the competitors and simultaneously keep the expenditure low, there is a significant incentive for the company to move into new business areas and start thinking beyond the pumps. One issue for the homeowners is their dependency on a reliable sump pump to insure dry houses and because these pumps only run when necessary, the homeowners must trust the system to start as required, and this is not always the case. In our society today, we get all kinds of information through digital solutions like smartphone applications. I will investigate how a remote monitoring and controlling device for the sump pumps could be integrated, what it should consist of and how homeowners would value a solution of this kind.

To gather insights from homeowners, I adopted traditional ethnographic methods such as interviews and observations. As this is a case study conducted in a Danish context, I interviewed homeowners in different areas of the country, with different occupational backgrounds, and ages ranging from late teenagers to people with several years of experience as retired. I will take a Value Sensitive Design approach and conduct a conceptual investigation to explore the market and define relevant human values to consider. These values will be a core point in interviews and discussions and have considerable awareness throughout the project. An empirical investigation will be conducted through interviews, participation in meetings and workshops to grasp the deepest understanding of homeowners' concerns and incentives. The technological investigation is done as a discussion of the possible solutions, by taking the departure in a flyer produced for this purpose.

I will analyse the homeowners' responses, their feedback, and their perception of the proposed solution. Throughout the project, I have shared information and discussed findings with the engaged engineers from the company, and by combining insights about homeowners with these discussions, I will recommend how to move ahead with the development of the solution.

Problem Analysis

Water as a Necessity

We all need water!

Few people will argue this statement. Life as we know it would not exist without water. Almost every species on this planet depends on it for its survival, and our ecosystem functions correctly because of it. Water has the ability to make its way through even the smallest cracks, it can even diffuse through concrete and other barriers. Throughout history, a great deal of effort has been devoted to managing water, diverting it into and away from public areas, homes, or fields. In the meantime, there are a lot of different opinions and methods of how we preserve and protect the wells and other sources of water to maintain this access to water.

Humankind needs water as a resource, so diverting wastewater, and drainage water away from houses and from wells, which we use to provide clean water, is also essential. This is to protect houses from flooding and the damages flooding events entail, and to protect the groundwater from being polluted. Still, people are fascinated by water in numerous ways, and they are drawn to it, many people find it relaxing to look at the sea, a leak or listen to the sound of flowing water.

In 2020 the number of water damages to buildings due to flooding was more than a hundred thousand and increased by approximately 10 % compared to 2019, so many people have suffered from these incidents and will continuously suffer in the future. A malfunction of a pump needs immediate attention during heavy rainfall and can be difficult to approach due to the location of the pump, as shown below:

(Private photo of sump pump installation)

This is not a place where most people want to spend time during a storm or other critical weather conditions.

Living by the Water - Pros and Cons

Many people find it relaxing and beautiful to be near water, and to live by or have a view of water has been a costly affair for many years. I visited a family who has been living close by the river for 35 years and still loves it. They have the river flooding by less than a hundred meter from the house. They elaborate on how the water level has risen over the years, resulting in some vegetation dying out in the garden and soil being like a swamp in the winter and very dry in the summer. But they have never experienced flooding of more than just a bit of the lawn and are not especially worried about it. There is a little extra work by keeping the lawn nice and useful, but nothing out of the ordinary.

And just a couple of hundred meters further down the street lives a more troubled family. Here drainage of the garden, draining around the house and pumps in various places are some of their everyday concerns. Sometimes just listening to the pumps starting in the night can bring some ease to the mind, a kind of insurance of keeping the water away from the house. In the garage, several backup pumps are stored in case of pump failure.

(Private photo)

Visiting another average family living by the lake and river only thirty km away also brings a troublesome story forward. They bought the house sixteen years ago in 2006, and at that time the house had been lightly flooded some twenty years ago, and only on one occasion. So, they knew that there was a minor risk of flooding already when moving in, but it did not occur to them that they soon would experience sleepless nights due to worries about whether their house would be flooded or not. They entered their house in June when everything was green and beautiful, but the first flooding experience of many followed that winter. As time has passed, they have experienced several serious flooding events. They soon realised that they had to take radical actions if their house and belongings should be preserved. All actions taken are paid for by themselves, and it has been quite an expenditure. Over the years, they have invested in a wall surrounding their property, including the courtyard and terrace. They have added numerous new layers to the soil, constructed wells and invested in more than a few pumps.

(Private photo)

At the premises, the raising level of the lake and the river are not the only concern, the level of the groundwater has risen more than sufficient, and by now it is just below the surface. This high level of groundwater has resulted in slightly humid walls inside the house. Only because they clean the walls now and then with disinfecting soap, they can keep the house free from mould and avoid the health risks connected to this. But there is a lot of work and different concerns linked to these circumstances. During the last flooding event, occurring last winter, the water level was so high that the wall they had built was not enough anymore, they had to add more layers by adding sandbags to the wall.

(Private photo)

The story elaborated to me was about the concerns of being able to stop the water in time. The Danish Emergency Management Agency and the municipality are obligated to help citizens with these problems, but the help is always late, so homeowners need to act themselves. They elaborated on how the neighbours immediately came to help to fill the sandbags and do the hard work. They had dug wells to place pumps in, to pump the water to the other side of the barrier constructed of the wall and extra sandbags, and the pumps needed to be functioning correctly. The pumps are submersible pumps of different sizes and placed appropriate according to size and the amount of water required to be pumped away. Every night, they would go outside to check on the pumps every other hour, still with the apprehension of stepping out in water when stepping out of bed. This anxiety of flooding and constant

awareness is quite a psychological load to carry, and there is a high risk of being stressed out and coming down with a psychological illness. To ease some concerns, they have constant surveillance of available data for the weather forecast, raising groundwater and torrent.
Another consequence of the rising water level is that the vegetation by the waterfront and in the affected gardens are constantly below water, resulting in decay of the root, trees dying and the problem escalating since the number of trees consuming water decreases.

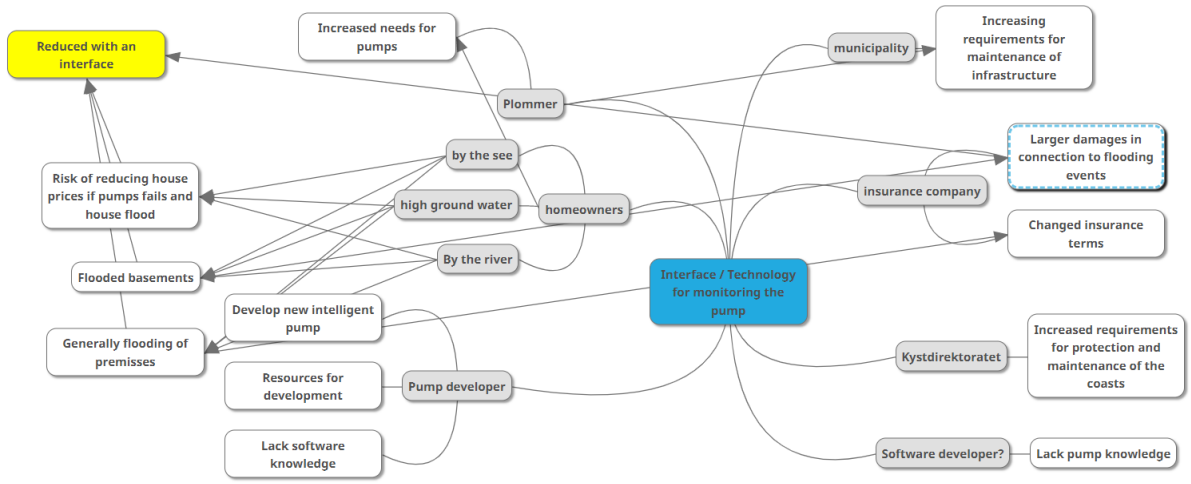
Groundwater and Climate Change

Over the last few decades, we have experienced more heavy rainfall than usual, the rainfall has increased by 10 cm over the last 150 years and is now increasing by 1.5 mm each year. This might seem like a small amount of water, but when it is all over the ground it will amount to quite a bit and contribute to the rising level of groundwater (GEUS, 2019). The sea level has risen on average 2 mm each year for the last century, and the forecast predicts an increasing level of up to 103 cm in the year 2100, and when a torrent hit, special exposed areas will suffer from a water level of up to 510 cm above normal water level (Langen et al., 2020).
The rising groundwater level and the increased number of flooding events due to climate changes indicate the growing relevance of looking into the topic, and it has increased the debate about how to preserve our streams, dikes, and locks. An example of this interest is the C5a-project by the European Union, where the focus is to investigate the challenges in 7 different cases of the North Sea Region (European Union, 2022), Ringkjøbing Fjord being one of them. In the project, all the challenges are investigated, from when the rain falls to when the water ends up in the sea, called cloud to coast (C2C). In this project, they are collecting data from various stakeholders, using a holistic view. As part of this effort, a citizen's meeting was conducted where homeowners discussed their concerns and elaborated these concerns to the project managers of the C5a project. Denmark has segregated its sewer systems, so rainwater and drainage water from private houses must not enter the sewer system. If rainwater is no longer able to get into the pipes, then the soil will have to absorb more surface water, increasing the need for drainage systems to work correctly. The citizens of the municipality of Ringkjøbing-Skjern had several concerns for their properties in the future. Some were concerned about how to get rid of the water from the fjord since the lock towards the sea nearby only can release water if the level inside the fjord is below sea level. Other concerns were the damages to the roads and houses building up over time when the water only is removed slowly, and the surface is constantly packed with water. Yet other concerns were how the implementation of sewer systems in different areas is delayed, causing problems because of the rising level of the groundwater.
Regarding the rising level of the groundwater, themes of climate change, rising temperature and the geological composition of the soil need to be taken into consideration (GUES, 2019). Where the rising temperature will prevent the air from absorbing the same amount of water as previously, it also

contributes to the rising level of the seas due to the melting of ice, and hard layers in the soil, like clay, make the water infiltrate the soil slower. Both the municipality and the homeowners can take significant actions toward containing the water and moving water to areas where it is not causing any damage. Since December 2000 Denmark has been obligated to protect and maintain the water ecosystems according to the European Water Policy simultaneously by considering the environmental and human impacts and generally making sustainable choices (European Union, 2000).

Mind Mapping Stakeholders with a SCOT approach

Entering this huge and complex knowledge field, it is interesting to identify the stakeholders affected by climate change, legislation, and technological development. When using the approach of Social Construction of Technology (SCOT), the reality is real because we give it a reality through social agreement, and we have the flexibility to make individual interpretations and impact the outcome through intergroup negotiation (Klein & Kleinman, 2002). We identify the relevant social groups and describe their problems and possible solutions. By doing this, I imagine who can be affected by the development of a monitoring solution for sump pumps. The issue needs closure, it must stabilise in consensus and acceptance of all groups. At last, we need to see how it impacts the wider context, to go into the world and consider who will benefit from this development, and how and by who it will be developed.



(Figure 1: SCOT map of relevant social groups, their problems, and possible solutions)

Accommodation of the Rising Problems and Concerns

In Denmark, the municipality also has the obligation to shape, prepare and maintain the public roads, parks, paths, and other public areas in a way that accommodates the rising challenges concerning climate changes (Transport-bygnings- og boligministeriet, 2014).

With projects like the C5a-project, combined with the actions which are taken by the municipalities according to the legislation, and the rising responsibility amongst the public, several projects have clarified some recommendable actions to take as a homeowner. And there are many things you as a homeowner can do to prevent your house from flooding. Likewise, the municipality needs to take their responsibility seriously and maintain streams according to current legislation.

Some actions could be an investigation of the soil to predict the best solutions, planting trees, establishing rain basins in gardens, collecting rainwater, and planting green roofs are all recommendable actions to be taken. In some cases, this is not enough, and the homeowners must pump away water from their estate, just as I witnessed in the above-mentioned cases. When the water comes in close to your home, a reliable system to keep it dry is essential to the homeowners.

As Grothmann and Reusswig from the Department of Global Change and Social Systems, Potsdam Institute for Climate Impact Research concluded in their article from 2006, simply informing people about the risks of flooding will not necessarily influence their behaviour towards taking responsibility for their own protection (Grothmann & Reusswig, 2006). They suggest that listing concrete applicable actions to the public is most likely to have an effect and that communication should address how effective and costly initiatives will be for people to see their possibilities. In the article, the approach taken is the Protection Motivation Theory, which is based on the two factors threat appraisal and coping appraisal. It is people's own perception of their risk of flooding and how they will be able to cope with it. Since the problem of flooding is increasing and extending to new areas, some homeowners will underestimate their risk of a flooding event.

Looking through the literature and in my initial talk with residents with flooding problems, I can see a knowledge gap in how we get people to acknowledge the rising problem of flooding and how we can enable them to prevent even small flooding events and hence damages to properties. Furthermore, people often respond positively when they can see the value of the effort, and this is a reason for looking into people's values to see what matters the most and try to accommodate it.

The Two Branches

Reflecting on my initial research, I realised this was a project with two branches. The branch I as a Techno-Anthropologist will investigate is obviously a solution involving a technological development prospect and an opportunity for interaction between humans and technology. The other branch is following the water and the threads the water pulls through legislation, moving all the way from European Parliament to the little city council committee in the individual municipality, leaving them with difficult legislation to interpret and hard choices to make on their own.
Following the first branch, I reached out to a pump manufacturer for a collaboration, hoping to benefit from their knowledge.

The Company in Collaboration

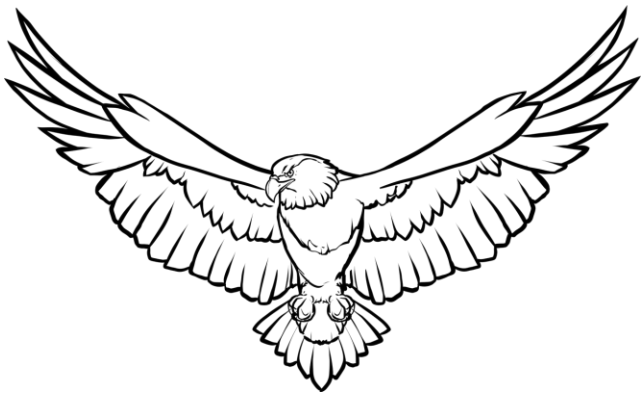
The company was founded by a blacksmith in 1945 and started as a small traditional blacksmith business. The development of the first product in the pump manufacturing business was due to a lack of supply of acceptable quality pumps. The company expanded heavily over the years and is today represented in more than sixty countries. In 1975 the founder and owner created a foundation and transferred his ownership to the foundation, to make sure that the company could serve the best interest of society in the future also. The foundation must ensure and support good economic standards for the company simultaneously with giving donations to philanthropic purposes. In 2020 194 million DKK was committed to philanthropic projects. The foundation is still the primary owner of the company, leaving a small part of stocks for employees and family. This allows the company to invest a larger part of the economic surplus in development, education, and innovation with a long-term perspective.
The company and the foundation have taken a strong responsibility to the world's poorest people and, in collaboration with NGOs, they help provide clean water worldwide. They also engage with research by supporting different projects within technical disciplines and natural science. By supporting initiatives meant to reduce the number of people on passive public benefit, the company likewise engage in social inclusion.
The revenue in 2020 was more than 26 billion DKK, and in the first six months of 2021, the revenue had increased considerably compared to 2020 and was more than 14 billion DKK. The company consists of both production, development, and education in several countries. In 2020 there were employed more than 19000 people and of them 4200 in Denmark. The development of useful tools for monitoring and controlling the pumps is a feasible opportunity because the company have the resources, skills, and knowledge within the current employee portfolio.

The Innovation Group in the Company, “The Bird”

The group I relate to and my access to the company is a small project group. I will call it “The Bird” for it to remain anonymous. The Bird is an innovation group, and I gained access to the group through a hackathon in which I participated last summer. A hackathon is an intensive work event for either system or concept development, usually starting with a description of the premises and the challenge followed by a compressed work process by the participants to generate ideas, prototypes, or concepts for further development.

The Bird was founded in 2019 and consists of a core of four engineers with different working experiences and educational backgrounds, to bring diversity to the group. There is an engineer with much experience from a completely different manufacturing field operating as the project manager. Furthermore, one has studied nanoscience and completed a PhD in laser physics, and another is a former electrician, now an engineer with experience in control and constructing algorithms. At last, there is a highly experienced engineer also with roots in physics and a specialist within tribology. For the purpose to give even more diversity to the group, relevant personnel from other development departments are recruited for specific tasks, workshops, or innovation discussions from time to time.

The company engage in agile processes and the Bird engages in front-end innovation, digging into which problems are worth the effort solving, thinking beyond the core technology, being creative and doing research on promising concepts or technologies, from here on the ideas generated within the Bird are pushed into the organisation for further development. In the process of being creative, the diversity of the group plays an important part in bringing different angles to the developed ideas. The Purpose of this group, existing in an organisation of a large, old, and well-founded pump manufacturer, is to develop ideas of not alone new technology like a new pump but developing the core beyond the pump. It is an opportunity to create ideas for new business opportunities, either by combining existing technologies in new ways or by creating ideas for technologies supporting the pump.



Problem Statement

The issues about climate change causing rising temperatures, severe storms, and a higher level of water all around the world will not be solved overnight, if ever. Homeowners all over the world are experiencing increased flooding and at the same time, it can be breath taken how fast development in digital solutions goes. I find it relevant to investigate how we can develop a digital solution to support homeowners in their battle to protect their houses. Regarding what type of solution is needed, whether it is monitoring for homeowners' own use, controlling pumps remotely or it is by delegating the assignments to a third party, I will work on discovering by posing the following problem statement:

> *How can we increase homeowners' ability to prevent flooding events?*

The following research question will answer this:

> *Which values are most important to homeowners when having flooding events in mind, and why?*
> *What kind of values must be built into a technological solution to enable homeowners to interact with it and bring them peace of mind?*

To address this question, I perform interviews with people affected by issues of rising water levels and flooding risks, either as a private person or on a professional level. Likewise, I will include a few homeowners who do not have these challenges…or at least not yet.

In my imagination, the solution will be a digital service, either as a newly developed or as an interface to an already existing digital solution as known in smart homes, apps, satellite, or web connections. The user of the solution can be different stakeholders like homeowners, plumbers, or public service management personnel. They might have different wishes for required features and have different opinions on which values are most relevant.

The purpose of this report will be to come up with ideas for requirements for the technical specifications for the solution. Likewise, to influence the design and development by grasping insights about homeowners' values through the approach of Value Sensitive Design.

Methods

What is at Stake?

In the initial research, I have identified several relevant groups of people affected by issues concerning water entering private homes and public spaces using a SCOT perspective. When using the SCOT perspective, there needs to be a negotiation to reach a consensus between the groups. Looking at the Pinch and Bijker articulation on the bicycle air tire, this closure was reached by redefining the problem (Klein & Kleinman, 2002). The vibration produced by the air tire was seen as a major difficulty to some groups, while others find them comfortable. In the meanwhile, when the competitive bicycle racers could reach a much higher speed, the initial problem with vibration evaporated (Klein & Kleinman, 2002). Today, we cannot imagine how a bicycle can function without air tires. As there is no existing technology to modify, the value in this research would be to identify the needs for a technology of this kind, and I have seen several situations where connectivity to pumps is relevant.
To justify relevant technological development, I use a Value Sensitive Design (VSD) approach to identify what is at stake and which human values are required to be taken into consideration and integrated into the technology.

Literature Review

During my initial research, I made some review of existing literature. I search in academic literature to see if the problem had been researched before, using “Google Scholar” and “Scopus”, since these databases are broad within the fields of both technical and social science. In this search, I found only a few articles of relevance.
I went on exploring the problem in a non-academic, but somehow expert world by using a simple google search. In this search, I found both environmental expert journals, pump- and software manufacturers' options and different homeowners associations.
Also, with support from employees in the Bird, and other departments, I looked into the existing market, both in the sump pump market and in the market of similar software technology, I had access to several market analyses performed by the company or data paid for by the company.

The review likewise consisted of a review of literature on the methodology of Value Sensitive Design. This was to investigate how different values previously had been conceptualised and considered in design processes.

Gaining Access to the Collaborative Company

As earlier described, my initial contact with The Bird was through the hackathon in which I participated. The progress of this hackathon was designed in steps, we were presented with different challenges, and in groups, we were to come up with an idea, describe it in problem analysis and problem solution, make a testable hypothesis, a business plan and through the process pitch the sub-ideas while getting and giving feedback on the ideas. It was a competition between the groups, and the hackathon ended with a pitch to the director of the innovation department and two professors from the university.

During the hackathon, I deliberately tried to be seated near some employees of The Bird and by this building rapport with these employees, just as it is described by Spradley (Spradley, 1979a). I did this because I hoped for future collaboration with this company on my master thesis. As Spradley describes the relationship moving from apprehension to more exploration, all of us had this journey at the beginning not knowing each other's competencies and just exploring our opportunities (Spradley, 1979a). As we spent several days working non-stop, we all got a better understanding of each other and again moved into a relationship where cooperation and participation on equal terms became possible. This was even strengthened by the fact that I live nearby and have an interest in the local area. Afterwards, I imposed upon the opportunity for them to remember me and my somewhat different academic direction and reached out to them to discuss a collaboration on my master thesis. And fortunately, they liked my idea of me joining their team. Throughout the fall, we had some discussions about what my task should be and how I should do a project of my interest while combining the knowledge the company owns and my academic learnings.

At the beginning of my entering the company to work on my master thesis, I participated in a 2-week workshop with nine participants. It was planned as an innovative workshop for pushing new ideas into the organisation of the company, as described earlier in this report.

Prior to the workshop, The Bird had set the scene for the workshop, and by initial describing why the challenges were interesting, everyone was brought up to speed. This included the technological descriptions, the frame that we were to play within, and the rules for the work done at the workshop. One of the rules was that we were all equal, so no one was more powerful than the others in a given discussion.

There were sketched three separate challenges for which the framework was presented, and starting with the first challenge, we should each come up with at least 3 ideas that we could see as relevant or desirable for this specific challenge. The ideas were clustered and afterwards, we should work in groups of either 2 or 4 participants and discuss and describe the ideas and kill the ones we did not like. Further on we discussed, made drawings of the ideas, and presented the work to the rest of the participants. Afterwards, new groups were made, and we looked into the ideas again. For all ideas and sub-ideas, there must be a testable hypothesis, a description of what the challenge or problem is, and a description of the solution. Likewise, we were obligated to consider the desirability, viability, and feasibility, where

the desirability is how much the solution is a desirable solution for customers and why. Viability is a matter of whether the company can develop and build the solution, and feasibility is looking into if the company should develop the solution or not. Throughout the workshop we as participants spent an enormous amount of time together, we were all staying at the same hotel, so we were together from breakfast to bedtime, and during this time we all got to know each other very well, enhancing the collaboration and common understanding. Afterwards, all the materials were sent to a designer to make them look nice and printed as a catalogue. This catalogue will support further discussions on the ideas widely in the organisation.

The workshop and the ideas generated herein all concerns sump pumps. Some ideas were more of a conceptual character, and it was supported by a lot of new technical ideas. The ideas spread from ideas on how to make a new kind of level sensor, to discussing various methods of connectivity. These ideas were all fresh in my mind when I talked with the homeowners and enabled me to imagine technologies and possible solutions or challenges in the situations.

Gaining Access to Stakeholders

My initial research had the departure in conversations with people I already knew and had easy access to, as I gathered that their issues are just as real as people with whom I am unfamiliar. Further on, to get in contact with other stakeholders, I both used my network of friends and former colleagues to get access to people who might talk to me. Also, I looked into areas with high levels of groundwater using "Dingeo" (DinGeo, 2022) and in some areas, I dumped notes into their letterboxes. In this way, I got in contact with three relevant informants. I discovered dumping descriptive notes in letterboxes was not the best way to establish contact, since only three responded, and I delivered more than twenty notes in letterboxes. Another approach was to join different Facebook groups, and both make posts in the groups and approach the people expressing relevant issues. Initial I made posts explaining my purpose and did not get any responses at all, so I changed my approach from descriptive posts to a simple post of *"Does anyone here has experience with sump pumps and drainage, please write me a private message"*. And then I got responses, from all around the country, people wanting to help, even someone offering me a free pump if I needed that. When I afterwards explained the purpose of my desire to talk to them, they were all helpful and agreed to an interview or put me in contact with other relevant persons, groups, or organisations. In this way, I got in contact with homeowners with issues of high groundwater, homeowners with the concern of flooding from streams and leaks, small private businesspeople, and technicians from a municipality. And even some people in associations surrounding the streams, in Danish, called an *"Ålaug"*. Furthermore, I discovered an interesting group where members were highly active, I will call it *"the landowner group",* and I will return to them at a later point.

I also tried without any success to contact several insurance companies, both by calling them up, writing to a specific person in the company and even asking when a Salesperson from one of the insurance companies called me up to sell insurance to me. In all cases, there was no luck, and I wondered if the

responses had been different if I had approached them as a representative from the Bird proposing a new business opportunity and not as a student? This is something I might investigate at a later point if I get the chance. Through my engagement with the Bird, I also got in contact with other engineers and business developers in other departments of the company.

Interview

The interview I have conducted have been of different types. As I started by talking to people I already knew and had easy access to, these were more friendly conversations. In these conversations, I interviewed people without them knowing (or at least taking notice of it), as Spradley argues often is the case (Spradley, 1979b). When talking to private homeowners and people from "Ålaug", I used descriptive ethnographic questions to get the conversation going and get people talking. In all situations, the explicit purpose of the interviews was always a conversation starter since they wanted to elaborate on their issues and concerns, and I wanted to gather knowledge about the issues and discover which values were the most important to them. When explaining my project and my idea for technological development, people expressed interest, and some even called it timely diligence. I used descriptive questions to encourage people to a wide elaboration on their situation and the concerns they have (Spradley, 1979a). Some interviews were conducted through the phone, some online and some in real life. It is my experience that interviewing over the phone takes more effort to keep the conversation going due to a lack of visibility, but fortunately, these people were eager to talk, so it was not a problem as long I was interested in both their concerns and them as human in general.

Each interview was prepared individually, since all informants had individual interests, and it gave me a chance to bring in issues that had come up during prior interviews.

As the project moved ahead, I realised that to come up with useful information to bring forward, I needed to get in contact with some of the earliest interviewees again. And I succeeded in most of the cases, only a few did not find the time to talk to me again.

During the conceptual investigation where I was discovering the challenges of the problem, I discovered a bunch of interesting stakeholders, some more accessible than others. I envisioned how this technology could be of major importance and provide meaning to all the stakeholders identified, still I focused on the homeowners, them being the most direct stakeholder. Due to the methodological challenges of gaining access to private plumbers and insurance companies, and the fact that introducing an idea for a new business model throughout the organisation, and to existing customers of the collaborative company can cause harm in their business relations, I kept my main investigations within the private homeowners. I also had some conversations and participated in meetings with employees at different municipalities and agencies, to grasp the challenges some homeowners elaborated on concerning the maintenance of streams.

Overall, I have conducted thirty-three interviews, with only a few not being relevant and participated in three meetings with municipal employees, project groups and associations, just like I participated in two different workshops concerning water management plans and flooding in a specific municipality in Denmark. All this amounts to a little more than twenty-five hours of audio files, a full book of notes and a nice gallery of pictures.
It was through the interviews, I discovered that one of the ideas from the workshop, a maintenance service, would be a good idea to combine with the monitoring solution.
At the time when I started to talk to people again, I used some user stories to get some concrete material for the conversations to be based upon.

User Stories

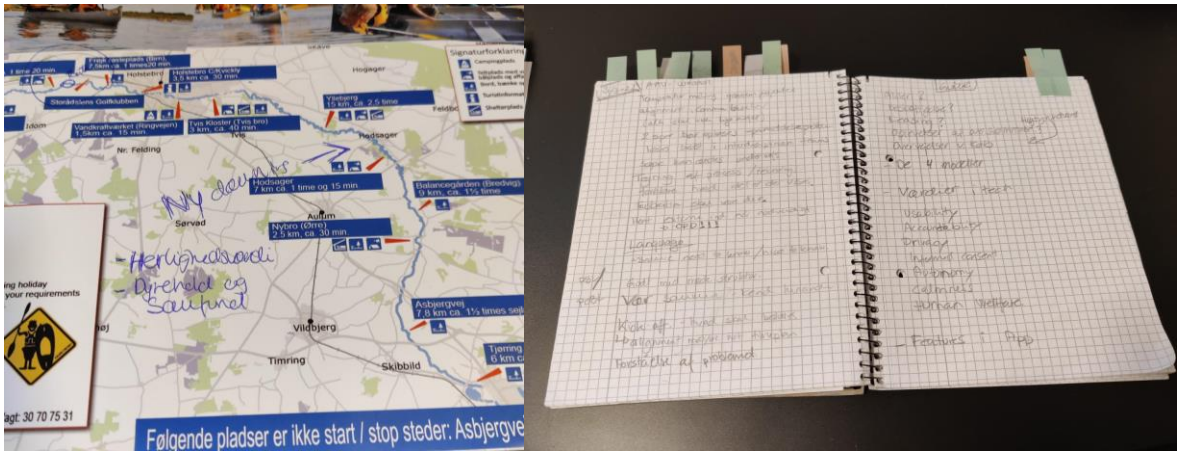
One of the members of the Bird has experience in software development, and it was during a conversation with him, that I gained knowledge about user stories. A user story is composed by making a short description of what the user would like the system to do for them. It is frequently used in software development and can provide you with specific knowledge of features or service levels. As Jeffries et al. describe it *"The user story is the medium of analysis - the medium of communication between the customer and the programmer"* (Jeffries, Hendrickson, Anderson, & Hendrickson, 2001). It enabled the communication to be concrete and when I wrote the user stories, the process of what the product could be, became clear and transparent to me. I created four different user stories for this purpose regarding the service solution in an "As a…. I want… so that…."- way:

- As a homeowner, I want a notification so that I can act in time before flooding becomes a problem.
- As a homeowner, I want a notification so that I know that the service manager is coming to fix the problem.
- As a homeowner, I want the service manager to call me to let me know he is coming so that I am informed about the situation.
- As a homeowner, I want a subscription solution where a service manager always keeps the pump and the sump healthy without me knowing so that I am not disturbed during the day with concerns about the sump pump.

Discussing the issues from this point, making it concrete, homeowners could easily relate the solutions and express their opinions on which solution would be the most relevant to them.

Fieldnotes

Trying to keep track of all findings, I kept notes of all interviews, just like most of the interviews were recorded. In some situations where taking notes complicated the conversation, I did it afterwards. And in some cases, I even made an audio file during the drive home, trying to avoid that I should forget an interesting thought. Furthermore, I took pictures where I was allowed to do so because I find pictures highly informative and good for jogging my memory, just as it is described by Emmerson, Fretz & Shaw (Emmerson, Fretz, & Shaw, 2011). Sometimes I use what was just available, like a commercial map:



(Private photo: map used for notes and descriptions in discussion with homeowner and notebook)

I regularly reviewed my notes to be sure I was headed in the right direction. In this situation, I also found my diary particularly useful.

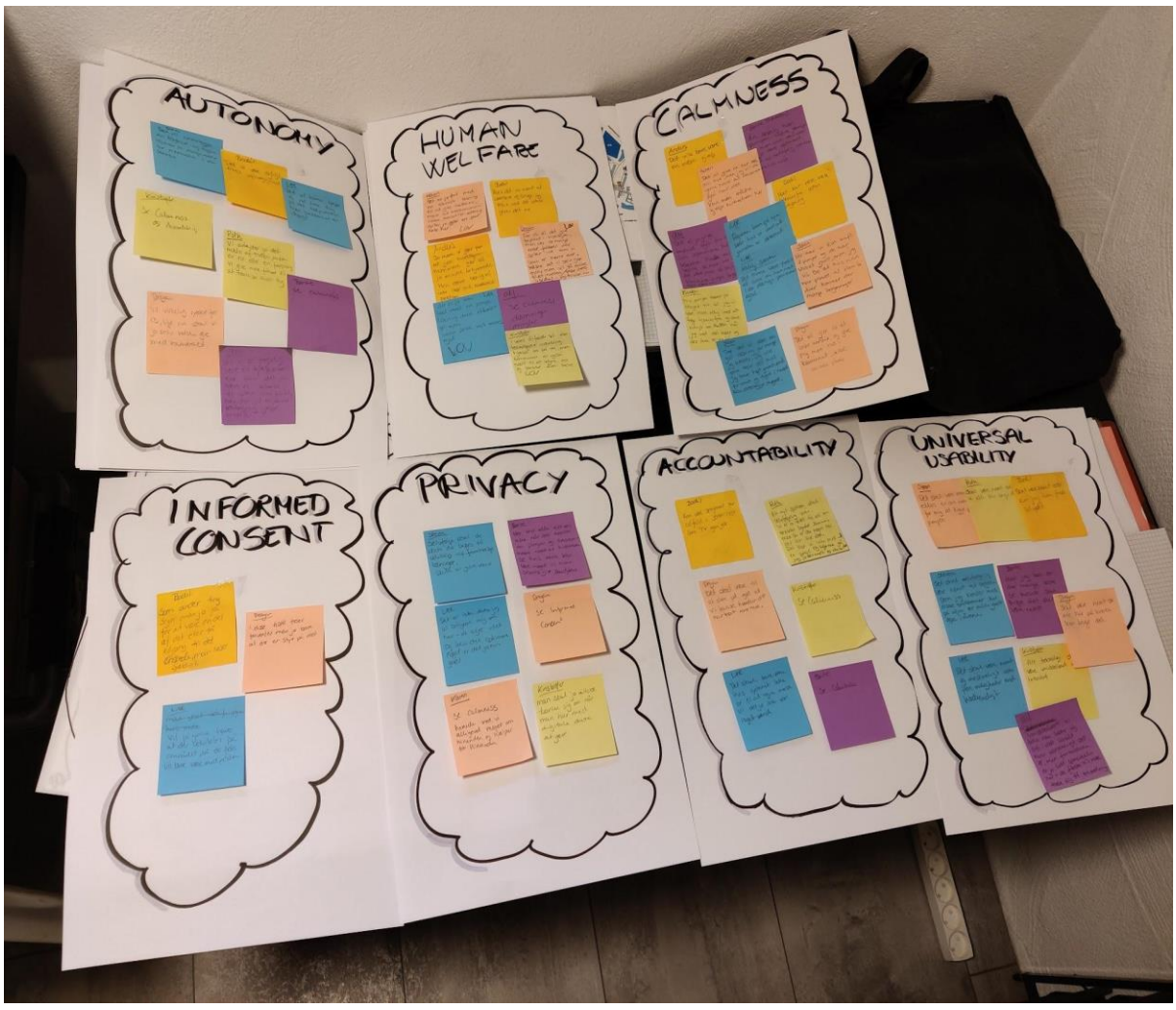
Transcription

When listening through my audio files, I transcribed relevant parts of them, allowing me to capture both the language and the tone of voice. In this situation, I defined relevant parts as parts with statements that can support expressed values, either by expressing concerns or ideas for development. In all situations, listening to the audio files made me remember the scene more precisely and capture the state of mind and feelings of the interviewee. The process of transcribing the audio files into a part of written text has the purpose of me being able to find the parts and cite them correctly as the interviewees' experience. For making the transcription easy to work with, I used the free transcription tool, https://otranscribe.com/ (Bentley, 2017). I find this tool nice because it rewinds a few seconds every time it is paused, and you can easily make timestamps.

The transcriptions are in Danish since all interviews were conducted as is. I believe it would have been awkward interviewing the homeowners in a foreign language and would have created a distance between us, which I worked hard on limiting. All citation is translated by me and will be attached as Appendix A.

Coding

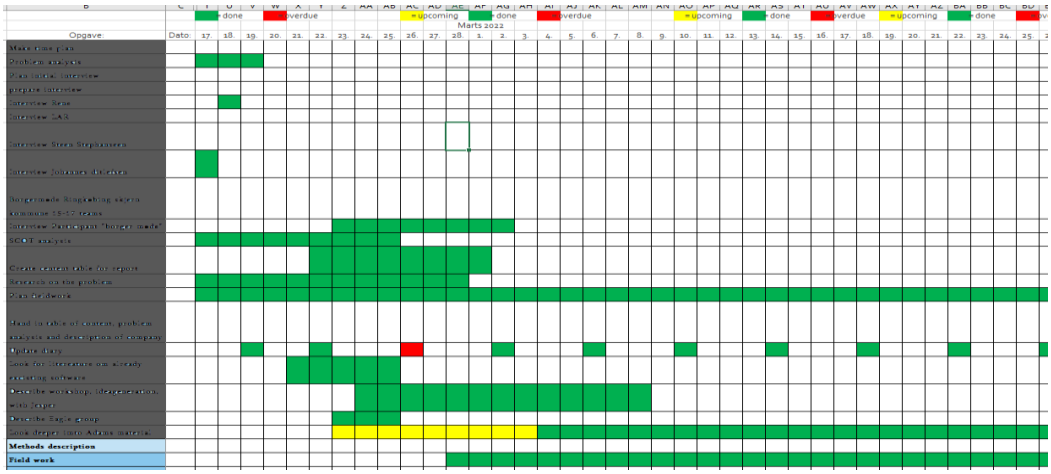
Through my initial research and talks with people, I started to get an overview of the relevant values to put into the technology and solution, and throughout the coding process, these values were in my mind. I will call this a value-driven coding frame, inspired Saldaña and the way he describes the hypothesis-driven coding process as a holistic view of your data and a method to grasp the basic themes in interviews with a predetermined aim of findings (Saldaña, 2014). In this way, I focused on the values and how the people expressed feeling about the different values, how they saw the values and if a specific value should be supported, or if it was not relevant. Using post-its with different colours, related to the different informants, gave me an overview of the number of statements concerning the different topics.



(The process of finding statements supporting the different values)

Planning

To get an overview of my work I have used a Gantt diagram, which I have reviewed regularly, and altered the plans according to my findings. Also, I have made short deadlines to keep on track for writing the report.



(Gantt diagram used for planning)

Expounding Stories

When I was interacting with potential users, I elaborated on some of the stories I came across to others. In one situation, I was invited to speak about some stories to the participant at the association's yearly assembly. I gathered that this could bring forward some interesting contacts for me since the board of the association was quite eager to talk to me. Mostly, these stories were to bring attention to the human consequences of flooding events and to bring the stories forward to the politicians making decisions on how and when to maintain the streams, dams, and utilities. Also, besides insights from the participants, I gained some knowledge on how to present these stories excitingly.

Theoretical Perspective

Value Sensitive Design

When using Value Sensitive Design (VSD), values are in our minds throughout the research and design process and will influence both the process and the outcome. The process is a tripartite methodology consisting of a conceptual investigation, an empirical investigation, and a technological investigation. Throughout the process, the themes will be revisited several times, so the design ends up being something consisting of more than just the individual elements. Considerations must be given to which values can be supported and which will be suppressed in each design feature, and if some values are contradictory, just as it is described by the American professor at The Information School, University of Washington, Batya Friedman (Friedman, 1996).

In the stage of the conceptual investigation, I did a literature review of existing literature on VSD and explored how various values relate to the integration of them into technological devices. Going by the suggestion by Friedman, this was also the time when I considered my perception of values and what I meant by the individual values (Friedman, 1996). I will return to this point later when going through my empirical findings too and listing the values of interest in this project. At the same time, considerations of the different stakeholders, their impact on the technology and how they potentially will be affected by it must be done just as suggested by Cummings (Cummings, 2006). Here I revised my plan of whom to talk to and corrected the questions asked since I discovered that homeowners were not genuinely interested in a lot of different features, mostly the ones bringing them peace of mind. I had also realised that the idea of the subscription for a technology like this was compelling in combination with a service solution. By combining the software technology and service, the appreciated values can be supported even more. In the conceptual investigation, I also had access to a market analysis performed by the company in collaboration. In this market analysis, the starting point was the installers, and it became important to me to grasp these insights because this was a stakeholder I was not allowed to interact with, due to the harm it potentially could cause to the sales department. Important takeaways from the analysis were that most installers do not take pumps back for repairment, because they do not think it is worth it. Simultaneously, when replacing the pump, more than sixty percent use the same brand as already installed and point to the price as a reason to shift to another brand. At the same time, they point to good performance and reliability as reasons for choosing the specific brand they work with. This means that there must be some new development and greater incentive than money for choosing one brand over another, something meaningful to motivate the customers.

During the empirical investigation, my focus was on how the engaged people would prioritise the values and if their behaviour would change and looking into if some values were found to be contradictive. To foresee if homeowners' behaviour would change is difficult, it will be my best guess, built on my own experience and looking with half an eye at the behavioural change framework of self-efficacy by Albert

Bandura, a David Starr Jordan Professor in Psychology at Stanford University (Bandura, 1977). This theoretical perspective is engaging with the human's willingness and support from outside to make changes, considering people's individual capacity, motivation, and ability to make the necessary changes. In this case, I looked at their enthusiasm, tone of voice and state of mind in the situation regarding flooding events and their wish for tools to prevent these events. Likewise, attention was given to the reactions to the presented solutions and wishes for features in a monitoring device, and later for the service solution.

Since the suggested technology as a digital monitoring device and a service agreement for the sump pump solution are not developed yet, the technological investigation was done as a discussion concerning desired features. Likewise, the discussions regarding the service solutions were conducted using the scenarios created by using the user stories, as described above. Using these results, I revisited the values and made a schematic representation of my findings. I took notice of how the different values chosen in the conceptual investigation could best be supported by the technology and had the different features in mind when reflecting on the recommendation for required features.

Reflecting on how to go forward from this point, I considered making a digital prototype to assess the market amongst users, as a part of the technological investigation. Since I collaborated with three students from the university, who also were looking into making a prototype, I decided not to pursue this angle.

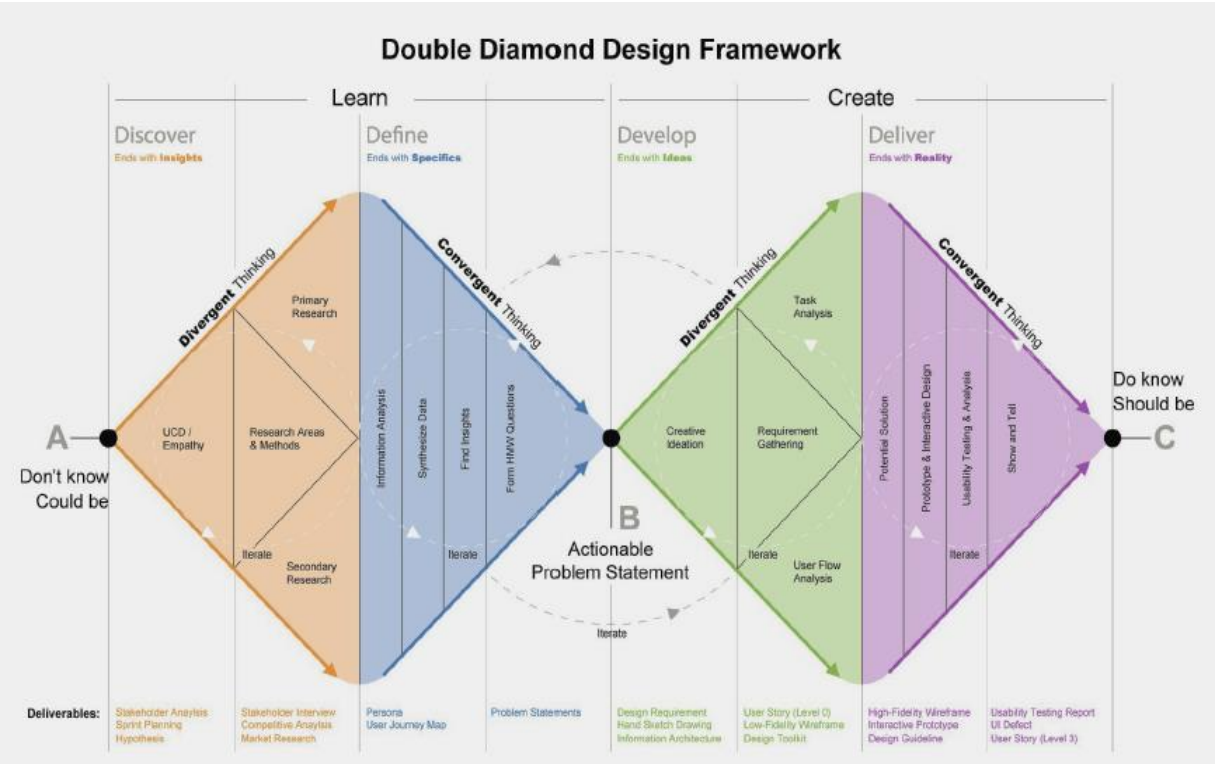
In the field of participatory design, it is quite important to listen to the user and alter the plans according to their expressions. Adjusting the scope and methods during the process is important, and I have altered my plans a few times during this project. The alterations were due to the limitations of the stakeholders for various reasons, and adjustments were made according to the homeowners' expressions of what they found to be most valuable as well. As Cummings points out, the iterative approach is critical because requirements change as the design becomes better (Cummings, 2006), I argue that the iterative process is critical in all stages, and in this case, iteration contributed to changing and developing the idea over time, extending the original idea.

Social Construction of Technology

As earlier described, I used a SCOT map to identify the stakeholders. The framework of Social Construction of Technology resides in four elements, the first being the interpretive flexibility, meaning the technology can be used for different purposes in different social contexts (Klein & Kleinman, 2002). In this case, the monitoring device might be used by the homeowner as security to prevent flooding, but at the same time, some of these data can help the pump manufacturer improve the pump technology. The second element is the relevant social groups, defined as humans having the same interpretation of a problem or an artefact. I have identified the relevant groups with the purpose of them having the same

problem or wishes regarding a given technology. The third element is the closure, stabilisation, or agreement, where there must be an agreement on what the technology consists of, how it is used and that it will cause no harm to anyone (Klein & Kleinman, 2002). I have not done this part in collaboration with the stakeholder, but I have considered the different group's benefits and harms caused by the technology, and it is included in my analysis. The fourth element of SCOT is looking into the wider context. This is where the considerations about indirect stakeholders and sociocultural and political impact are evaluated. In this part, I considered how the technology can enhance the market, be beneficial for the company in collaboration and the future perspectives for the business model.
In the third and the fourth step, I collaborated with three other students from the university and had discussions with the members of the Bird, both to get validation of the material, to be inspired and to make sure I am on the right track.

This report will not be a step-by-step guide in either SCOT or VSD, but a combination of all the angles I found relevant, to bring attention to the consideration of human values when designing technologies. The process of this project can best be explained by using the Double Diamond model, a model widely used in design processes for the last two decades. Putting the process into a model is giving the project a structure, not a straightforward process, but a dynamic process, where I have returned to previous steps several times, and the idea has been adjusted and extended.



(Figure 2: Double Diamond Design Framework, (Nessler, 2018))

Analysis

The Big Picture

As we have seen in the problem analysis, challenges and concerns regarding flooding are relevant issues to bring forward. There is an issue with the pump, whether it starts when needed, and some desire for predicting flooding events. Homeowners' concern for protecting their properties is worth taking seriously and as it is a growing problem, so is the need for the development of smarter up-to-date solutions with human value in mind. A similar issue could be the security of your home when you are not at home. Many people invest in a home security system to prevent intrusion from burglars and feel peace of mind knowing that they either will be notified in case of a break-in, or someone will come to check the house. And people pay large sums of money for a service like this.

Another similar issue could be monitoring and controlling a heat pump, these systems are already well established in the market and are widely used in summerhouses in Denmark. In general, smart systems with the ability to monitor, control the systems and feed you different information are a fast-growing business. Climate changes and reducing energy consumption have had a significant impact on the development of these systems, as people are getting more aware of the challenges. Likewise, the growing economic impact of rising energy prices influences the homeowners to reduce energy consumption and intelligent systems are solutions providing homeowners with the ability to make a difference in this context.

One could argue that these already existing systems could be compatible with a solution regarding pumps as well, in this case, I argue that the challenges are more immediate and necessary because you know that someday you will have a problem, but that is not necessarily the case in other situations. For instance, if you live in an area with a high level of groundwater, you know that your pump must run when there is heavy rainfall otherwise your house will be flooded quite fast. If your heat pump stops functioning, it will be cold, but the house will not be damaged within a few hours.

Similar solutions to monitor pumps are in the market and can be purchased wholesale in the US, but the sales channel and support for the products are unclear, making it a market with potential all over the world since the problem of flooding events is increasing everywhere. Also, the combination of offering a software solution for monitoring the pump and a service agreement for maintenance and repairment of the pump is not available as it is today.

To avoid making something half-hearted and mediocre, we must determine what homeowners want from technology; likewise, we ought to avoid just doing what other people do and making their system fit our existing solutions.

A monitoring technology can help homeowners in many situations, ease their minds, provide some security to their houses and in general ease their everyday life. Furthermore, it will have a positive

impact on society, since flooding events are a costly affair and preventing them will have a positive economic effect, both on an individual and a societal level.

Likewise, the company in collaboration have a strong brand well established in the market and this can be beneficial when moving into new business areas. We should not neglect this opportunity for branding the company by creating a valuable product for homeowners, also supporting some branches in reducing the impact of challenges created by climate change.

Values

Definition of value

The late Professor of Anthropology at the London School of Economics and Political Science, David Graeber, elaborates on values and the definition of such in his book "Towards an anthropological theory of value: The false coin of our own dreams":

> 1. "values" in the sociological sense: conceptions of what is ultimately good, proper, or desirable in human life
> 2. "value" in the economic sense: the degree to which objects are desired, particularly, as measured by how much others are willing to give up to get them
> 3. "value" in the linguistic sense, which goes back to the structural linguistics of Ferdinand de Saussure (1966), and might be the most simply glossed as "meaningful difference"

(Graeber, 2001, p 2)

The definition of values can be characterised as sociological, economic, and bare linguistic, but how we as individuals perceive it will often be a combination (Graeber, 2001). And in different contexts, we will appreciate some values more than others. We will outmost distinguish between the values found important in various contexts, e.g., what we as an individual find important, we will look for values to support us and our well-being as an individual. Then there will be different things coming to mind when we look at what we find important in a relation to other human beings, in this context we compromise our personal values to some extent to support a fruitful and satisfying relationship with others. When considering values from an organisational point of view, the centre of attention will be put on how to benefit the organisation, creating a meaningful environment for employees and a healthy economic situation for the organisation. These appreciated values will also in some cases differ from what we consider valuable and important in society.

There will be various perceptions of values between individuals since what they find meaningful will differ. Individuals base their perception of meaning on their worldview, and different individuals will perceive right from wrong differently. These perceptions will be the foundation of a person's worldview and will be altered according to the person's previous experience (Pedersen, Prangsgaard, Tuft, & Nørreklit, 1983).

In VSD twelve values with ethical importance are often found to be implicated in the technological design, as described by Freidman et al. (Friedman, Kahn, Borning, & Huldtgren, 2013).

Human Value	**Definition**
Human welfare	Refers to people's physical, material, and psychological well-being
Ownership and property	Refers to a right to possess an object (or information), use it, manage it, derive income from it and bequeath it
Privacy	Refers to a claim, an entitlement, or a right of an individual to determine what information about himself or herself can be communicated to others
Freedom from bias	Refers to systematic unfairness perpetrated on individuals or groups, including per-existing social bias, technical bias, and emergent social bias
Universal usability	Refers to making all people successful users of information technology
Trust	Refers to expectations that exist between people who can experience good will, extend good will toward others, feel vulnerable, and experience betrayal
Autonomy	Refers to people's ability to decide, plan and act in ways that they believe will help them to achieve their goals
Informed consent	Refers to garnering people's agreement, encompassing criteria of disclosure and comprehension (for "informed") and voluntariness, competence, and agreement (for "consent")
Accountability	Refers to the properties that ensures that the actions of a person, people or institution may be traced uniquely to the person, people, or institution
Courtesy	Refers to treating people with politeness and consideration
Identity	Refers to people's understanding of who they are over time, embracing both continuity and discontinuity over time
Calmness	Refers to a peaceful and composed psychological state
Environmental sustainability	Refers to sustaining ecosystems such that they meet the needs of the present without compromising future generations

(Schematic definition of values: (Friedman et al., 2013, pp58-59)

As a part of the Value Sensitive Design methodology, considerations of which values cause harm or benefits to the different stakeholders are important, just as some emphasis must be put on the values being either corresponding or contradictive. Likewise, choices must be made as to which values to investigate.

Human welfare is a value of totality and would be supported by the less worried mind, at the same time the invasion of privacy can be diminishing it. To have an optimal functioning technology, information in form of digital data must be extracted to make the predictions, tests, and future pump development

as desired. Due to this, the values of privacy and informed consent must be considered, to evaluate if it corresponds to the desired solution. At the same time, a conflicting value can be universal usability, since making information and usability easily accessible, can compromise data protection. The sharing of data can, however, lead to individuals having more autonomy by releasing time for other purposes. To support this autonomy, accountability of the system and the reliable service which also requires some data collection must be in place, beneficial for both the user of the system and the pump manufacturer. Balancing these values, by making the users "have a say" in the development, will support calmness within the individuals, as it is argued by several contributors to Routledge International Handbook of Participatory Design (Simonsen & Robertson, 2013).

In my honest opinion, values are the fundamental meaningful issues to the individual. It is what matters to you, no regard why, and it will be influenced by your historical experience, the personal struggles you have had, your skills and your perception of the world in general. It is what enables us to change something and from our personal perspective distinguish between right and wrong and choose what is right for us in the given situation.

Choice of Values

In the initial research, I limited the twelve values to seven, as shown below in a schematic format. I added a column to present my definition of the values, as this has been the starting point of the talks with the different stakeholders. The deselection of Environmental Sustainability is not due to lack of importance or people not valuing it, it is because supporting this value and looking into sustainable ecosystems such that they meet the needs of the present without compromising future generations, can be a project in itself, and would require a life cycle assessment of the product. Pursuing the development of this solution would require the manufacturer to look into this area as well. Freedom from bias, courtesy, and trust are values of large importance, although it relates to a greater extent to the interaction with devices with more human interaction. Feeling betrayal, unfair treatment or impoliteness requires another human being and interaction with them to a greater extent. Likewise, I deselected ownership and property because it would be more important in other situations.

When the suggested solution extended itself to also consist of a service agreement for the sump pump solution, you could argue that trust was a value also important to investigate, since this will require more collaboration between humans. Still, I did not alter the project to include it, but I will come up with insights in this direction.

All values cannot be covered in this research project, and I have chosen the values I believe are the most powerful in this context. During the interviews, we discussed the values, and how the interviewee and I perceived the values in question, this increased the common understanding and build rapport in the situation.

Human Value	Definition	My definition
Human welfare	Refers to people's physical, material, and psychological well-being	The way people feel, is the need for happiness fulfilled? Both concerning their physical abilities, their material belongings, and their psychological concerns. Bringing users peace of mind
Privacy	Refers to a claim, an entitlement, or a right of an individual to determine what information about himself or herself can be communicated to others	The level for data protection and invasion of privacy, considering encryption of technology
Universal usability	Refers to making all people successful users of information technology	How easy, simple, and intuitive is the technology to use. Limited human errors
Autonomy	Refers to people's ability to decide, plan and act in ways that they believe will help them to achieve their goals	The way, people will free up time for other arrangements
Informed consent	Refers to garnering people's agreement, encompassing criteria of disclosure and comprehension (for "informed") and voluntariness, competence, and agreement (for "consent")	The agreement between the supplier and the user for beneficial usage of data, the option to agree and the option to deny. Beneficial for both user and supplier
Accountability	Refers to the properties that ensure that the actions of a person, people or institution may be traced uniquely to the person, people, or institution	Reliability of the system features, the system is well-tested
Calmness	Refers to a peaceful and composed psychological state	The ability for people to be relaxed, unconcerned and have peace of mind

(Schematic definition of values: (Friedman et al., 2013, pp58-59), including own definitions)

Core Value and Supportive Values

When interviewing people, they expressed the importance of the different values by emphasising whether they thought the value was particularly important, slightly important, or not important at all, in this context and in general. This was performed because I would then be able to conduct both qualitative and quantitative analyses of the data. By extracting, interpreting, and comparing statements from different interviewees I made visual representations and I will analyse them by unfolding the insights in the next sections of the report. The graphical representations are there to give a quick overview of how important the homeowners found the individual value to be.

Autonomy

With software technology communicating the status and other parameters from your pumps, we can bring some peace of mind to the homeowners by providing them with time and mental capacity to concentrate on other issues. Having these options enhance homeowners feeling of freedom, and we can bring choices to the people involved, just like when the automobile was introduced in the 1900 century, it brought choices to the people living in rural areas (KLINE & PINCH, 1996). An informant, working as an EU consultant, describes the technological development with enthusiasm:

> *"We would really appreciate being independent of checking whether the pump is functioning correctly or not, especially when I have a job consisting of a large amount of travelling"* [1]

She expresses how the concerns would be minimised with a technology where she would be notified in case of a malfunction, giving the family time to act in proper time. As it is today, they must do these things manually, and when they are away and the weather forecast is not promising it always brings some concern, and sometimes they have to make other people check for them. As Kline and Pinch describe how the rural inhabitants were used to going to the local church, attending the local school and always using the local facilities, but when the automobile was introduced, people had for one, more time to do other things, but also the option to choose to go to another church if they did not like the minister (KLINE & PINCH, 1996). By introducing an option to monitor and maybe control your pumps, we can leave people with a less worried mind and time to do other things. Another informant, a Laboratory Assistant, told me:

> *"This technology would be of a huge help to us, we would have the personal resources to carry out more activities at the times when we are most affected by the flooding"* [2]

When pointing at the personal resources, she expressed a need for minimising the concerns and getting in a better psychological state due to the increased overview of time. Yet another informant, a Social Worker, told me that she saw it as a considerable benefit for their family, she said:

> *"I am able to push it away from my mind, but my husband spends a lot of time worrying about the impacts a high level of groundwater has on our house, it would definitely free up time for him"* [3]

She does not have major concerns about the flooding issue in itself, her concerns relate more to the well-being of her husband, which affects all members of the family. She also elaborated on how he can go to the garage just looking at the floor, where they can see the problem increasing in the humid

concrete floor. Another dimension to autonomy can be the ability to reside in your own house, a Craftsman explained to me:

> *"My wife is not home at the moment, she is residing at our holiday house, she does not want to be here when the water level is that high, she cannot sleep at night, she keeps listening to whether the pump runs or not. An alarm system would calm her down, I believe, enabling her to stay here when she wants to"* [4]

For both, the opportunity for them to be together at the desired times is expressed as valuable. Not something people without these issues would consider a dilemma since we are not usually limited in this way.

The interviewed Restaurant Owner also pointed out how a monitoring device could free up time for him. Today, during the wintertime when the flooding issues are most concerning, he has an employee or himself watching a video camera installed in the basement, to make sure that the pumps are running.

(Private photo of the basement at the restaurant and surroundings during a flooding event in February 2022)

The problem is that if the pump stops running, the basement will be flooded within a few hours, so they spend a considerable amount of time on this assignment. He told me:

> *"It would make a huge difference for us, knowing that we would be notified if there was a problem, right now we have to watch the camera ourselves, with a monitoring device I could spend more time in the kitchen, where I like to be …and with my family"* [4]

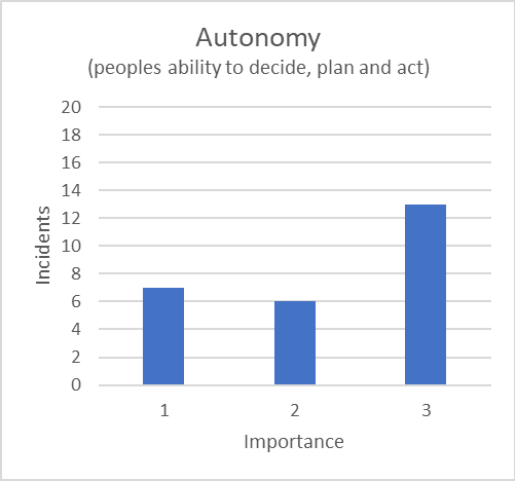
So, this would most likely increase his *"ability to decide, act and plan in ways that he believes will help him achieve his goals*", as the value "autonomy", is defined by Friedman et al. (Friedman et al., 2013, pp 58-59).

An interviewee working within the technology and environment department at a municipality elaborated on how he saw the monitoring device as a complementary device to a service subscription, he expressed:

> *"Of cause being notified would be of great help, but I think what will have the biggest impact in people's experience of autonomy will be the service leaving them with an insurance of someone else taking care of the problems when they arise"* [6]

He believes that taking it a step further and making external persons take responsibility for the system and the solution would be the most feasible model. In this case, I had to take into consideration that he lives in a suburb in the northern Zealand, where the average income in this municipality and the general economic foundation are among the top five in Denmark (Kruuse, 2022)

Building upon these statements about how people expressed the importance of the value of autonomy, I found it an important value to support.



(Graphic representation of interviewees' expression of the importance of autonomy, the majority find it important or particularly important)

Our society today is incredibly stressed, and people have a lot of different engagements besides family, friends, and work, which forces individuals to prioritise their time. The kind of freedom a technological development of this kind can provide for the people affected by flooding can contribute to human welfare as well.

Accountability

With accountability in mind, the essence is for the individual to see their values reflected in the system. For them to be able to trust it, see the relevance of the information and count on the data presented to them. The reliability of the system to communicate the correct information over time and individuals being confident in the outcome of using the system (Friedman et al., 2013). One of the informants, a Farmer, told me about how she would have to rely on the system, she said:

> *"A new system must be reliable and of assistance. We are used to repairing the tractor ourselves when it breaks down, and it sometimes does. We cannot do that with a pump. And right now, I am checking the drainage pipes in the fields manually, so some kind of notification or indication of a malfunction would be nice"* [7]

Lacking the competencies in the specific field of occupation within the pump and drainage maintenance, she appreciates a high level of accountability and the idea of subscribing to a service agreement with skilled personnel is welcomed.

(Photo: Wikipedia Common: Sump Pump)

These pictures show what a complex system, a sump pump system is, and being such a complex system the requirement for reliability is high. For a Craftsman within this field of occupation this will of course not seem complex, however as most homeowners are unskilled in this field, the desire for a well-functioning system enlarges. This is a good indication of the need for a monitoring device, just like a service provider's ability to get an overview of the system would improve. The Social Worker also indicated the unique traceability as a meaningful ability to her:

> *"My husband would be a lot less worried if he could see that the system had been running without complications over a period of time"* [8]

She and her husband also elaborated on how tracing the data from their pump could help them in the future, and they were willing to share the data with the local pump manufacturer:

> *"I wonder if this is not a job for the local pump manufacturer, them being the best with the pumps. I would like to get the information and so would they, I believe"* [9]

Here it shows how he is confident that the system would be beneficial for both themselves and the manufacturer. He goes on about how he has confidence in the local brand and therefore will have confidence in the system as well.
An interviewed Caretaker likewise expressed faith in the system, due to the recognisability and reputability of the brand, but she had other concerns as well:

> *"I can be worried about if the connection would be unsteady when there is a power failure, just like the television signal disappear during a storm"* [10]

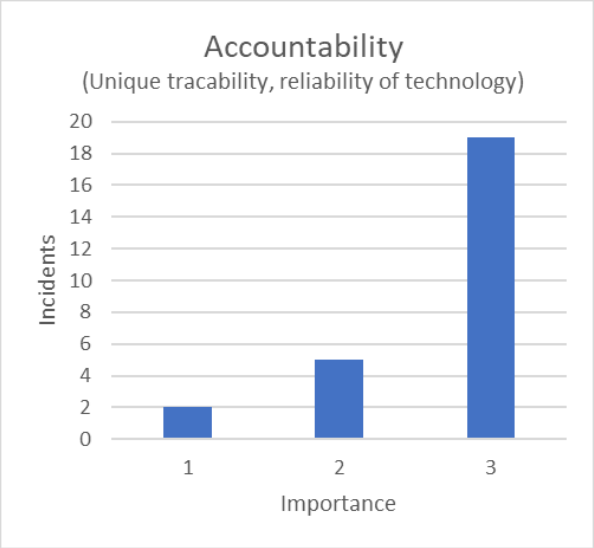
This is, of course, a concern that must be addressed. Her main concern was that power failure often relates to bad weather conditions, and in these cases, they are dependent on their sump pump system. So how connectivity is enabled is something worth considering and some ideas from the workshop are engaging with this issue, so I feel confident that the necessary actions will be taken. The Laboratory Assistant also expressed:

> *"The system just has to be well functioning and accountable, otherwise, it is not worth anything"* [11]

By this, she tells me how she is counting on the system and expecting it to deliver what is promised, this being both data protection and reliability of the system. Another informant told me:

> *"I have only had two pumps over the years, and they have been functioning perfectly, but I would imagine the experience of a malfunction would magnify your worries"* [12]

Even without prior flooding experience, he expresses how a malfunction of the system would cause concerns, and the appreciation of accountability enlarges.



(Graphic representation of interviewees' expression of the importance of accountability, the majority find it important or particularly important)

Looking into the statements above, the value of accountability is likewise a value worth supporting in the technical solution. The value of accountability will support other values as well, as the technical solution supports the reliability of the sump pump system.
When the company developing the technology takes responsibility for the events, the data collection, and the data protection and has collected data to support this, they are accountable for it, which also will provide the system with a trustworthy imprint.

Universal usability

When working with software development, universal usability has a high priority, just as Friedman et al. point out (Friedman et al., 2013).
The objective of applying universal usability to a product is to obtain the highest number of successful users, enabling as many users as possible to benefit from the system, as it is described by Shneiderman and Hochheiser (Shneiderman & Hochheiser, 2001). Ben Shneiderman is a Professor at the University of Maryland, Department of Computer Science and Harry Hochheiser is an Associate Professor at the University of Pittsburgh, Department of Biomedical Informatics, both parties have been engaging the Human-Computer Interaction over the years. They also emphasise a level structure, with restricted vocabulary, so more experienced users can have more options than less experienced.
These angles are worth investigating when setting the requirements for the design. Emphasising this, a Caretaker told me:

"It needs to be simple, otherwise I will not be able to work it out" [13]

Being aware of her reduced competencies within the technical skills of operating digital devices, she would be satisfied with only having the most relevant information at hand. The necessity for humans to succeed in the usage of technology without causing any damage is important for humans to feel secure. Intuitive interaction with devices guiding people in the right language, using cogent easy understandable names to provide information, will promote the involvement of users. Keeping it simple will enlarge the diversity of the potential users, as one of the informants, a former Sales Representative, explained:

> *"Of course, it needs to be simple to operate. Most of the people I know having this problem and the need for sump pumps, are rather old and do not have that much experience with digital devices of this kind"* [14]

By keeping it simple, he is convinced that these older people even when lacking technical skills are willing to interact with it if they feel capable of operating it correctly. To some extent, this can be a barrier if the customer is younger people wanting the ability to alter settings, as another informant, a Stock Worker, told me:

> *"I would like to be able to see all the data and depending on the situation be presented with the most relevant information first, so I would like to set the notifications myself"* [15]

Someone feeling confident in operating more complex settings would not fear missing important notifications, while people lacking this confidence would keep on worrying if they would be notified or not, not having an overview of the different options.
The importance of keeping it simple and universal usable is supported by a statement from the Restaurant Owner:

> *"It needs simplicity so that we all can operate it and have the overview, we have different employees here, so it must be easy and intuitive to everybody"* [16]

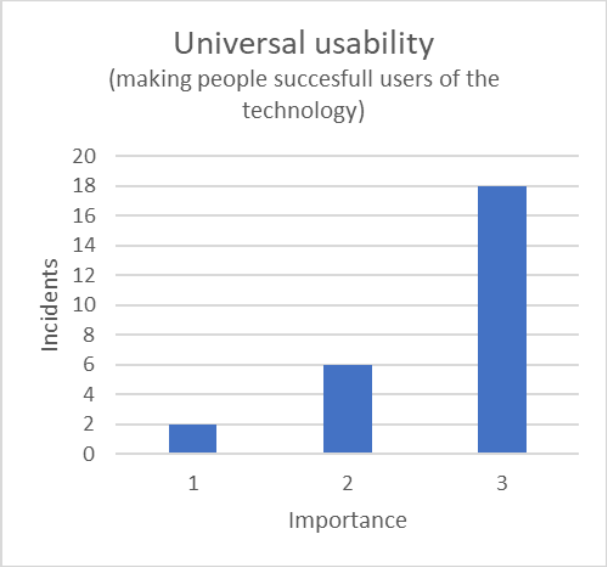
Emphasising simplicity, so different people can manage the system without causing any damage is of high priority, and it will also support the experience of the values of both autonomy and accountability. Another informant, a former Bachelor of Marine Engineering, expressed:

> *"It must be very simple, otherwise I would rather go look directly at the pump"* [17]

He expresses how new technologies must be intuitive and simple or easy to understand, otherwise, he would just do as he always has done because this is what he knows. A monitoring technology, safe to use, aimed at the homeowners can provide them with both capacity, ability, and motivation to take the necessary precautions regarding flooding events. Another informant, a Molecular Biologist, told me:

> *"All new technology needs to be smart and intuitive"* [18]

Like others, he expresses how reducing the time learning new technologies preferable must be kept at a minimum, reducing less relevant features would enable homeowners to interact with the system without causing harm to it. The statements above are visualised in the following graphical representation, showing how most interviewees found it important that many people can successfully use the technology.



(Graphic representation of interviewees' expression of the importance of Universal usability, the majority find it important or particularly important)

These things come together; I find the value of universal usability important to support enhancing homeowners' ability to respond to flooding situations in time. The challenges in the information and alteration level are of technical nature and must be solved in the solution, making it a successful experience for a wide range of users. Having a successful experience with the use of a monitoring device will motivate for further operation of such, bringing the homeowners in a position where they have enhanced ability to act when needed.

Universal usability will often be opposed to the value of privacy, because providing users with easy access and extended possibilities, will ease the security level, in the next section I will explore how valuable this is to the homeowners.

Privacy

When we are working with digital devices, collecting data, interpreting it, and sharing it, we cannot ignore privacy. The right individuals have to decide if they want others to have information about them and what kind of information they want to share. In the European Union, all members are obligated to embrace the General Data Protection Regulation (GDPR) as it is described in the legislation put into effect for all member states by May 25, 2018 (European Union, 2016). In GDPR the essential principle is that everybody has the right to privacy, and as the Molecular Biologist puts it:

> *"You always have to think about privacy, when you are working with digital data"* [19]

Also, the Restaurant Owner said to me:

> *"In these days I just expect it to be covered properly, protecting sensitive data"* [20]

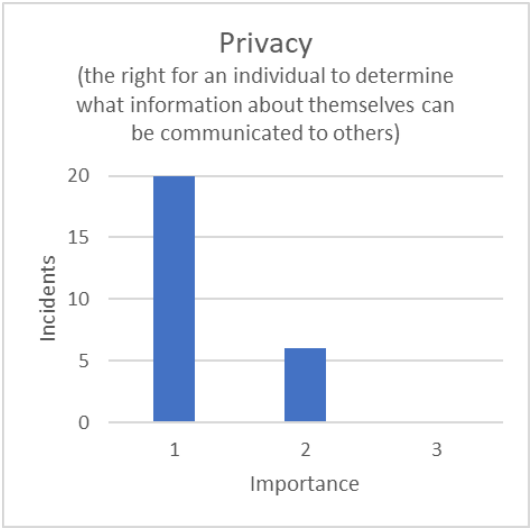
Also, the Laboratory Assistant expressed:

> *"Working with patients all the time I always consider privacy, but in this case, the data will not tell anything about me, so I do not find it that important, also there are laws covering it"* [21]

As they all express having confidence in the developing company complying with the GDPR, it is not of any real concern to them, combined with the data not being truly sensitive. A Farmer elaborated on them not having the concern at all:

> *"In the rural areas, we already know a lot about each other, so this is not a real concern for me. We have this knowledge, and we often use it to help each other"* [22]

She also told me about how having these collaborations in the rural areas, sometimes causes concerns for the neighbours when they realise they have flooding issues themselves because they know that the farm next to them is in the same situation. They already share data; the only difference would be that the data became digital.
These statements support how the importance of this value is close to not existing, almost no one sees privacy as important in this context.



(Graphic representation of interviewees' expression of the importance of privacy, the majority do not find it important)

The few finding privacy important in this context express how they always find data protection important and that they are profoundly private persons. I will argue that they also are influenced by their field of occupation, one being a student in a business school just learning about GDPR and the importance for a company to comply with the law, and one is in a position to develop his employer's policies on this area and the last ones working with payrolls in their jobs.
The value of privacy is, at least in this context, related to the value of informed consent, which will be described in the next section.

Informed consent

To protect sensitive data, as the legislation obliges all EU members to do, obtaining informed consent for the usage of the collected data is of great importance. An agreement must be comprehensive and contain all information about what kind of data will be collected, interpreted, and shared, enabling the user to make his or her own decision willingly based on the provided information (European Union, 2016). The necessity of collecting the data must be considered and explained, with options to limit the sharing of data if the users feel greater comfort with this.
When he was considering how the agreement is meant to protect the individual's sensitive data and what the agreement would consist of the former Sales Representative explained:

> *"Of course, one would agree to share the data regarding the pump. It will help develop the technology and increase its reliability in the future. These data are worth a fortune for the developer"* [23]

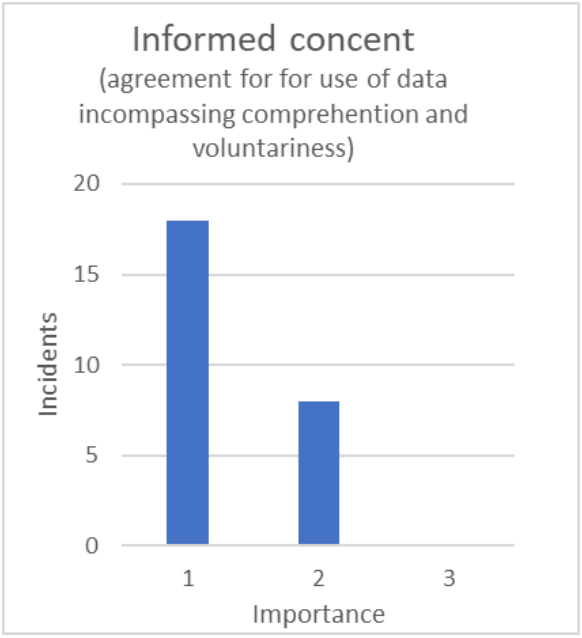
The Laboratory Assistant supported him:

> *"These data are not sensitive to me and if sharing them can make some optimised solutions in this field of interest, I would gladly share them, I believe everybody with flooding issues would"*[24]

And the Laboratory Assistant was again supported by the EU Consultant when she expressed:

> *"Where I live everybody knows what there is to know when it comes to pumps and flooding, it is historical in this part of Denmark. And if someone can learn from it, one would immediately consent to the use of data*" [25]

They all agree that the development in the field of interest is more important combined with the fact that it is not sensitive data, but not considering an option where there is no compliance with the legislation.



(Graphic representation of interviewees' expression of the importance of informed consent, the majority do not find it important)

Another angle to this is how digital users are used to getting overwhelmed with information on agreements to personal data and cookie usage policies whenever entering a website. As a Caretaker explained:

> *"As we do with other things, I assume we will just agree, to be a part of the solution and gain access to information, it is not like you read it, you just consent"* [26]

She explains how the expectations for the companies to comply with the legislation are high. And the EU Consultant also elaborates on how the GDPR is something companies take extremely seriously, due to the high penalty regarding this issue.

Reasons for the people interviewed not finding either privacy or informed consent particularly important, are also to be found in the development of our society. They are values of great importance to everybody, but it is just expected that this part of the technological development will be fulfilled and hence not given much attention. Our view of what is the norm in this context has changed over the years, our worldview has developed. If we make the comparison to people putting their children into a car without a children's car seat, this will seldom happen today, but previously it was the norm. Our perception of what is socially acceptable in this context has developed over time through our interaction with technology and other human beings. We are using our ethical perception of values to understand new technologies and how they influence us. We change our perceptions according to the development of technologies, and designers develop the technologies according to how the world is changing, just as the Dutch philosopher of technology at the University of Twente, Peter Paul Veerbek explains when he is talking about technological mediation and how *"the design of technology is, in fact, doing ethics"* (Veerbek, 2017). Veerbek describes how the approach of Value Sensitive Design is a natural part of the guidance ethical approach to design processes. Because we have moved to a state of mind where it is the norm, we accept and trust the data protection, in this context these ethical requirements for data protection are not in front of our awareness, still being important but just expected to be supported as a natural thing.

Calmness

While Friedman et al. define calmness as a peaceful and composed psychological state (Friedman et al., 2013), I refer to it as the ability to be relaxed, unconcerned, and have peace of mind. And peace of mind is what I would like to bring to the people with flooding issues. One of the homeowners without flooding issues told me:

> *"I think it would be a very nice solution for many people I know, with notifications and stuff like that. I would like to have the solution if I were living in an area with a high level of groundwater. I know what kind of damage water and flooding events can do to a house"* [27]

He expressed how getting rid of the concerns about the health of the house would bring value to him and ease his mind. Just as a Farmer explained:

"It would ease my mind if I knew that I would be notified if there was a problem" [28]

And the daughter of another Farmer told me:

"It would give us some calm here at my mother's house, but I would like the neighbours to have it too, maybe we can help each other then" [29]

By this, she explained how it would be of help for her to know that her mother did not have to go out to check the pump, the mother being old and the daughter concerning about her health in general. A homeowner with many years of flooding experience likewise explained to me:

"During the wintertime when the water level is very high, we do not sleep through the whole night, we have to check the pumps otherwise if the pumps stop, we risk flooding of our house within a few hours. Also, during the daytime in these periods, if we knew the pumps had been running all day, our children could go home alone from school. As it is today, they are not allowed to do so because of the risk of an overflooded courtyard" [30]

She is concerned about how the house may be flooded during the night and therefore not getting proper sleep, just as she is concerned about her children not being able to go home before their parents because of the risks of them being harmed. One can only imagine what kind of pressure these circumstances put on the individual's psychological state of mind. Moving the awareness from the constant state of alert to a state where you need to act when you are notified would be highly appreciated by these people. A Caretaker also expressed this appreciation:

"It would mean that I could be away from home during a storm without concerns" [31]

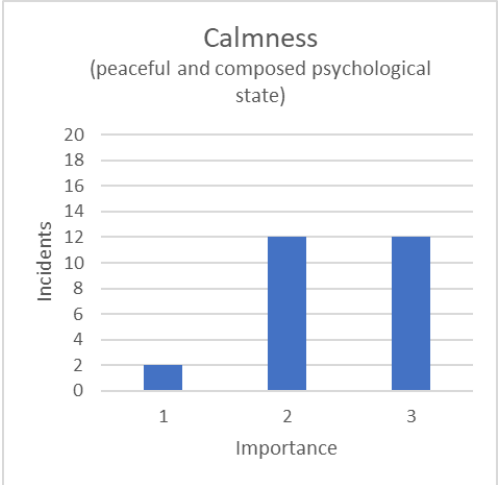
Another informant supported her:

"My pump operates quite often, so I would be calmer when leaving my home and sleeping well at night if I knew that the system is functioning correctly" [32]

The Stock Worker also told me:

"It would be worth a fortune to have knowledge about the condition of the system" [33]

These altogether express how the concerns would be eased, and peace of mind increased by this kind of security. This is visualised in the graphical representation of how important the homeowners found the value of calmness.



(Graphic representation of interviewees' expression of the importance of calmness, the majority find it important or particularly important)

Based on these statements, calmness is also a value expressed as important, and supporting this value will support the peace of mind I want to bring to the people with flooding issues. Likewise, the abilities generated by the previously discussed values support the value of calmness.

Human Welfare

As well as the majority of those interviewed, I find the most significant and comprehensive value to be human welfare. Bringing people peace of mind in the way they feel, fulfilling their needs for happiness, regarding their physical abilities, their material belongings and the psychological concerns must be the ultimate state to reach. Within the society of engineering the code of ethics starts with "*Engineers, in the fulfilment of their professional duties, shall: 1. Hold paramount the safety, health, and welfare of the public"* which supports the importance of considering human welfare in the technological design (National Society of Professional Engineers, 2019). With confidence that the projected solution can provide peace of mind to the homeowners, I also find that the value of human welfare will not be supported to a degree reaching beyond the core issue of removing water from basements. I will here present some insights to support this statement and some insights recognizing the importance of supporting human welfare. One of the interviewees, the Nurse, expressed that a monitoring device is not enough:

> *"It is okay with a technological solution, which will provide us with a good night of sleep, but when the municipality is not acting in time… that plays a significant part as well"* [34]

She expresses how the development of new technologies is welcomed and implies that this technology will be a support for their well-being, but not the only solution. To understand this, it is important to have insight into how she has seen her parents struggle with the municipality over the years. Even if she has not experienced the flooding herself, her worldview consists of these occurrences too, since she experienced the impact, it has had on her parents. Her parent's farm is placed near a stream, which the municipality has, in the farmer's opinion, neglected to maintain for years. Just like them, an informant from "the landowner group" explained:

> *"In our case, the technological development will help us some of the way, but the municipality has to wake up and maintain the stream by looking at the water flow capacity and not only the quality of the water or some bug protected by EU"* [35]

He is referring to "Natura 2000", which is a large, coordinated network of protected areas. Areas with valuable and threatened species and habitats (European Commission, 2022). In this directive, the area where he lives is appointed to be a "Natura 2000 area", and one of the threatened species Ophiogomphus Cecilia (Danish; Grøn krølleguldsmed) lives here, and since the "Habitat Impact Assessment Commission" argues, that they cannot rule out that maintaining the stream, will harm these bugs, the municipality omit to do so.

(Ophiogomphus Cecilia, Photo: Wikipedia commons)

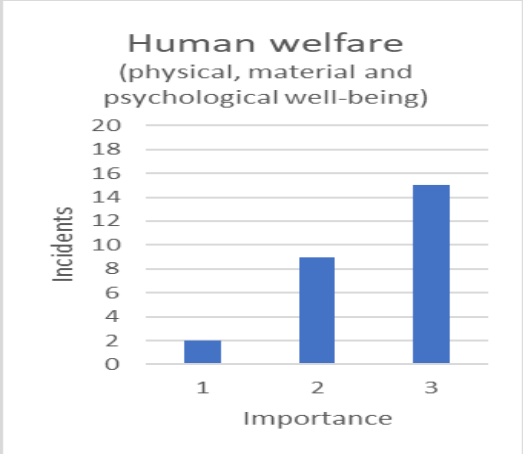
"The landowner group", which consists of people living in these areas, experiencing flooding events due to neglected maintenance of streams, are frustrated and unsatisfied. When the municipality's argument for omitting to maintain the stream was that they cannot rule out that the maintenance could cause harm to the threatened species, one of the homeowners commented:

> *"Well, I cannot rule out that these repeated flooding will damage our houses, our economy, and our psychological well-being. I feel like a small citizen being worth less than bugs and aquatic plants"* [36]

He expresses his disappointment in the help they receive from the municipality and the feeling of being left behind without acknowledgement from the persons making the decisions, and he is not alone with this experience, as another informant goes on:

> *"For us, a technology like this will provide comfort in our everyday life, but there are other relevant elements that we cannot control ourselves as well. Perhaps the fact that we as individual homeowners take actions to prevent flooding can encourage the municipality to do their job too… but I doubt it"* [37]

Several informants have shown these signs of exhaustion like they have given up the fight when the discussion came across the collaboration with the public authorities. I cannot help wondering if this is an example of over implementing some EU regulations, as we have seen in other situations in Denmark, e.g., when the Commercial Fishermen were told to install cameras on their boats to encourage compliance with the regulations regarding the landing obligation (Danmarks Fiskeriforening, 2020). The EU legislation is not requiring that the Danish authorities demand video surveillance of the fishermen to monitor the landing obligation, it is just what has been chosen in Denmark (European Commission, 2020). Given the long journey of legislation from the EU through the European Commission, the European Parliament, the Danish Parliament and ending up in the municipalities or at other institutions to be interpreted and enforced, it is no wonder that interpretations differ. While some homeowners showed exhaustion regarding the flooding issues in general, they also showed enthusiasm when discussing the technology and how I imagined it to be provided and emphasising the importance of supporting human welfare.



(Graphic representation of interviewees' expression of the importance of human welfare, the majority find it important or particularly important)

The Eu Consultant expressed how she liked the described solution:

> *"A solution where the pump can test itself and notify you if there is a malfunction would be optimal. Developing this solution would be timely delegacy and definitely bring some peace of mind to homeowners with these issues"* [38]

She combines the reduced concern with autonomy and accountability and considers these values to support calmness and by this supporting human welfare. Just like a Farmer described:

> *"The more action we take to ease our everyday life, the less worried we will be. Even if it does not solve all our problems, it will provide us with some peace"* [39]

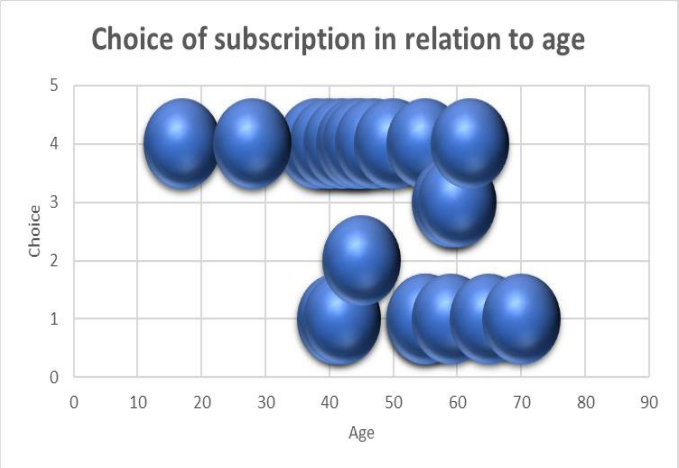
The technological solution can provide the homeowners with some peace of mind. In areas where the problem only consists of a high level of groundwater, it will provide peace of mind to a greater extent than in areas where the flooding mostly is caused by streams over flooding.
In the light of these statements expressing frustrations and to support human welfare in general, even more, I will suggest a study of the legislation in the field of environmental sustainability, biodiversity, and nature conservation, in combination with the impacts on landowners' ability to protect their land and property, to be conducted.

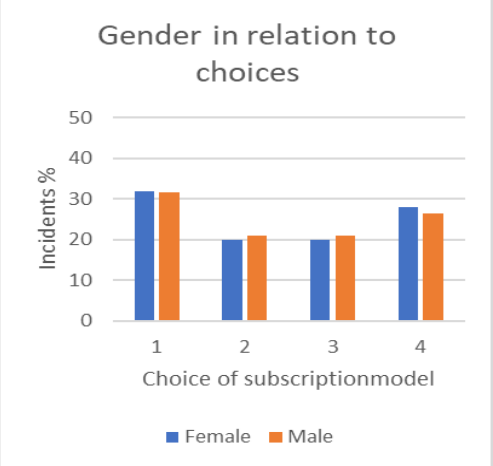
The Conceptual Model for Design Requirements

Summing up these insights about homeowners' interests in the different values, I argue that even if expressed as less important, privacy and informed consent are important because there is a general expectation of compliance with these regulations. Likewise, the value of universal usability, accountability and autonomy is regarded as important both explicitly and by the argumentation supporting the values of calmness and human welfare.

To define the design requirements, I made some choices during the different investigation stages of the project. One decision was that the technology would be an app or an interface and that I wanted to investigate which values homeowners found most important to support in a device used in this context. In addition to this, the idea of a service subscription as it was generated in the prior workshop became a subject of discussion with the homeowners as well. Some ideas as suggestions for easy installation, enabling the digital connection in other ways or installing alternative sensors to enable monitoring of other parameters are worth pursuing to support the idea of a solution with a service subscription.

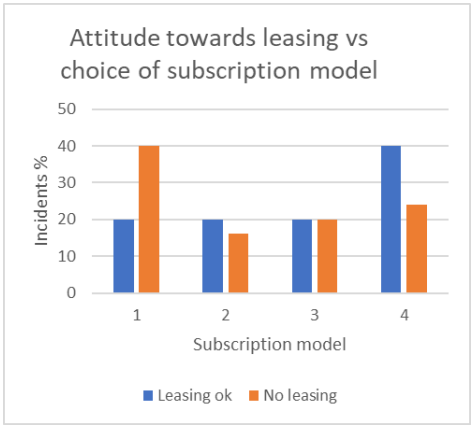
As described earlier, some discussions had the departure in user stories and when analysing the homeowners' responses, I looked into if there seems to be some tendency regarding gender, age, flooding experience, and so on. The interviewees were asked to pick the model of service level that applied mostly to them, one being the lowest service with “just an app” and four being a total service where you are just informed of actions taken and someone else has the responsibility. I made several visualisations of these data, and I will refer to different levels of service as “choice”.

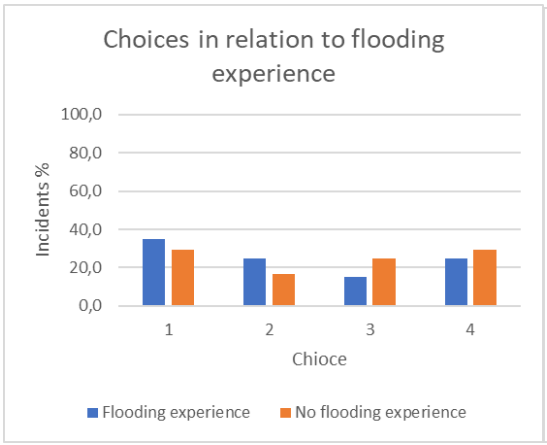


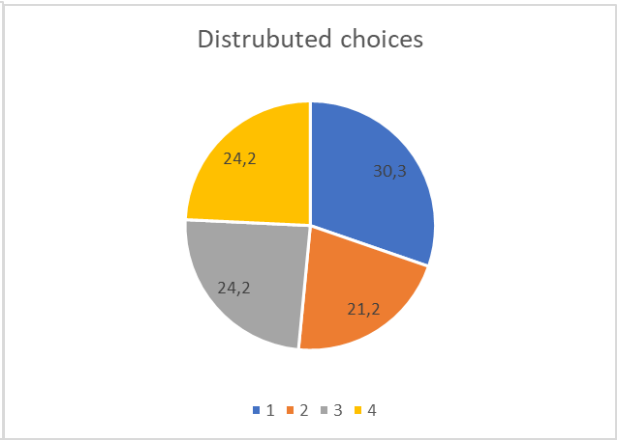


When looking at these, there seems to be a tendency for younger homeowners to choose the subscription with the highest level of service, while homeowners are more likely to choose different subscription levels later in life. In this case, other parameters are more relevant, such as the fact that the younger homeowners interviewed had more experience with subscriptions in general and to a higher degree a positive attitude towards leasing. And if age is not taken into consideration, just looking at the gender,

there is no gender difference. People's attitudes toward leasing and paying subscriptions, in general, have a larger impact on their responses than whether they were young, old, male, or female. In the cases where females chose the lowest level of service, they were used to someone helping them, either their husband or other hired help, and they expressed that they would choose a higher level of service if they were living by themselves. Then gender could be argued to have an influence, however, I argue that this is imaginary because they are not living by themselves, and if they were to buy the system today, they would go with the model fitting their current living situation.

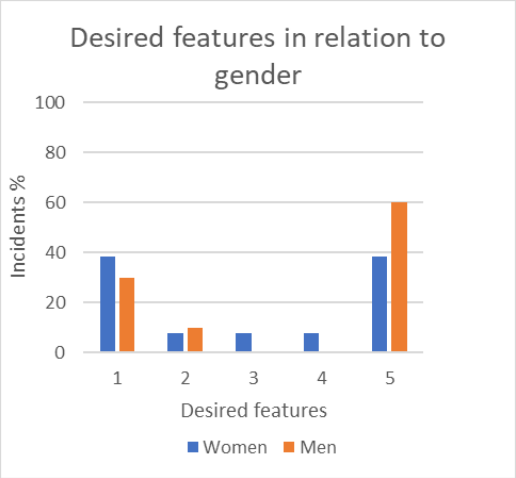


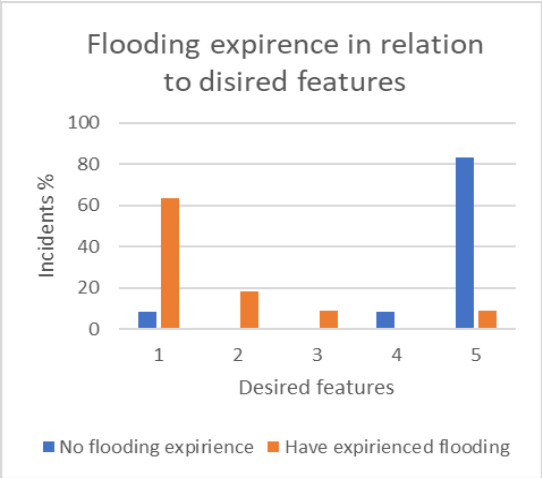




Taking flooding experiences into consideration, this neither seems to have an impact on which model the interviewees chose, and there is almost no difference in which models are chosen, meaning all are relevant. When reaching beyond choice number one, it involves external persons with skills in this field of occupation, so approximately seventy percent of the homeowners are interested in a solution providing them with a service agreement for their sump pump system.

When talking about which features the interviewees found relevant to put into the digital monitoring device, I described the imagined levels where one is notifications on failure, predictions based on data connection, weather and pump condition, and five being notifications on failure, predictions based on data connection, weather and pump condition, options to check conditions including log files, online help/troubleshooting, risk assessment of basement health (requires external sensors) and information on power consumption and flow in drainage.





In this case, the gender is not as relevant as whether they have experienced flooding or not. They expressed how the experience of a flooded house or premises makes you alert, not only the fact that you will have a lot of water to remove but also the considerations about the house's health in the future, the economic impact it can have if you have a lot of damages and all time and effort put into repairing the damages and general recover from the experience. When you have experienced flooding, you would just like to get notified in case of an upcoming challenge, making the lowest level of features desirable, because it would cover their basic needs. The people desiring the highest level of features expressed the comfort to have knowledge about different parameters concerning their house. The Stock Worker told me:

> *"It would be very nice actually to know how much water my drainage system has removed because it is what my house has been saved from"* [40]

In this case, not having experienced the worst-case scenario with a flooded house, the homeowner appreciates some "nice to know"-data whereas the homeowner with experience would be satisfied with the "need to know"-data. The Laboratory Assistant told me:

> *"As long as we are notified if something is wrong, it will help us"* [41]

She here expresses how the most relevant information will cover her needs and be appreciated. As elaborated earlier, our society has some impact on these desires. As we are now, according to Klaus Schwab, founder and chairman of the World Economic Forum, living in the Fourth Industrial Revolution, where increasing interconnectivity and smart automation are changing technology and industries, just like societal patterns and processes are changing (Schwab, 2016). We are used to having the knowledge to a greater extent and trying to catch up with the breathtaking technological development in the digital field, we reach out for solutions we think we want, without basing our choices on a solid foundation. We are all creating our own sociotechnical imaginaries, a vision of a better future supported by technological development, as the founder of the STS program at Harvard University

Shiela Jasanoff and Sang-Hyun Kim, a researcher at Harvard University, argued: "Though never strictly determinative of policy outcomes, sociotechnical imaginaries are powerful cultural resources that help shape social responses to innovation" (Jasanoff & Kim, 2013).

When we are designing new technologies, we are designing for something better, something to ease our future, bring more knowledge or information to the user, and these created images are shared amongst our society and influenced by the collective imagination of what is desirable. All these desires must be supported by the human values that users find relevant and important. A Caretaker told me about her imagination of the delegated responsibility:

> *"It would be of great value if someone with the knowledge about pumps had the responsibility, then I know the right decisions would be made"* [42]

She expresses how the value of knowing that the responsibility of the system residing with competent people is important to her, because she is unskilled in the area herself, and she goes on:

> *"I know the brand, it is a good one, it also provides some insurance"* [43]

Recognizing the brand enhances the likelihood of her subscribing to this solution, which she shows enthusiasm towards. The former Sales Representative elaborated on how the people he knew with these problems were old, he continued:

> *"...and if they could get some help from a professional regarding the pumps, it would be even better"* [44]

He strongly believes that a solution with a connection to professionals would improve the solution for the older generation, and as he went on:

> *"I also think the solution is desirable for the younger generation because they pay for a lot of subscriptions already, and I know my own children would have this if needed, they are way too busy to pay the proper attention to the pump"* [45]

He confirms with knowledge from his own family that people are willing to pay for getting values of accountability, autonomy and calmness supported. Also, the Molecular Biologist supports this:

> *"I remember once we were on holiday and my mother was to keep an eye on the pump system, but she cannot do anything, I would really have appreciated a professional having the responsibility at that time"* [46]

He welcomes the idea of professionals having the responsibility, enabling him to relax and enjoy his holiday. The state of being constantly alert is consuming a lot of psychological energy. The necessity

of user's consenting to sharing data and agreeing that the system creates data for the purpose of pump development, sometimes without the user having access to these data themselves, could create a barrier. At the same time, several users expressed their willingness to contribute to future development in this field of expertise, due to their expectation of themselves benefitting from this progression into intelligent solutions. This taken into consideration, it might be an enabler to the solution, as the Laboratory Assistant told me:

> *"I would like a better and more reliable system, and development on the pumps is a part of that, and if I always have a well-functioning system because the pumps are getting better and someone takes care of it for me, I assume I will get the best solution"* [47]

Benefitting from provided service in more aspects supports the appreciation in a service agreement solution.

The requirements for a digital monitoring device will in this specific case have to support the values of universal usability, autonomy, accountability, calmness, and human welfare, just like the values of informed consent and privacy are important. A monitoring and notification system will automatically support calmness because autonomy and accountability support this value. Universal usability is the value that will in this case require the most attention when developing the actual software if the preferences of the different homeowners are to be met. Whether the connection should be as an application for smartphones or integration in smart home systems, I am not able to address, because even though several of the interviewed people were enthusiastic about smart home integration, none of them owned such a system and was not able to distinguish between the options and point at which they preferred.

Also, users' reflections on vocabulary and how intuitive the system seems would be beneficial to the designers. So, in the process of the actual creation and coding of the software, I will recommend involving users and paying attention to their responses in the process of evaluating the device. It would likewise be beneficial for the designer because of the concerns some homeowners had regarding their individual ability to alter settings. Getting their reflections incorporated into the design enhances the users' perception of influencing the design and will foremost create a better experience of the product, as argued in Routledge International Handbook of Participatory Design (Simonsen & Robertson, 2013). The design must acknowledge these concerns about users' ability to erroneously change settings and miss notifications to be able to support the value of calmness and human welfare.

Additional Insights from a German office in the Company

After reaching out to different people in the company, it came to my knowledge, that a project similar to my project had been conducted a few years ago, and by reaching out to the involved persons I got a few insights from Germany and Spain as well. Even though the investigation was not done as value focused as my investigation, the insights are relevant, mainly because they have been able to talk to installers as well as homeowners. These investigations have been focused on business development and do not include a lot of interviewees. Still, they found that a monitoring device would be appreciated by homeowners in both Germany and Spain. The installer had also found the connection through an app interesting, though they hesitated to be too enthusiastic about it since they knew that they would be the ones answering questions from homeowners. The business developer explained to me how there were planned activities to process a project within this topic, and that it was stopped because of a change in the cloud platform, and their support was removed.

They are now planning to move forward in the development of the connection to pumps and making it a “real project” as they explained. When calling it a real project, it means the company will invest in the development to a higher degree, and at this point, I strongly believe that the project team from the Bird and these people must enter some kind of collaboration. A lot of ideas supporting the monitoring device have been created as a result of the workshop conducted by the Bird, and these must be taken into consideration in the development project. However, I will recommend collaboration and encourage the sharing of knowledge.

I would have liked to have had this talk earlier in the project, enabling me to look deeper into the material provided by the German office. At the same time, it might have influenced my presumptions when entering interviews and possibly have caused biased findings.

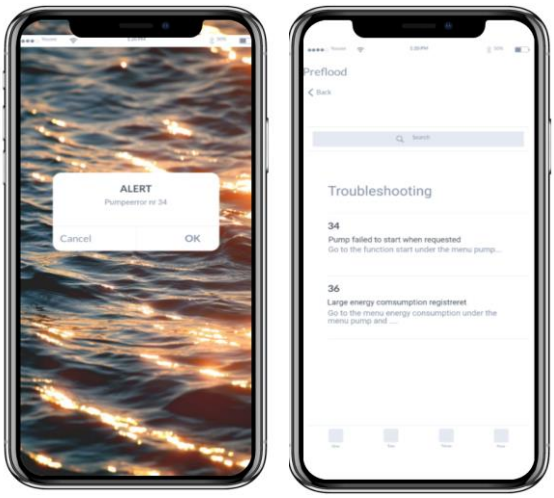
When I Looked into their material, I found that researching from a techno-anthropological angle clearly differentiates from the research done in business development by being focused on the human values in combination with the technology throughout the project. Likewise, the diversity of the interviewees and my investigations into other areas, such as the impact of legislation to understand the homeowners' pain, were not emphasised or not investigated in the prior research.

The Technology

Software Solution for Monitoring Pump Health

The software solution must be created as an intuitive, easy-access platform. For this purpose, it is necessary to support different operating systems like iOS, Android, and others, in all cases it must be compatible with the different systems. Likewise, the option of getting it as a widget connected to your existing smart home system is important, as these systems become more popular. As discussed above, the homeowners interacting with technology to a larger extent are more likely to invest in more technical solutions and new suggestions, due to their worldview and to support their created sociotechnical imaginary.

The complexity of a sump pump system requires expertise to some extent, and therefore there is an indication of the need for a monitoring device. It must be an intelligent solution, where the pump can transmit data about the relevant parameters to. These data can vary depending on what kind of sensors are chosen to be implemented in the sump or the basement. The intelligent solution must likewise have access to information like weather forecasts and measurements on the groundwater level, and an algorithm will predict your flood risk. Just as you will be notified if the pump has a problem starting when needed.



(Pictures of a cell phone being notified and looking into the notification, created in Marvel App creation, (Marvel, 2021))

As shown in these pictures, my suggestion for the device is that it must be easy and understandable, not filled up with irrelevant information and confusing options. The features incorporated in the monitoring device must meet the individual user's needs. This is to be understood as there must be a possibility to opt-in to different features depending on the individual's request, so meeting the wish for persons without technical skills to feel comfortable using the device as well as meeting the needs of people with broader technical knowledge. When a homeowner just wants notifications on pump status in connection to the weather forecast, there must be an option to limit the options available to the user. In the meantime, it is desired to make the system available to a wide range of homeowners, including the ones

who never thought about flooding before. This means that with the right sensors installed, getting information and predictions on flood risk, humidity in the basement, temperature, power consumption of the pump and other parameters should be an option too. To accommodate these requirements, it could be an option to use a level structure where the user must show certain abilities to get access to the next level of features, as Shneiderman & Hochheiser suggest (Shneiderman & Hochheiser, 2001). I believe a more viable solution will be for homeowners to make the suggestions for which features they desire themselves in the purchasing situation. If the system requires a lot of interaction to get started, it can agitate some homeowners from the very beginning, resulting in less feasible customer recommendations. Enabling the data for future flood predictions and enhancement of the pump development will in some cases require the installation of external sensors or new measurement technologies, and an umbrella of ideas for these purposes was generated in the workshop.

To meet the requirements for privacy of data, there must be consent information when signing up for the usage of the system. Depending on the chosen digital connectivity, there must be encryption on the device, ensuring the information is always kept private, and anonymous when shared with the manufacturer for the purpose of improving the pumps in the future. The level of security requested by the homeowners is low, still, insuring prevention against hacking is recommended, hence an unauthorised stop of the pump could have considerable consequences.

Developing this digital solution is a legitimate opportunity for the collaborating company because the expertise for developing the solution is already existing within the company, and they have skilled workers. In the meanwhile, the sales organisation will be challenged, because the usual customer segment regards wholesalers and not private homeowners.

Service Agreement for Sump Pump System

As an extension and to support this monitoring software, the idea for a sump pump service agreement generated in the workshop was reinvigorated. When describing the user stories, I imagined the solution to consist of four levels of service, as listed below.

- Level one:

  “As a homeowner, I want a notification so that I can act in time before flooding becomes a problem”, this is a situation where the homeowner just buys a pump, the installation and the data service requiring a minimum fee. In this solution, the homeowners are always in charge themselves, and responsible for the system, maintenance, and repairs.
- Level two:

  “As a homeowner, I want a notification so that I know that the service manager is coming to fix the problem”, this is a solution where the homeowner buys a pump, the installation, the data service and a service for maintenance and repairs. In this solution, the homeowner will be notified themselves as well as the service provider, and they will coordinate maintenance and

repairs with the service manager. The pump will be replaced in case of malfunctions as a part of the subscription model.

- Level three:
  "As a homeowner, I want the service manager to call me to let me know he is coming so that I am informed about the situation", this is a solution like the second one but in this one, the homeowner will receive a phone call to coordinate the events.
- Level four:
  "As a homeowner, I want a subscription solution where a service manager always keeps the pump and the sump healthy without me knowing so that I am not disturbed during the day with concerns about the sump pump", this is a complete solution, where the service manager is doing everything for the homeowner, no coordination at all, and the responsibility for a reliable sump pump system is placed at the service provider. The pump will also in this case be replaced in case of malfunctions as a part of the subscription model.

In the solutions where the pump gets replaced in case of a malfunction, the pump will be taken in for refurbishment at the pump manufacturer, contributing to reducing climate change by reusing viable parts of the pump. Replaced pumps are guaranteed to function, but are not necessarily new pumps, but the customer will not know the difference and will not be affected by having a refurbished pump.
This service solution is a new business area for the company in collaboration and will require a restructuring of the organisation. It could be establishing a new department for providing these services and coordinating the development of the pump, or it could be engaging with local technicians with experience in the field. In both cases, further analysis of the scenarios must be made to establish whether it is a realistic solution.
Taking the faith, the homeowner expressed in the specific brand into consideration in combination with the German installers' expression of not being interested in providing the service, I believe a new department in the company is the most viable solution.

The Market

Due to climate changes and the raising awareness on preventing flooding of houses, the market is growing, and the company's strong brand can be used to promote a new business model and technical solution and provide the company with a new revenue stream.

As described earlier, there exist solutions to other issues using monitoring of technologies and services with subscriptions, so an investigation of competition is also necessary as a step in the development process. These monitoring and controlling solutions already in the market are not directly transferrable but may be compatible, with the right software integration. The three students from the university whom I collaborated with did a Blue Ocean Strategy Canvas[1] as it is described by W. Chan Kim (Kim, 2005), to evaluate the competition, so I will not go further into these perspectives, although I have looked into the results to have this in mind when talking with the company in collaboration.

Co-creation with a software developer or other companies doing surveillance is worth giving some consideration. A strong brand can in these situations benefit the market potential, also for the other company, like the other company's existing customer portfolio can benefit the pump manufacturer. If the company choose to go in this direction, benefits and harms must be evaluated in every single case. Likewise, agreements on technical provided service are also known within other specialised fields of occupation, so even if some installers expressed "not being interested in taking on this responsibility of being a front figure", it needs more investigation.

Using a subscription model enables the pump manufacturer to engage in sustainability to a greater extent, by taking the pumps back to the factory for refurbishment. Actions like this are highly rated in society today, enabling the manufacturer to reduce their carbon footprint and active work with corporate social responsibility (CSR). Actions of this kind could be a motivation for the customer to choose a pump of this brand over a similar pump from a competitor. Corporations taking social responsibility is today a parameter of competition used to gain market share and promote employee engagement as well, as Eric Johnsen, Head of Sustainability & Business Development at DI - Dansk Industri, elaborates on in a podcast regarding sustainability (Høgh, 2021).

Looking into a subscription model, it will be possible to take advantage of people's growing habit of paying for services of different kinds, this being e.g., home security systems, streaming television, listening to music, workout apps and computer games and programs. If this is combined with the trust people have in the brand, it increases the market potential.

[1] Blue Ocean Strategy Canvas will help you gain a deeper understanding of the competitive environment, the factors by which the industry competes in terms of products, services, and delivery, and what is in the existing market. It is widely used to explore the unknown market, looking into a new market where competition is somewhat different from the known market the company usually deals with. Blue Ocean Strategy is initiated by W. Chan Kim and Renée Mauborgne, Professors of Strategy at INSEAD, and co-directors of the INSEAD Blue Ocean Strategy Institute in France.

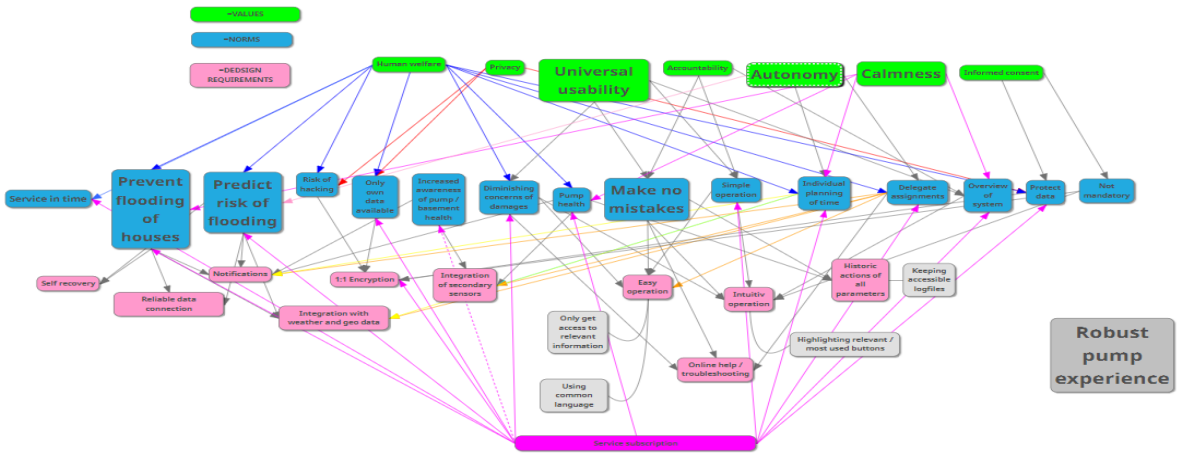
Going back to the market analysis made by the company in collaboration, it showed how further motivating factors were necessary to gain market shares, and as motivation, ability and capacity are elements needing fulfilment for humans to overcome changes we should investigate all branches of motivation (Bandura, 1977). A motivating factor can be easy access to and operation of the product, and introducing a reliable system with infinite durability, due to the free replacement of pumps, are also a reason talking into both ability and capacity. I have experienced in nearly all my interviews that a better system for keeping their houses safe is a great motivation, and homeowners expresses willingness to pay for it.

When working with Value Sensitive Design as in other participatory design approaches, being aware of the context you are working within is important. In my case, I have concentrated on talking to homeowners in Denmark, they live in different parts of the country, have different educational backgrounds and ages, have different circumstances for their flooding experience and have different reasons for dealing with the issue. I believe my empirical findings are a good foundation for proposing meaningful design requirements and validating the desire for a product like this one.

There are many competitors in the market, all withholding small market shares, so coming up with additional solutions to enhance the product would enable the company to gain market shares. If the company pursue the development of this solution, I recommend testing the market using pretotypes as I will describe below.

Pretotype

To evaluate if there is a market for the technology and how the idea must be tweaked to fit the market, a quick and easy way is using pretotyping as it is described by Alberto Savioa (Savioa, 2019). When using pretotyping, it requires a description of the idea, in this case, I produced a value hierarchy as our teacher, Associate Professor Maurizio Teli, elaborated on in a lecture in the seventh semester. This can be used to discover the technological requirements for this to succeed. The hierarchy can extend as discussions will continue, and it can function as a dynamic working sheet.



(Value hierarchy, used as a dynamic working sheet)

A “wanna-be app” to be sent out for people to test the features and the relevant options can be created in “marvel app creation”, which is a free tool for producing software prototypes (Marvel, 2021) Furthermore, it requires a testable hypothesis, like X % of Y will Z, here I suggest going with “50 % of the members of the landowner group on Facebook, seeing this post in the group, will sign up with e-mail addresses to get notified when the technology is available”. This hypothesis must develop over time as the results of the tests come in, and the hypothesis must be tweaked in the direction the users find relevant.

Testing

To test the hypothesis is a delicate step, a lot of things must be taken into consideration. First, if the market is right, in the first case the landowner group. Also, how to test it must be taken into consideration. I believe that the “fake door- pretotype” in this case will be the right solution. The fake door is, as Savioa argues, a great way to evaluate how interested users are in buying your product (Savioa, 2019). In this case, the designed pretotype is like an app for monitoring your pump and other relevant parameters, along with a firm description of the service agreement subscriptions and by pushing the material into relevant groups, it can be investigated how many people want to sign up for further information about the product, by encouraging them to give up their e-mail address. A stronger indicator could also be adding a “preorder” button, to evaluate the willingness to pay a fee in advance. At this step, I will encourage providing the users with a price tag for the solution as well for the sake of investigating if the price influences the user's decision on whether to subscribe or not. Although emphasising values is important, this is a business, so revenue must be created.

Value Sensitive Design as an Enabler of Better Revenue

Revenue has the awareness of every corporate leader, expanding the business into new areas and creating ideas for new technologies, is a core objective for the company in collaboration. An expression of being born digital is a focus point in the development of new ideas at the company, and as the potential in digital governance has accelerated over the last decade, it seems reasonable and meaningful to investigate digital solutions. We have, in society seen, how reporting taxes, applying for public help at the municipality, communicating with schools, signing up for sports activities, or even buying a train ticket have been digitalised in the last decade. In fact, if you do not have a credit card or the "train app" on your smartphone, you are not able to buy a train ticket at the station in the town where I live. As mentioned before, all these digital solutions with interconnectivity and smart automation are changing technology, society, and human inhabitants. This is just a part of living in the Fourth Industrial Revolution, as Schwab argues (Schwab, 2016), but humans need to pay attention and take responsibility:

> *"In the end, it all comes down to people and values. We need to shape a future that works for all of us by putting people first and empowering them. In its most pessimistic, dehumanized form, the Fourth Industrial Revolution may indeed have the potential to "robotize" humanity and thus to deprive us of our heart and soul. But as a complement to the best parts of human nature—creativity, empathy, stewardship—it can also lift humanity into a new collective and moral consciousness based on a shared sense of destiny. It is incumbent on us all to make sure the latter prevails"*
>
> *(Schwab, 2016)*

When moving towards less direct interaction between humans and more interaction with digital devices, we need to understand how we can support human values in our projected solutions. When designing for a specific purpose, the shared sociotechnical imaginaries will concern the intended users and not the majority of our society as it is described by Jasanoff and Kim (Jasanoff & Kim, 2013). Even if a value as universal usability is particularly important, it is not because the technology will be used by everybody owning a smart phone or a smart home system, it regards the diversity amongst the users, even though they are only a small group of all citizens.

This is a significant reason to make serious, in-depth inquiries before starting to design the technology, and Value Sensitive Design can make a valuable contribution to this process. Understanding the people you design for is just as important as understanding the technology. These people share the same imagination of something better coming in the future, provided by this technology.

Presenting Results to the Bird

As this project is a collaboration with a pump manufacturer, the results must be handed over at some point and to communicate my findings to the Bird, I set up a meeting where I presented my findings to the group. As the group is innovative and appreciates new angles, I decided to move away from a PowerPoint presentation to make drawings for the discussion and to have the departure from this point. I started by shortly explaining the problem that we are addressing with the suggested solutions, then I went on with a short explanation about the monitoring device and the service that I see as a possible solution to the problem. Already in this stage, I lost one of the participants since I had a presumption about them all knowing the described solutions in forehand since we have discussed them earlier. We had a discussion and I elaborated on how I had explained the solutions to the interviewees, using the user stories as an explanation and for them to imagine the solutions. I assume the misunderstanding was grounded in that they thought I was presenting it as if it were an unknown project to them, just as if I were presenting it to someone in another department. I was addressing them as colleagues, as members of the project group and them having an existing knowledge, I only explained what I found relevant for them to catch up, and at this point, he was with me again.

Then I described why the homeowners found the monitoring device and the service solution desirable, with the arguments from the interviews, and connected it to the benefits for the pump manufacturer. I furthermore elaborated on the seven values I had picked out to be relevant, what these human values mean to me and to the homeowners, and why it was these seven values picked. Then, I explained how gender, age, and other factors could influence the way homeowners answer, as well as if it is sometimes a combination of these factors.

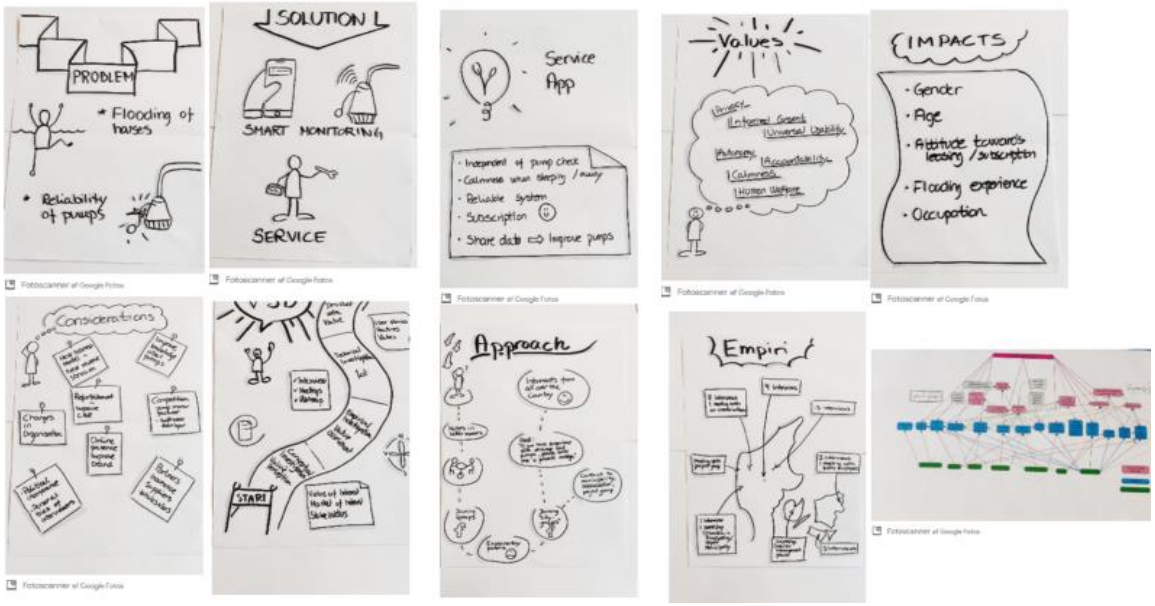
Furthermore, I touched upon some issues relevant to take into consideration when entering this new area of business, and some angles that should be investigated even more. As the last point, I went on with a description of the tripartite methodology of Value Sensitive Design, how I in the conceptual investigation looked into the value of interest, the market of interest and mapped out the stakeholders as a part of the research on existing solutions. I told them about the process of value assessment during the empirical investigation, conducting interviews and doing fieldwork of different kinds. Likewise, I explained how the technological investigation in this project consists of a prototype constructed as an information flyer using user stories, to give the conversations some direction and an understandable foundation. After describing what happened in the different stages and showing the constructed, Value Sensitive Design hierarchy, we used the hierarchy for a collaborative discussion on the design requirement for the software technology.

We then discussed what was missing in the presentation and in the hierarchy and added some more boxes to my working paper. Realising that the company would appreciate to have insights into how I had approached homeowners, and how many interviews, meetings, and workshops I had conducted and participated in to validate my findings, I extended my presentation with a few more drawings. Also,

they thought it would be valid and appreciative to incorporate more ideas generated in the workshop we had at the beginning of my stay with them. We had interesting talks about how I had approached the interviewees, and the diversity of the people included in my analysis, and they found my findings relevant and useful for argumentation when pushing the ideas forward to the management.

Some interesting findings like the fact that homeowners are willing to share data to contribute to the development of sump pumps are important knowledge for the manufacturer because as it is today, they have truly little knowledge about when and why the pump breaks down. This is because it is a box product, sold and never returned to the manufacturer for repair. Getting data about, e.g., when the pump runs, will increase the knowledge about weak parts in the product, and thereby give the manufacturer the ability to make a more reliable product and even estimate the lifetime of the pump. So even if the homeowners may not want a lot of features and information from the monitoring device, these data will be useful for the company. This kind of insight has not been investigated in former interviews performed by the company and must be seen as an important contribution to them. Like homeowners expressed interest in a service solution for the sump pump system, and how this would support human welfare, opens an opportunity for a new business model.

My methods for approaching homeowners, using the knowledge I have gained over the past years studying techno-anthropology, are somehow different from the methods usually used in the company. Gaining access to stakeholders can cause pain, especially people being willing to let the interviewer into their deepest thoughts. I managed this by browsing through interesting groups on the internet, going to these places and participating in public workshops regarding this issue. I have learned that putting too much effort into getting in contact with a specific stakeholder sometimes is a waste of time, and when you find it truly relevant because no one else has the same knowledge, you must try harder.

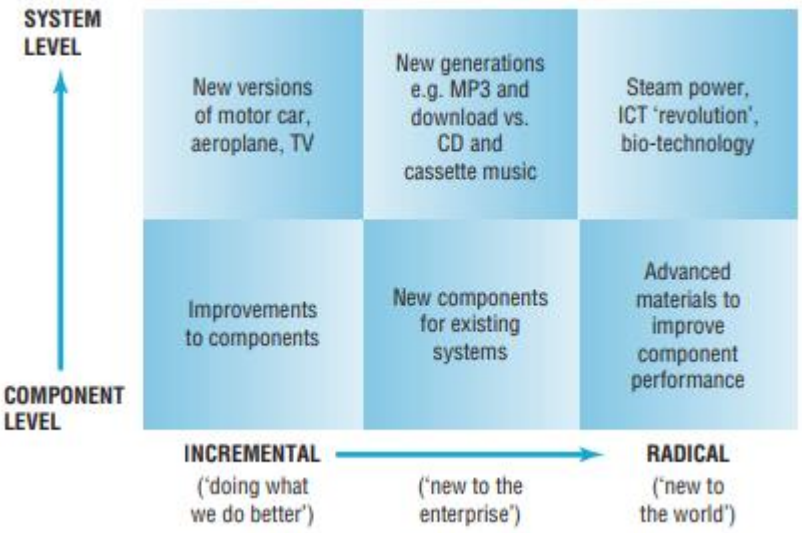


(Pictures of the drawing used for the presentation)

The Bird wanting to use my findings as a contribution and for argumentation when pushing ideas forward in the organisation is a particularly good incentive for having techno-anthropology as a discipline in a corporate situation, and it is satisfying to know that the effort I have put into the project is appreciated and viewed upon as a professional performance. They expressed satisfaction with the presentation and saw these investigations as relevant and useful, just like doing something else than a PowerPoint presentation was welcomed, as these drawings will be put up on the wall as inspiration and be a part of the office decoration.

For the management to invest in an idea, they must have some foundation and arguments concerning why this specific idea is a great idea. In this situation, the diversity of interviewees all welcoming the suggested solution substantiate the user's incentive for buying the product. The willingness to share data and the company's opportunity to improve its engagement in sustainability are likewise findings that support the desirability of the product, both for homeowners and for the engineers developing pumps.

Innovation has over the years been defined in many ways, by many people, and in the context of business management the Austrian economist Joseph Schumpeter explained it as “creative disruption” (Bessant & Tidd, 2015). The essence of innovation is creating something new, and as shown below new is not only a new artefact, new can be composed of old technologies embedded in new ways, services transferred to other occupational fields or an improvement of a tiny component of a product.



((Bessant & Tidd, 2015) pp 41)

When looking into existing products and enhancing their resilience or endurance we would describe it as incremental innovation, while the development of a product, a service or a business model that has never been seen before is radical innovation. In either situation, we interact with both technology and humans, and a technology push is just as relevant as a demand-pull to enhance the technical functions and establish a commercial foundation for the invention (Bessant & Tidd, 2015). Just inventing is not innovation, it has been shown many times over the years how a presumably great idea for a product ends up being a total failure. Failure, because the main objective was the product, and little attention was given to e.g., how the market developed, the financial aspects, how organisations should adapt to it and even if the customer segment changed.

Incorporating value sensitive design in the process of innovation can enable how the innovator is forced to engage with different aspects of and to the product and the potential market when going through the conceptual, the empirical and the technological investigation.

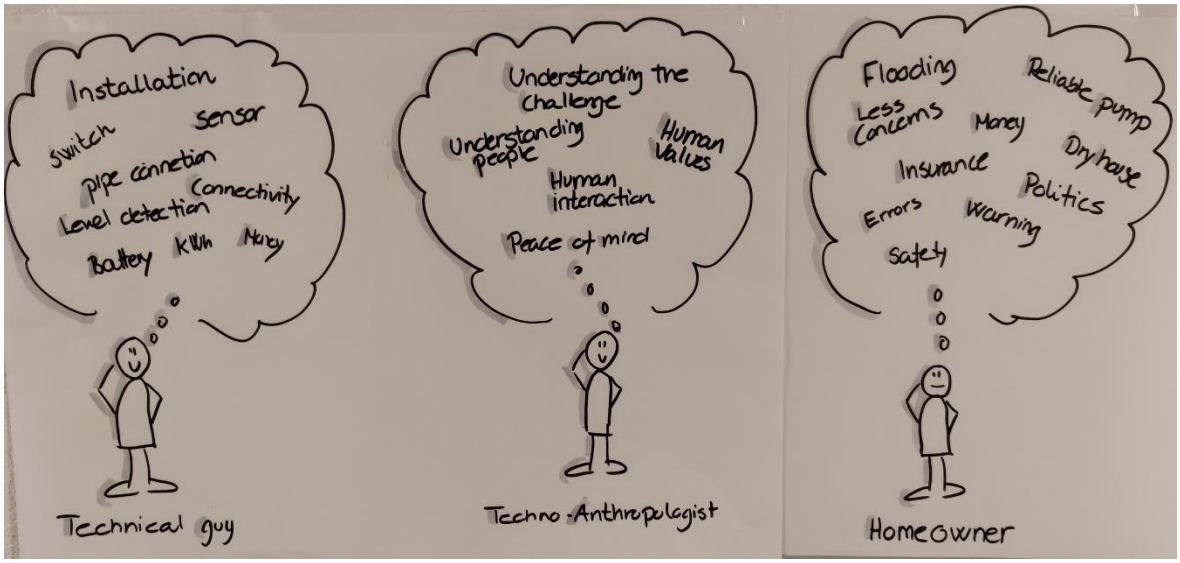
Digging deeper into human values and creating a thorough understanding of the context enhances the chances of success.

My Impact

As a part of validating my research and its usefulness, I decided to talk with the two engineers I have worked closest with. During this conversation, it was confirmed that my findings were useful and needed, if they did not believe that I would make a meaningful contribution, they would not have entered the collaboration in the first place. They expressed how I have confirmed the original idea, and how the findings are a contribution to support the gut feeling.

They describe how they, as particularly technical skilled people, have other angles to problems and another point of focus when interacting with homeowners. With my different academic background and diverse approach to problems, my interaction with homeowners with the objective to unfold their values brings humans into the context on another level. I have also contributed to the diversity in the project group, forcing the group members to think in new directions, and supporting a broader mindset in the group.

My findings have supported some ideas from the catalogue produced in the first workshop and have had a positive impact on the decision made to go further with a sprint on some of these ideas.



Conclusion

Based on thirty-three interviews, participation in three meetings and two workshops, I have gathered information about what is at stake for homeowners in flood-prone areas, what values they hold most dear, and what can be done to provide homeowners with a solution that provides them with peace of mind. To provide me with these insights, I have used a SCOT map to understand the relevant stakeholders and consider their problems as it is described by Klein & Kleinman (Klein & Kleinman, 2002). When interacting with the homeowners, I have used the Value Sensitive Design approach as it is described by Friedman (Friedman, 1996), and throughout the project having human values in mind. I have had discussions with professionals from the company I collaborated with, and reflected on their inputs, in the next pages, I will summarise the key insights gathered through analysing the empirical data.

The data is gathered in a Danish context, spiked with a few insights from market research done a few years ago in Germany and Spain. Even if it covers a diverse range of the population in Denmark, it will not be directly transferable to e.g., India. The company in collaboration have, as a global business, considerable insights into where these data will be comparable, and they now have a foundation for further development.

I have seen how homeowners experiencing challenges with flooding events are troubled in both a psychological, economic, and material manner. They pay large sums to prevent their houses from flooding, some face a reduced economic value on their property due to damages caused by water entering the house or merely due to the increased risk of flooding at the property. Concerns about pumps not starting when needed or stopping due to malfunction causing a high risk of a flooded house are keeping the homeowners awake at night. The issues regarding a malfunction of a pump have shown to be a significant concern for the homeowners, due to both the severe consequences it can have in some situations and that some homeowners have experienced a malfunction before, causing an increased awareness of the problem. These challenges are preventing them from having peace of mind. If we were instead preventing their houses from getting flooded and providing them with a system notifying them in case of problems, we can increase their ability to have peace of mind. Furthermore, an additional solution regarding a service agreement for the sump pump system can add an extra layer of security, and the pump manufacturer can get the pump into the factory for refurbishment, enabling them to gather knowledge about which part of the pump was worn out.
I would have liked to incorporate an angle where deduction in insurance premium, when using the suggested system, was an option, but here I experienced difficulties gaining access. I approached seven different insurance companies, some by “ordering a call”, some by writing an explanatory e-mail, and

some by reaching out to their business developer by contacting them directly. In some cases, I did not get any response at all, and in other cases, the response was that they did not have the time to talk to a student, due to the number of requests they get. That is of cause understandable, but I wonder how they had responded if I had approached them as a representative from the pump manufacturer instead. This was not a possibility at the time, but when the company pursues the idea, I will recommend them also to go in this direction.

The company have a large, well-defined sales department, with divisions responsible for different areas of the customer segment. Due to the importance of the relationship, the salespersons have built up over the years when collaborating and meeting customers' needs, I was not allowed to interact with any existing customers. These customers are mainly wholesalers and installers, meaning that these stakeholders were off-limits in my investigation. The main issue was the risk of misunderstanding in terms of the customers expecting the product I investigated to be in the market in a few months, and it will not. Confusion like this can have a considerable impact on the relationship between the salesperson and the customer and bring the salesperson into a less trustworthy position. Although I would have liked to have done research on and elucidated their point of view regarding the project, I found it to be a better solution, letting the Bird pitch the idea to the sales organisation at some point, and then process these investigations.

When we are looking into how human values are appreciated by homeowners, different values will be perceived in various manners depending on the homeowners' worldview. Their worldview is formed by the individual's history, struggles and experiences in the past.

In some interviews, I experienced the homeowner being resentful toward the municipality because they are responsible for maintaining streams and lakes. This resentfulness can have caused them to have a more painful experience of the flooding events, due to their reduced options for flood prevention as a homeowner. I cannot rule out that this personal bias can have influenced some responses, although I reflected just as much on the tone of voice and state of mind as the actual statements when analysing the data.

Using the Value Sensitive Design, I have selected the values I found important in this specific context. Privacy and informed consent are necessary values when talking about software and data management. These values are not found as particularly important by the homeowners in this context, but they are just expecting compliance with the legislation in this area. This expectation and the data not being significant sensitive data makes these low prioritised values in the homeowners' minds. Human welfare is the optimal state to reach, and by supporting a balanced psychological state of mind, this technology and solution will contribute to increasing human welfare. The values of autonomy and accountability are found to be important and are values directly supported by an insuring solution, making the system more reliable and freeing up time for other purposes, creating more psychological energy in the individual by removing concerns about flooding issues. Likewise, calmness is a value worth supporting, and supported by the above-mentioned values calmness will be an enabler for creating peace of mind

for the homeowners regarding the sump pump system. For all these values to be supported realistically, the value of universal usability is crucial to be supported, and the homeowners have a quite diverse perception of how this should be done. The perceptions of the preferred features were ranging from limited options for features to a desire for the ability to change settings themselves. This diversity can be met by levelling the granted access in the software, creating a successful experience for all users. Likewise, the options for different levels of service can support this value.

The homeowners also expressed an incentive to share information about the operational state and general health of their pump, e.g., when it runs, for how long and have the pattern changed over time. They all found it relevant and desirable to contribute to the development of the pumps in the future, so sharing insights about the pump with the pump manufacturer was of no concern to them. In situations where the interviewee expressed satisfaction with getting limited information themselves, they were still willing to share additional parameters to improve future solutions. These are valuable insights since the company does not have this information about the pump today.

Our objective is to provide the homeowner with a robust pump experience and the main values that must be supported are universal usability, autonomy, and calmness. The most important norms we want to support are the prevention of flooding of houses, prediction of future flooding and enabling homeowners to have a successful user experience. To enable this, a lot of ideas for technical solutions have been discussed in the Bird and some have been selected for further development.

I have seen that there are already existing solutions, in surveillance, monitoring, providing service agreements and even solutions of similar character regarding pumps in the US. I have explored the solutions and the market, and adding a subscription model for a service agreement solution for the sump pump systems will create an extra layer of security for the homeowners, providing them with peace of mind. Also, the solution can provide the company with valuable information about why pumps fail, thereby creating options for new development and extending the business for the company.

This project has contributed to the knowledge about homeowners' preferred features in a monitoring device for sump pumps and validated the market for a service agreement solution for the sump pump systems. This knowledge gained is desired for the pump manufacturer in the investigation of further business development and the angle taken brings values into a new light, when discussing value proposition within the company. Important takeaways are why homeowners prioritise as they do.

Fitting techno-anthropology into the context, I have found that visiting the homeowners at their premises, enabling them to feel comfortable and showing me sites influenced by the flooding issues, generate deeper insights. People expressing themselves in their own language gives a more nuanced picture and being at their home, they could easier imagine the solutions we were discussing, and come up with examples of where and how it could have been useful. These insights are bridging homeowners' values and requirements for the design of relevant solutions.

I found that the most desired solutions were a device notifying homeowners in case of a malfunction of the pump or other issues needing attention, in combination with a solution for a service agreement for the sump pump system. You could argue, that just going with the development of an application for monitoring the pump would be a good idea, the development is manageable, there is a market for it, and it will provide some peace of mind to the homeowners. The majority of homeowners having flooding issues do not have many skills regarding drainage and pumps, so when malfunctions occur, they are often brought into a position where further actions by other people will be required. This can create uncertainties for the homeowners, maybe on another level, still causing them trouble and interruptions in case of failure. Combining the monitoring of the pump and providence of service is a security that would reduce these uncertainties to a greater extent, bringing peace of mind to the homeowners. By exploiting the benefits of a reputable brand in combination with people's growing habits of using subscriptive solutions and their comfort with it, the company can expand their business and gain market shares.

A solution of this kind can contribute to making the sump pump systems more reliable and thereby increase homeowners ability for keeping their houses dry.

Future Perspectives Regarding the Solution and Related Research

The solution suggested in this project can provide homeowners with reliable protection from flooding of houses, saving them from concerns about the expenditure and the inconvenience associated with flooding. The homeowners' desire to have a solution of the kind has been validated in a Danish context. The extreme weather situations and raising levels of groundwater due to climate changes extend the market for products like these. The issues concerning flooding and the increased occurrence of these events are a global challenge, the market is growing, the competition is fierce and enhancing the available products can enable the company to gain market share. A business model where the pumps are returned to the manufacturer for refurbishment will ensure a circular economy, enabling the company to improve its CSR. Doing a life cycle assessment on the product is important to validate the promotion. The company is already engaging in products with connectivity and the development of an app has already started, so the company has the competencies in-house to proceed with the development. A new business model regarding the service agreement is required, and considerations of different set-ups in different contexts are important. Change in the organisation is required to proceed with this, but simultaneously it opens up new business opportunities. Organisational changes in a large company like this require hard work and time for employees to adapt, so these changes are considerable undertakings and projects in themselves. Still, these arguments advocate pursuing the development of the idea and creating new revenue streams for the company.

Entering a collaboration with insurance companies where, as a suggestion, the homeowner gets a deduction in the premium or gets an option for full coverage by the insurance in case of flooding, could provide for a good business case. I will suggest pursuing this collaboration to create new sales channels through the insurance companies, as well as providing the homeowner with an opportunity to engage with solutions beyond the pump.

I have experienced how homeowners are not perceiving values of privacy and informed consent as real values, more as something expected to be met. Its importance has not been diminished, though influenced by the Fourth Industrial Revolution and governed by the GDPR, it is incorporated into our daily life, and we do not give it much attention in cases like this.

Furthermore, other legislations pushed by the European Union create frustrations for the homeowners because of the ambiguity in how to interpret these directives. In the light of that, I believe it would be relevant to investigate how legislation in the field of environmental sustainability, biodiversity and nature conservation is interpreted in combination with how it impacts the landowners' opportunities regarding the protection of their land and houses.

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