Displaying rainy days in Bergen(s Tidende): Combining weather and news in a user-friendly way

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Chapter 1. Introduction

1.1 Background

Weather is not just something we talk about when we have run out of interesting subjects, it affects our day, mood and weekly plans. It is an interesting part of nature, thus it is intriguing to look at how to best use and present data related to weather. As a resident of Norway's rainiest city, I also find it engaging to tie the city's attitude towards rain to my research.

Weather being displayed with news is not something that has been seen much in Norwegian digital newspapers. Aftenposten (Schibsted) currently has a very simple weather report, only containing weather icons and the temperature for four days. The biggest national sources of news, TV2 and NRK, present the weather after their news reports on their broadcasted news programs, but not directly on their online news pages.

This thesis works with BT (Bergens Tidende) to "develop relevant and 'true to brand' weather services on their platforms". Bergens Tidende is a local daily newspaper covering the western part of Norway. The paper originated in 1868 and is among the oldest newspapers in Norway (Dahl, 2010, p. 49). It is today the biggest newspaper outside of the Norwegian capital, Oslo. They currently cover the whole backside of their physical newspaper with a weather forecast, but wish to rope it back into their digital platforms. This is due to the front page of BT's website receiving a large number of visitors, such as the approximately 120 000 unique visitors that had viewed the site's front page in the last week of October 2020 (F. H. Pedersen, personal communication, 2. November 2020).

The western part of Norway, especially Bergen, is known for their hardy and rainy weather. BT wants to play on the locals' love for reading about weather by enhancing the presence of weather on their platforms, and thereby hoping to strengthen their position as the primary news source in the region (F. H. Pedersen, personal communication, 11. February 2020). The contents of the assignment included, but was not limited to:

1) A personalized weather forecast on the front page, where the degree and method of personalization was up to the study to decide. 2) Enriching articles tagged with weather by displaying relevant forecast data. This could be an article about a storm accompanied by wind data, or an article about the summer arriving with a long-term forecast. 3) Visualizations of theme pages about weather and/or climate, which BT already has for culture, sports, and more. 4) Unique alerts in extreme weather, like storms, heat waves or floods. And 5) bathing temperatures etc. for the summer months.

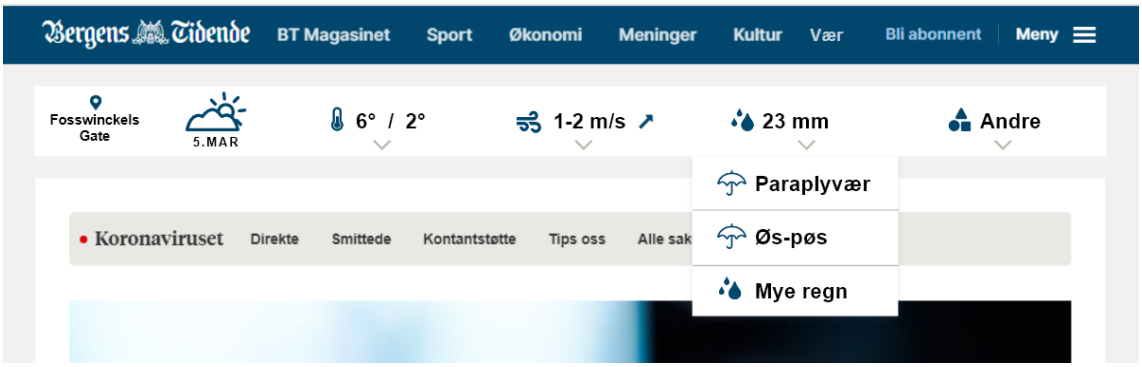


Figure 1: One of the designs made in this study, related to the first point on BT's list.

1.2 Objectives

To meet BT's request, it is important to understand the needs of their readers and how to meet them. Thus, this study aims to answer the following research questions:

- **RQ1.** What different needs do the users of weather services have? And how can we cover these needs in a customizable weather widget?
- **RQ2.** What makes a good summarized local weather report?
- **RQ3.** How can we use user-centered design to gain insights to create different weather forecast designs?

To answer these questions, we will conduct a literature review on related work and relevant literature, make use of evaluation methods to collect insight about user needs, and employ methods of development to build a prototype to test on users.

1.3 Contributions

With this study, the insight collected via survey, interviews and user testing will be valuable for future projects regarding news and weather. It will especially sustain those who wish to develop weather services locally, and even more specifically, news organizations that wish to develop and implement their own weather themed designs. Additionally, the findings of this study are a contribution towards the organization who provided the task and presents a detailed prototype for further development.

1.4 Thesis outline

This thesis contains five chapters including this introduction. **Chapter 2** conducts a literature review of related work regarding weather and news, followed by a look at user-oriented design theory. **Chapter 3** addresses the methods used. First, it will describe Iterative and incremental methodology used to develop a prototype. After, it will discuss methods of evaluation like surveys, interviews, heuristic evaluation, user testing, and how these were used in practice. In **Chapter 4** the results from the various methods of evaluation are presented. Finally, **Chapter 5** summarizes the findings of the study in correlation to the research questions, along with future work.

Chapter 2. Literature review

2.1 Related work

Oh no, it's raining! A study of how information in online weather reports is interpreted, integrated, and used in everyday decision-making by laypeople

In 2016, Anders Doksæter Sivle studied the communication between weather experts and everyday people. Their thesis aimed to investigate how online weather reports are understood by its users in regards to degree of certainty along with previous knowledge. This included analysis of factors that influence the amount of information used by the users, the reasonings behind certain user behavior, as well as how complex and uncertain information from the popular Norwegian weather service Yr.no is handled when making decisions for everyday weather-dependent activities.

The results revealed that for the most part users interpreted forecast information close to its intended meaning (p. 140). However, there was sometimes a clear variation of how end-users interpreted the symbolization of icons such as the color of clouds and amount of raindrops. This was affected by prior experiences and reflections of symbols and words. The studies showed that the information in weather reports should be easy for a user to tie to prior experiences. The thesis uses symbols and wind information as an example and suggests that it should be nuanced and appear realistically to achieve effective communication (p. 141).

The paper also stresses the importance of multiplicity of representations, for example having maps, graphs and sum-ups all be available to the user and let them have a choice between types and amount of information (p. 141). This is due to the varied needs of users, especially when making well thought out decisions versus making quick decisions around weather dependent activities. It also enables everyone to acquire information in a way that they like and understand. However, too much information could create distractions or make the information more demanding to read, so it is advised to not go overboard (p. 142).

It is suggested that local experiences and differences between cultures and social groups should be considered when making a weather service. Making use of widely used guidelines for weather services is useful, but making sure it is understood locally by understanding the culture leads to more efficient decision making (p. 142). A way to integrate this could be to have some fun local words for how much it is raining. Like “hølj-regn” or “øs-pøs”, which are expressions for heavy rainfall, or “pingleregn”, which is an expression for rainfall with smaller raindrops or drizzling.

300 Billion Served. Sources, Perceptions, Uses, and Values of Weather Forecasts

In this study from 2009, Jeffrey Lazo, Rebecca Morss, and Julie Demuth conducted a survey towards U.S. citizens to understand the public's sources, perceptions, uses, and values of weather forecasts. It had 1500 participants and aimed to understand 1) where, when, and how often they sought out weather forecasts; 2) how they perceived forecasts; 3) how they used forecasts; and 4) the value they placed on current forecast information. In regards to general human behavior, the data provided by the study is valuable in order to understand how the general public uses weather services. However, it should be noted that due to the sample of participants consisting solely of U.S. citizens, there may exist possible cultural differences between the U.S. and Norway that could affect survey responses. Despite how long ago the study had been published, it does continue to be useful for this thesis – in which the survey has asked some of the same questions – by supplementing data from a larger sample participant pool. It should also be noted that the study touches on the monetary value of weather forecast information per household, which is not relevant to this thesis.

When surveying the use of forecasts, the study asked participants to rate the importance of 14 different types of information in their weather forecasts. As seen in figure 2, precipitation and temperature were the most important factors. When and where precipitation would occur were among the most important aspects to the survey takers (p. 791). In general, a majority of respondents indicated that chance, type, and amount of precipitation were very or extremely important to them, as well as high and low temperature. When comparing the importance of when high and low temperatures would occur to the occurrence of precipitation, the precipitation came out on top. The paper theorizes that this may be because of the difference in impact, as precipitation may have a larger personal impact than temperature, along with the fact that temperature oscillation is more stable than precipitation occurrence (p. 791). The forecast attributes deemed least important were cloudiness and direction of wind. The study also notes that even though wind speed and direction, humidity, and cloud coverage were less important than precipitation and temperature, they were rated as extremely important by 5%-11% of the participants, which indicates that they are still highly relevant to some users (p. 791).

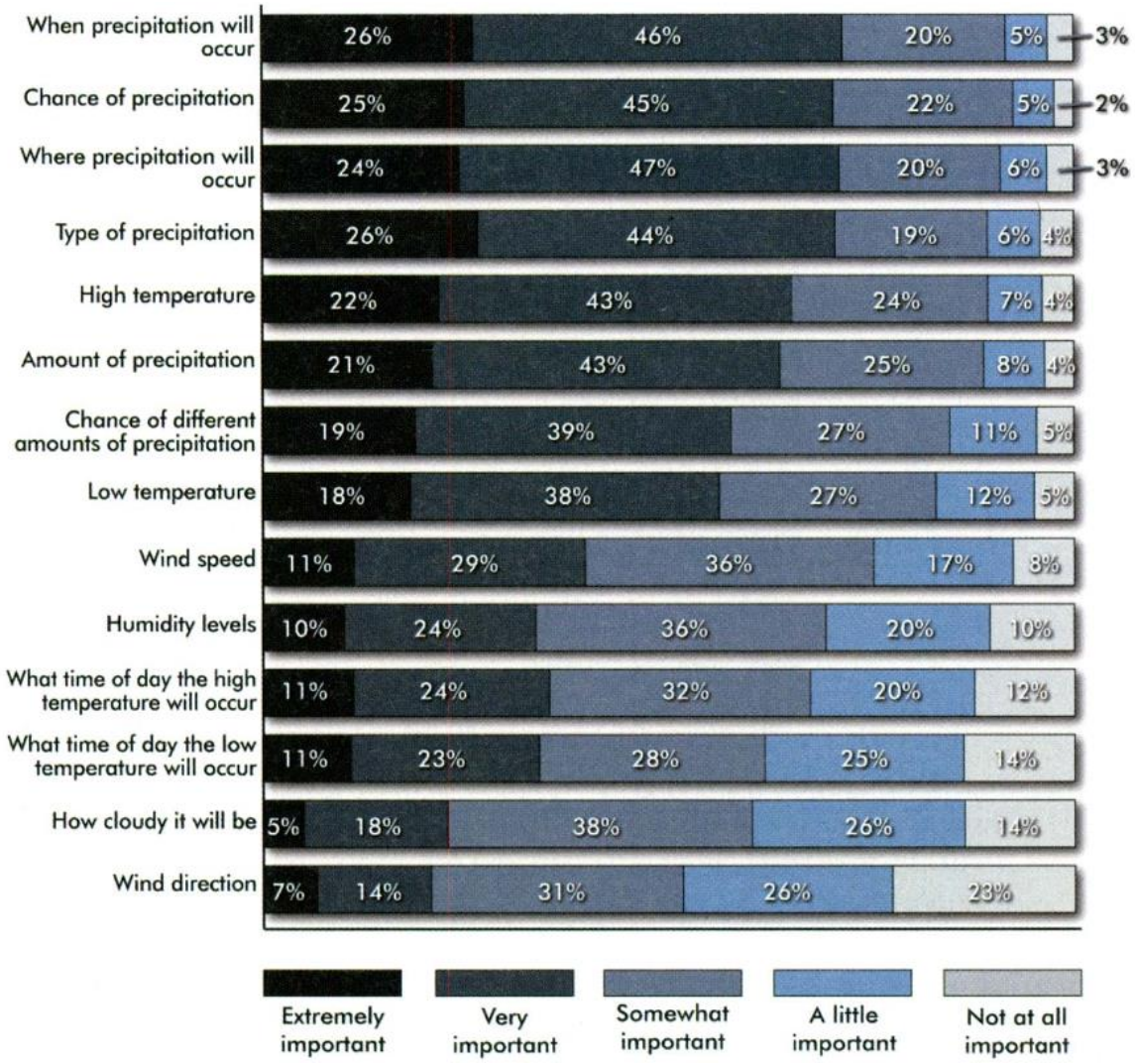


Figure 2: Participants were asked "How important is it to you to have the information listed below as part of a weather forecast?" (n = 1 465).

To examine decision making, the survey asked how often, on average, the participants used weather forecasts in relation to a variety of activities. Around 85% of the participants responded that they checked the forecast simply to know what the weather would be like. The paper theorizes that this may indicate that people have a high interest in weather regardless of planning needs, and that some may even find weather entertaining in some way (p. 792). The paper also notes that people who were not able to articulate any specific reason for using forecasts may also have landed in this category (p. 792). The remaining results showed that participants were more likely to use forecasts for activities where they had more freedom, like planning what to wear or weekend activities. Activities that they had less control over, like getting to work or school – or activities at said places – made participants less likely to use forecasts (p. 792). Though it should be noted that 20%-30% of participants answered that they usually or always used forecasts for these activities, so there were still a fair number of users with those needs.

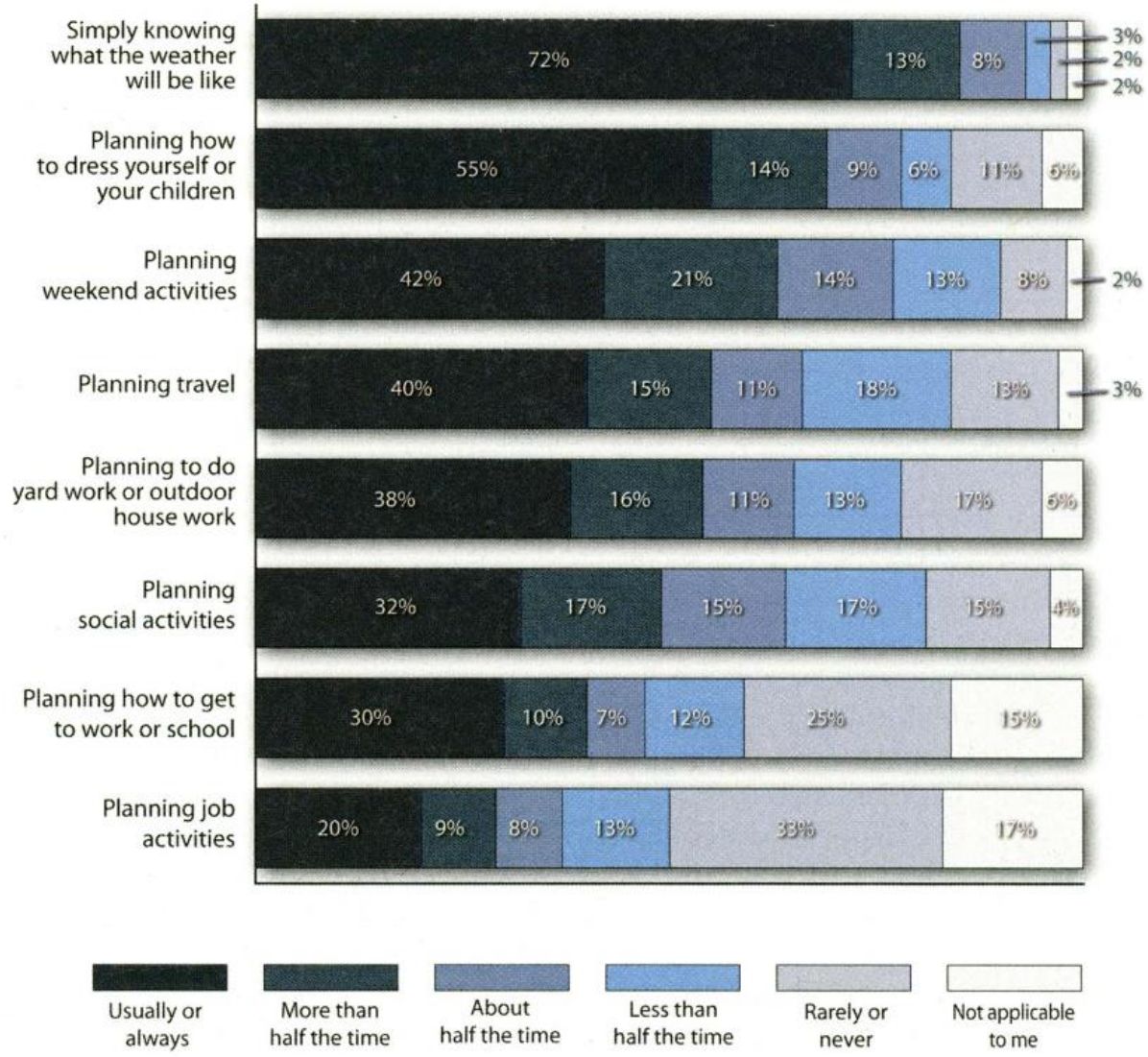


Figure 3: The participants were asked "On average, year round, how often do you use weather forecasts for the activities listed below?" (n = 1 465).

What is a good forecast? An essay on the nature of goodness in weather forecasting

In this essay, Allan Murphy (1993) identifies the “goodness” of a weather forecast by three categories: consistency, quality and value. He defines consistency in a forecast as the degree it matches up to the forecaster's best estimate or judgement on the weather situation (p. 282). For example, if the forecaster is uncertain in their judgement and this is not reflected in the corresponding forecast in either words or numbers, there is a lack of consistency. Quality reflects the degree of correspondence between forecasts and observed events (p. 283). Reliability, resolution and discrimination may be taken into consideration when identifying quality. Lastly, value relates to how useful the forecast is to a user (p. 285).

The studies done in the essay suggest that these three values can affect each other. For example, failing to maintain a high enough level of consistency can directly reduce the expected forecast quality and forecast value (p. 292). To achieve high levels of all three types of goodness, the paper recommends paying close attention to the formulation, evaluation and communication of the weather forecasts in question, and identify possible beneficial changes (p. 291).

Despite this study's age as well as the technological advancements of today's weather forecasting systems, the three factors of consistency, quality, and value, are still crucial to modern forecasts.

Seasons in the sun - weather and climate front-page news stories in Europe's rainiest city, Bergen

This paper by Elisabeth Meze-Hausken (2007) is a research article that studies the front-pages of printed media in a span of 10 years. The aim of the study is to look at the different contexts in which weather and climate are published as a front-page news article (p. 17). The study gives some possible insight to what is important and interesting to a local user in a town such as Bergen.

By analyzing the front pages of Bergens Tidende, the study found that the context was wide, ranging from articles with an entertainment aspect giving information on damage and accidents caused by weather, to more serious articles debating climate changes (p. 29). The study additionally asks what makes good and bad weather by comparing the descriptions with factual meteorological data. It found that good weather is as least as important to the reader as bad weather (p. 29). Meaning readers were just as interested in reading about the upcoming rainy weather as the sunny weather. Seasons also had an impact on the perception of good and bad weather. The article infers that for defining a nice weather day in the winter, the amount of sunshine is most important (p. 29). In spring, events like Easter and other celebrations and events affect the perception of a nice weather day, along with the expectations of escaping winter. Additionally, the sunshine and temperature range of a beautiful day is larger in the winter than during other seasons. In general, days with some sunshine and moderate temperature that follow a bad weather period are viewed as wonderful weather (p. 29). For bad weather, the article describes this as harder to define because the amount of rainfall does not have to be high. Duration and intensity of rainfall can be factors that land the weather on a front-page article (p. 29).

An especially interesting finding was the notion that the people of Bergen pride themselves on living in the wettest city, and can seek comfort in this notion combined with participating in rain-themed events (p. 30). This insight implied that an "x days with rain" counter would be a potential feature, maybe paired with a counter for sunny days. The Bergensers' pride over rain also strengthens the cultural argument for using local words for rain.

2.2 Theory

Human Computer Interaction

As the name of this concept indicates, HCI touches on the relation between humans and computer technology. The Interaction Design Foundation (n.d.) defines HCI as “a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers.” Furthermore, they point out that HCI has over time expanded to cover most forms of information technology design.

The Design of Everyday Things

Don Norman (2013) provides a seasoned perspective of how user-centered design should function, and what principles should be followed to create a good user experience. He defines experience design as “The practice of designing products, processes, services, events, and environments with a focus placed on the quality and enjoyment of the total experience.” (p. 5). He refers to user-centered design as human-centered design, and describes it as an approach that puts human behavior, needs and capabilities first (p. 8).

His terminology makes it easier to put into words why something should be included and why it works. With his 7 principles of design, designers are made aware of possible faults and shortcomings in a prototype, as these guidelines can be followed where they are applicable. The first principle, discoverability, means that the user should easily be able to determine what actions are possible (p. 72). Discoverability is a result of five fundamental psychological concepts coming together from the overarching seven. These are affordances, signifiers, constraints, mappings and feedback (p. 10).

Feedback communicates the results of an action (p. 23), like the light signaling that a computer monitor is turned on or in standby-mode, or the sound from a doorbell when someone rings it. Feedback should be immediate and not overstimulate or understimulate the senses of the user. If a user wants to switch out wind metrics for wind descriptions, the change would have to kick in as soon as it has been selected. If the change was delayed or needed a refresh to kick in, the feedback would be inefficient. The design could also use other measures to ensure good feedback in this example. A visual feedback like a checkmark insinuating that the changes have been saved, would be ideal.

The next two principles are affordances and signifiers. Affordances refers to the relationship between an object and a person, and are determined by the abilities of the interacting agent and the qualities of the object (p. 11). It is how we determine how something should be used. In the real world, a chair affords sitting and a bed affords lying down. A signifier communicates where the afforded actions should take place (p. 14). An effective signifier ensures discoverability of an affordance and efficient feedback (p. 72). In HCI, a button or link should signify that it affords being clicked/activated.

Figure 4: The front-page widget has sections with downward arrows that signify they afford being interacted with.

Mapping covers the relationship between controls and their actions (p. 72). An example of mapping in the context of web design could be a slideshow with arrows on each side. When the right arrow is pushed, the slide should be pushed towards the left to uncover what the next (right side) slide is. The arrows should also point in the related direction. If none of this is in place, the user is likely to be confused or make errors due to bad mapping.

The next principle concerns constraints, which can be physical, logical, semantic or cultural. Efficient constraints guide actions as well as making interpretation easier (p. 72). A physical constraint limits the possible actions (p. 125). An example of a physical constraint could be a button that cannot be pressed unless an input field is filled out. Logical constraints are often related to mapping and touches on the logical relationship between the spatial or functional layout of components, and the things that they affect or are affected by (p. 130). An example could be the concept of “the last piece left”. Say there were three buttons, where two had clear names indicating what they would lead to, while the third had a vaguer naming, a user would likely try the last button if none of the two others were related to what they were looking for. Semantic constraints rely on the meaning behind a situation to control the set of possible actions (p. 129). An example is the “traffic light” color model, where the user would rely on their knowledge of the world to know the meaning behind the colors. Cultural constraints play on the norms and unspoken rules of different societies (p. 128). An example could be reading direction or the meaning behind different colors, like the color of death being black in some cultures, while it is white or purple in others.

A conceptual model is a simplified explanation of how something works, like folders on a computer (p. 25). The conceptual model of the widget should already be somewhat established, as weather and the related icons were already well known in the target group consisting of the general adult population of Bergen. The menu tabs of the theme page widget are an example of a feature users have a conceptual model for. In addition to already being familiar with vertical menus, the tabs may remind them of drawers, which clues the users into thinking that there is content “within” each drawer if you interact with it. Especially seeing as each drawer is labeled.

Universal Design

Universal design concerns ensuring accessibility for everyone and anyone. It not only covers the user experience of anyone with a disability, but also helps people with less severe disabilities, like those who use glasses. It can also help someone who simply has strong sunlight shining on their screen, or someone who only has one hand available at the moment (Baxter, Caine & Courage, 2015, p. 50).

The Norwegian Directory of Digitalization lists seven principles of universal design originally made by The Center for Universal Design in 1997 to be used as guidelines for buildings (“Kva er universell utforming?”, n.d.). The first principle is equitable use, which as previously mentioned, determines that anyone, regardless of abilities, should be able to use the design. Flexibility in use means that the design accommodates a wide range of preferences and abilities. Simple and intuitive use indicates that the design is easy to understand regardless of experience, knowledge, language skills, or current concentration level. Perceptible information means that the design communicates necessary information to the user regardless of ambient conditions or the user's sensory abilities. Tolerance for error involves minimizing hazards or negative consequences of accidental or unintended actions. Low physical effort allows the design to be used efficiently and comfortably and with a minimum of fatigue. The last principle is size and space for approach and use, which means that the appropriate size and space is provided for approach, reach, manipulation, and use regardless of someone’s size, posture, or mobility.

In 2014, a new regulation came into effect regarding universal design on websites that are new or heavily altered since 2014, operate towards customers in Norway, and are informative or offer a service (“Kva Seier Forskrifta”, 2016). These websites need to follow 35 out of 61 success criteria of the WCAG 2.0 standard within 2021, or they risk a fine. WCAG stands for Web Content Accessibility Guidelines, which were developed by The Web Accessibility Initiative (WAI), who is an initiative by The World Wide Web Consortium (W3C) (Brewer & Henry, 2020). The success criteria of WCAG can be divided into four principles, which are perceivable, operable, understandable and robust (“Oppbygging Av WCAG”, 2015). There are three levels of success criteria, A, AA and AAA, which cover a different degree of needs for different groups and situations, AAA being the highest level. For the Norwegian standard, the highest level of the 35 success criteria is AA, with 24 of the criteria being level A. It is important to this project to cover these success criteria, as Bergens Tidende operates via a site and app that needs to follow the criteria to avoid getting fined. Though this would have to be continuously worked on through the different iterations as the prototype takes shape.

Chapter 3. Methods

As this study is based on a collaboration with an organization who wants to see a product made, Design Science Research is an approach that covers both scientific research and design. It is a methodological approach concerned with devising artifacts that serve human purposes (Formoso, 2014, p. v). It intends to solve problems in the real world but also make a scientific contribution.

3.1 Method of development

For this project, Iterative and incremental (Despa, 2014, p. 42) was the methodology of choice for the software development, as the aim was to do incremental testing as the product developed. The methodology involves building a basic model, which is extended on, then tested, then extended on, then tested, in a cycle until it reaches the project owner's requirements. This was a methodology that fit the scale of the project in regards to size of team and the development needed, as this project consists of a team of one, and no coding on the product was planned. Choosing an iterative methodology allowed delivering results in increments, which made it easy to keep a good overview over where the project was standing, and where it was going next.

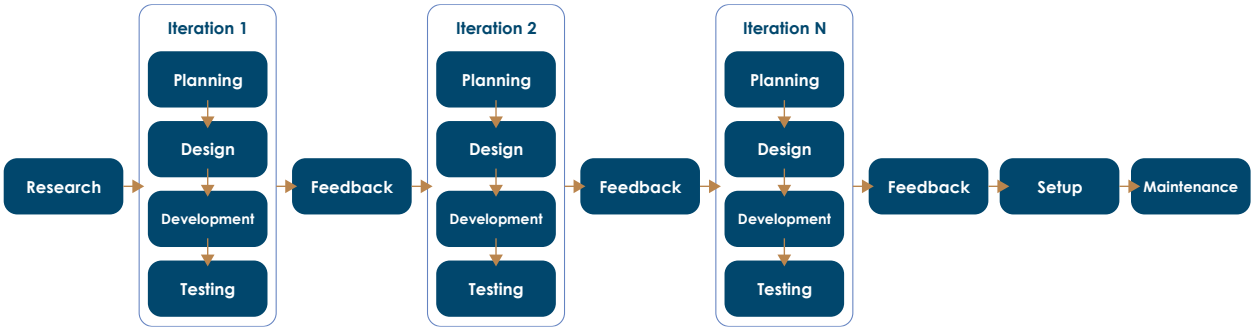


Figure 5: An illustrative figure of the Iterative and incremental process.

Iterative and incremental is an agile methodology. Agile methodology was launched in 2001 by 17 technologists who came together and drafted four major principles for agile project management (Sacolick, 2020). The set of principles was named The Agile Manifesto and aimed to help developers make better software. The four principles are 1) Individuals and interactions over processes and tools, 2) Working software over comprehensive documentation, 3) Customer collaboration over contract negotiation, and 4) Responding to change over following a plan (Beck et al., 2001).

There are other agile methods than just Iterative and incremental. For example, the Dynamic systems development method is an iterative development model, where strict quality standards are defined at the start of the project along with fixed deadlines (Despa, 2014, p. 46). The method conducts testing early and continually, and the workspace is typically shared by the team and product owner for efficient feedback. An example of an incremental agile method is

Scrum, which makes use of development cycles named “sprints” (p. 45). Each sprint can consist of planning, designing, developing, testing, and project owner feedback. The tasks in a development team using scrum are assigned by the team members themselves, and the progress is managed by a “scrum master”.

This thesis aims to answer the research questions by using design methods where a prototype is created, followed by the use of evaluation methods. The intention is to both study how people interact with the design and to test if it works as intended. In design methods the issue of whether something works goes beyond technical or practical questions, and extends into questions of social, cultural, aesthetic and ethical concerns (Gaver, 2014, p.147). A prototype helps us visualize the solution to these issues.

3.2 Method of evaluation

While shaping a prototype it was important to make use of different evaluation methods to ensure coverage of the users’ needs. Baxter, Caine and Courage (2015) provides an overview over formative and summative evaluation methods (p. 432). Formative evaluations are used to discover insights early in the product development, and help shape the design direction. It usually involves testing on simple mockups or prototypes. Summative evaluations are typically done on a more detailed prototype or the actual final product towards the end of the project to evaluate against a set of metrics. The evaluation types cover qualitative and quantitative methods. Qualitative methods involve collecting data that has a rich verbal description, while quantitative methods collect data that are more numeric and measured in standard units (p. 104).

Surveying is a quantitative method that allows a higher number of participants. The method usually involves sending out a set of questions that have premade answers to choose between. Surveys can be good for identifying a target user population for a new product, or find the current pain points or opportunities for a product to fulfill (p. 266). For existing products, surveys can help us learn about the user population and their characteristics, or how they currently use the product. Surveys can be used by themselves or as a supplement to other research methods, like right after user testing.

Interviews are guided conversations in which one participant seeks information from the other (p. 100). There are three different types of interviews that can be used to collect insight. Structured, semi-structured and unstructured. The studies of this thesis made use of the semi-structured form of interview. While a structured interview will strictly stick to a line of specific questions which are often close-ended and quantitative, an unstructured interview will be treating the interview more like a loose conversation, asking open-ended and qualitative questions (p. 222).

The semi-structured type will combine these (p. 223). Some questions may be open-ended, while others may be close-ended. The order of the questions may be changed as the interviewer sees fit, as well as the removal or addition of some questions. This way of

interviewing opens possibilities for the interviewer to tailor the interview to their needs and follow up on interesting answers, which was fitting for this study's weather themed questions. Having the opportunity to ask close-ended questions makes it possible to follow up on questions a survey may not have covered. Some drawbacks of the method are the increase in time taken to transcribe and analyze the interview and a possible lack of consistency.

The interview's flexible nature means it can be combined with user experience activities, like card sorting or observation. As a result of individual interviews, perspectives from multiple users can be analyzed and used for decision making.

Pilots are test-runs done within the method of evaluation before applying it to real participants (p. 155). They let us discover any problems that might occur in the first instance. Running pilot studies help us make sure that the equipment and setup works smoothly, the questions are clear, weed out potential bugs, iron out potential timing issues and provides practice (p. 156). Ensuring minimal hiccups is important to achieve accurate data.

3.2.1 In practice

The aforementioned methods were mixed and matched for the actual studies and insight collection. Most studies had an element of interviews to properly collect qualitative insight because of the project's user-centered nature.

Field study

The first form of evaluation in this project was a field study. A field study makes use of a broad range of data-gathering techniques in the environment of the user (p. 380). In the case of this project the user environment was varied. Both the weather and the newspaper could be accessed on the user's phone from anywhere. In addition, a global pandemic came into play at the time of the field study, which made it hard to conduct in-person interviews. Thus, digital solutions were picked and planned out accordingly. A survey and a semi-structured video interview coupled with a short practical task were conducted. The survey was made using the surveying tool SurveyXact, while the interviewing was conducted via www.whereby.com. Whereby is a video call service with the ability to share a screen. It was chosen because of its easy setup in browsers, and for having a simple interface. This makes it easier for participants with any level of technology experience to participate.

The participants were asked questions about their habits around weather in both the survey and the interviews. The goal was to get a feel for users' weather routines, preferences, and potential pain points before kicking off the project.

Post-it exercise + interview

By applying BT's wishes and the insight collected in the field study, a design was made of the front-page widget. The design was not clickable, but the participants saw illustrated iterations of what the widget could look like and contain. Six participants, all from the Bergen area, were recruited via the author's own network and invited to do a video call over Whereby. They were

asked to visit the digital collaboration board tool Mural where they could interact with elements like post-it notes on their screen (see figure 6). The first of the six participants was the pilot interview, which was a test to confirm that the right questions were being asked or if anything was unclear or confusing.

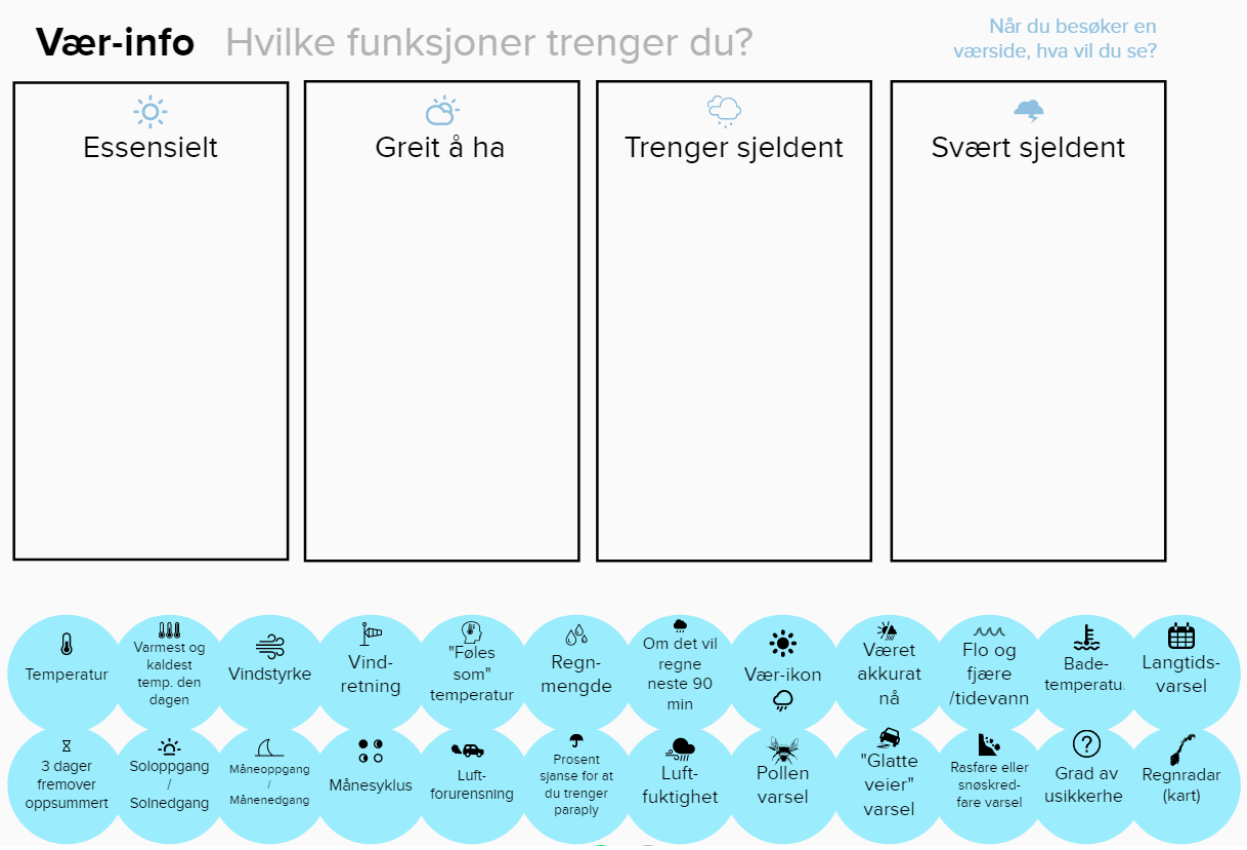


Figure 6: Participants were asked to rank their weather needs by dragging the blue circles to the box that matched their preference for the function. The boxes translate to "essential", "good to have", "seldom needed" and "very rarely needed".

By going through and documenting what kind of functions and features weather sites like Yr.no, storm.no and pent.no had, a list of 24 relevant weather features were placed on interactive post-it notes. The features were temperature, warmest and coldest, wind intensity, wind direction, "feels like" temperature, amount of rain, next 90 minutes rain prediction, weather icon, the weather right now, ebb and flow, bathing temperature, long-term forecast, 3 days summarized, sunrise/sundown, moonrise/moondown, moon cycle, air pollution, percent chance of needing an umbrella, humidity, pollen notice, "slippery road" notice, avalanche danger notice, degree of uncertainty, and rain map. The participants were asked to place these into one of four categories related to the degree of need: "essential", "good to have", "seldom needed", "very rarely needed" while talking about their reasoning.

The second part of the study conducted a semi-structured interview to catch up on some questions that were not asked in the field study, and to potentially put the other parts of the

study in perspective. It started off by asking about their reasons and routines around checking the weather, and extreme weather. Followed up by questions about their relation to- and routines around reading the news, and if there were situations where they checked the news and the weather at the same time.

In the last part of the study, participants were shown 4 different versions of the front-page weather widget. The versions differed in timespan. The first showed the current weather, the second and third showed a two-hour span with two different versions of how it was set up, while the fourth intended to show the whole day. The fifth version showed what displaying weather for different places could look like, but this concept was discontinued. They were also shown what it would look like within the context of the BT front page.

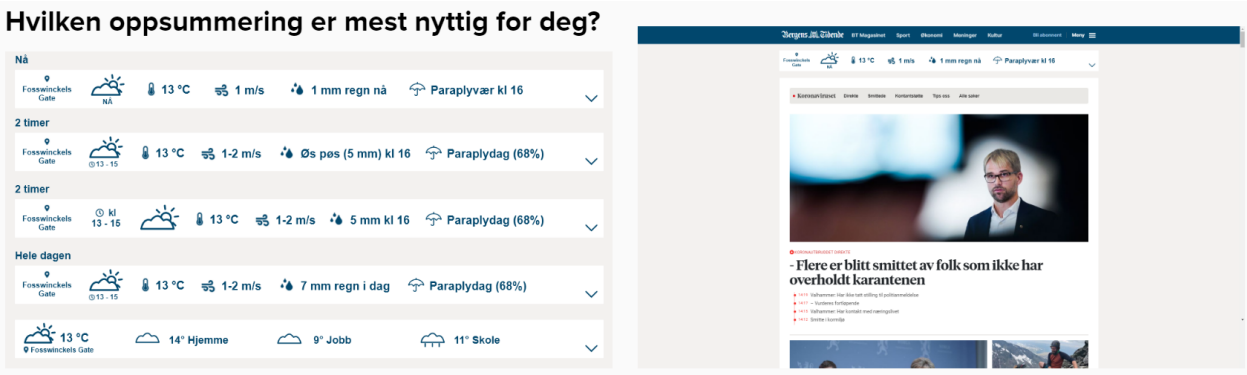


Figure 7: Participants were asked to evaluate which of the four summaries were most useful for them related to time (the options being now, two versions of 2 hours and the whole day). The bottom design showcased what displaying weather for different places could look like. On the right side is an example of what the widget looked like when on BT's front page.

Heuristic evaluation

A heuristic evaluation is a formative usability inspection method based on 10 heuristics made by Jakob Nielsen and Rolf Molich in 1990. They argued that products should adhere to these ten heuristics to ensure a good user experience. Baxter, et al. (2015) suggests having three to five UX experts assess a product by walking through a set of tasks and noting down whenever anything conflicts with the heuristics (p. 434). Because of the limited size of the project, the study aimed to perform this method in a more simplified manner. In addition to keeping the heuristics in mind while making the prototype, an assessment of the relevant heuristics was done internally. Not all of the heuristics were 100% relevant to the project, as the project worked with only a small part of an already established product. This is reflected in the findings. By evaluating heuristics, we hope to – at some level – ensure that a product provides a good user experience.

User testing

After working with creating the interactive prototype in Adobe XD, it was time to put the design to the test. Because of COVID-19 there was a need for physical distance at the period of testing, which made remote testing a highly useful evaluation method. This summative method

is typically good for getting a more diverse and geographically varied sample size (Baxter et al., 2015, p. 440). For this project it mainly fulfilled a need for distance to the participant as there was never a need for insight from outside the Bergen/Vestland area. For the remote testing, 5 participants (+ one pilot participant) were recruited via the author's own network and invited to do a video call over Whereby. A link to a clickable prototype stored online via Adobe XD was then sent via the chat function of Whereby. The participants were also asked to share their screen so the interviewer could follow their process live. Because of practical reasons like limitations of Adobe XD, the participants were asked to partake via a computer specifically.

The interview started with asking consent to record the participants and informing them of what the recordings would be used for and their right to withdraw at any point. The users were then asked about their age and line of work or education. Afterwards, the participants were asked questions about their relation to weather forecasts, and what made a forecast "good" in their eyes. They were also asked what made a forecast "bad" and if they had any stories of bad experiences. This was to collect personal opinions for the second research question.

When the participant opened the link to the prototype, the front-page widget was the first part that met them. They were asked what info they got from the page they were looking at. The next question was what they thought were hiding behind the "other" section at the end of the widget strip, as this feature was suspected to be unclear. Then they were asked to click it and describe how they interpreted the alternatives (pollen, ebb and flow, pollution, etc.) and if these were of any use to them.

Figure 8: The last option named "Others" was challenging to give a name and icon that made it easy to understand what would happen when you clicked it.

Next, the participant would be asked to click the other weather values and talk about their preferences. The temperature alternatives were "Feels like x°" and describing the temperature via recommended clothing, like "shorts weather", which is a common Norwegian phrase to describe warm weather. The first wind alternative was more text-based but had scientific wording like "weak breeze" while the second one had a more common phrase like "a little wind". The precipitation alternatives included telling the user if they would need an umbrella or not, a description stemming from Bergen like "øs-pøs", or a more common phrase like "heavy rainfall". The participant was also asked what time span they thought the widget was covering.

The users were then asked to navigate to the weather themed page from the top menu and give their first impression. They were also asked to give thoughts around having a separate weather themed page with weather and climate news together with a bigger weather widget. Additionally, their needs were questioned when asked if there was anything they felt was irrelevant to them at first glance.

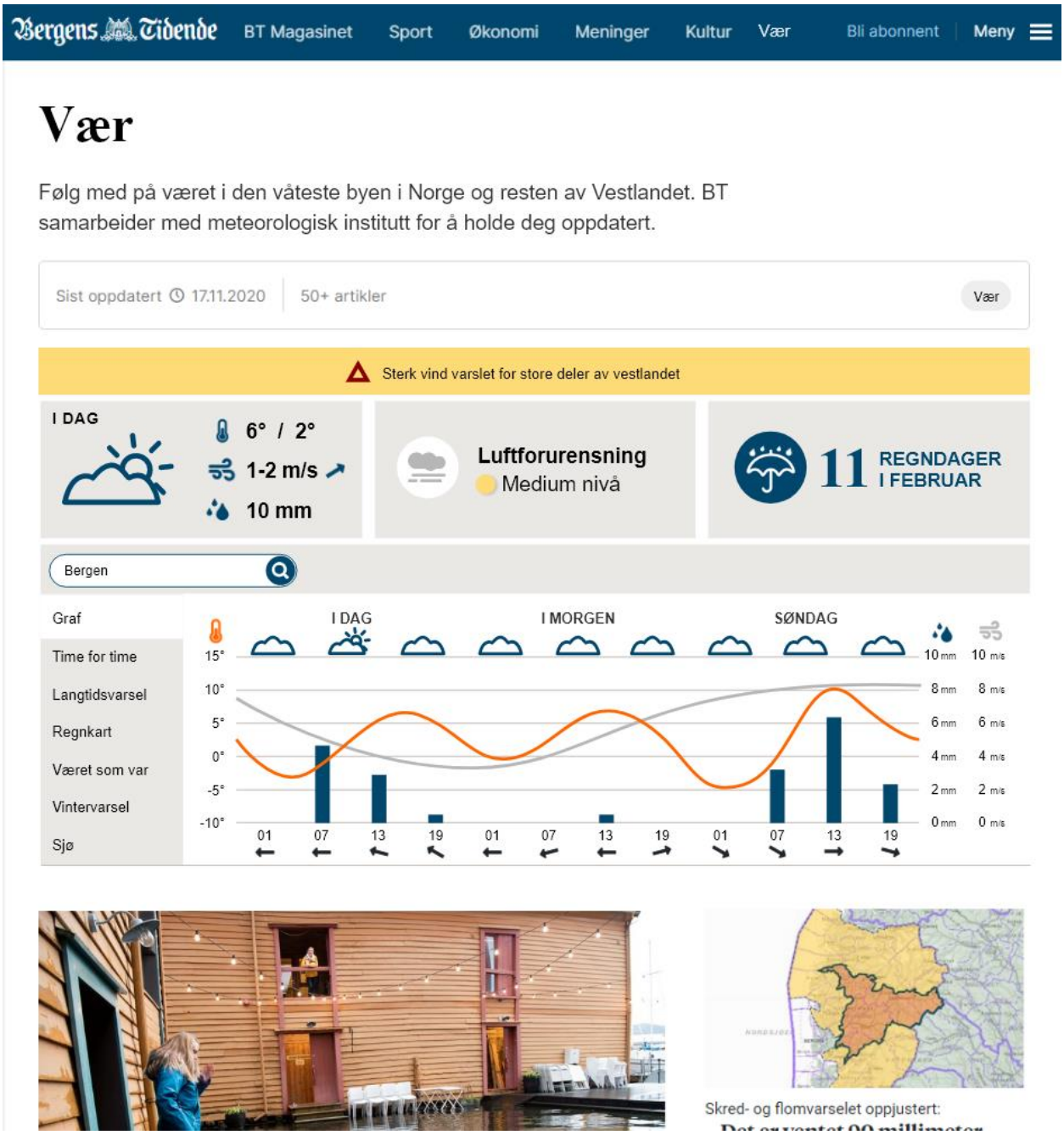


Figure 9: This is what the participants first laid eyes on when they entered the weather themed page. (The graph was changed out for the "hour by hour" format for the later participants.)

Next, they were asked what they expected to find inside the "winter forecast" tab, and why they thought so. They were then asked to click it, and talk about their impressions of the content that met them. This continued with spring, summer and autumn versions. After talking about the seasonal tab, the user was instructed to click through the rest of the tabs from the left side menu while giving opinions of each of them.

When they had gone through all the tabs and reached the sea tab, participants were asked their opinions about the different sea-themed sections. The two last participants were also presented with two versions of “ebb and flow” as a very limited form of A/B testing. A/B testing involves comparison of two variations of a product, or two entirely new designs (Baxter et al., 2015, p. 493). One of the options would be showing the four times in a day that the sea levels were at the highest and lowest with static icons and time data that would grey out if that time of day had passed. The other version was described to them as more dynamic, where the water would be animated and go up or down depending on the real time ebb and flow (See figure 10). The participant was asked which one they preferred and why. When the walkthrough of the tabs was done, the user was asked if there was something they felt was missing or if there was anything that was completely irrelevant to them.

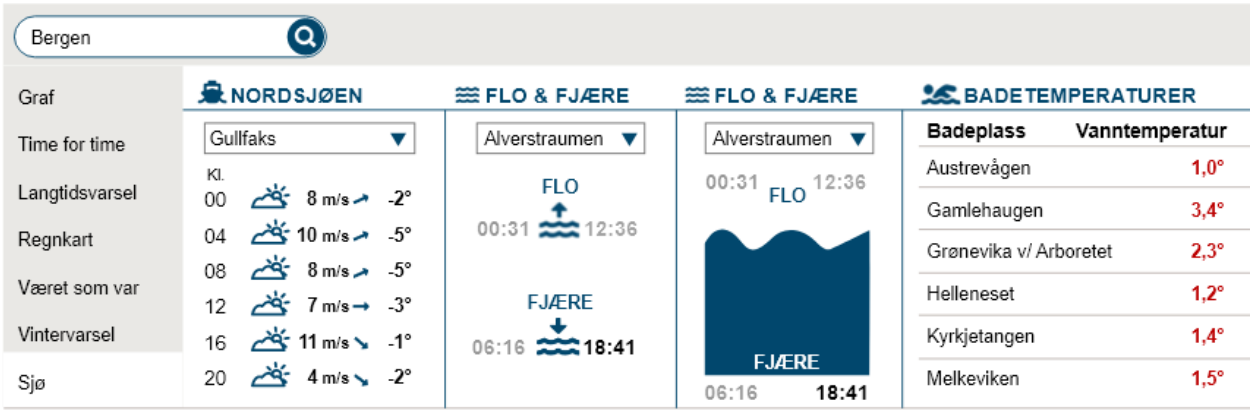


Figure 10: The sea tab had a simplified A/B testing, where the participants gave opinions on which version of “ebb and flow” they liked the most.

Before ending the interview, the participant was asked if this was something they would have made use of via BT, and their thoughts around that. This was then followed up by asking if extreme weather would make them more likely to visit this themed weather page.

3.2.2 Ethical Concerns

Due to the digital nature of the methods of evaluation, not many ethical concerns were relevant. Like mentioned earlier in the chapter, the participants were informed of the purpose of the study in each batch of interviews and asked to verbally confirm their consent to participation. Of course, there is an ethical challenge in already starting to record before asking the participant’s consent, but the recording would have been stopped and promptly deleted if the answer were to be negative. To make sure there were no surprises outside anyone’s comfort zones, the participants were informed about video recording being involved when asked to participate. The interviewees were also told that they could resign from the study at any point, and given the contact info to do so.

Anonymity was an ethical concern that was upheld by not mentioning names when presenting the process or results, and talking about the participants more generally such as using word choices like “one participant said”. Their order did not matter as much, thus they did not need to

be numbered. After the qualitative data was processed, any trace of their identity was erased. Video and audio files were only stored until that point. The dataset from the field study survey was shared with one person, but no identifying information was collected.

Chapter 4. Evaluation

4.1 Findings

4.1.1 Field study

The field study – which was conducted before the prototype was started – aimed to find out how people use weather services, which were the most popular existing ones, and an indication of why. It also touched a bit on extreme weather and the use of BT.

The survey had 185 complete responses. Though due to not requiring all answers, most questions had as much as 190 responses. Most participants were between the ages of 50-59 (46%), and the female (55%) to male (45%) ratio was close to equal.

69% were from Bergen, while 13% were from the west of Norway but not Bergen. **The survey revealed that Yr.no was by far the preferred weather service**, especially when survey takers were asked to only pick one service as their main one. While getting the option to pick more than one weather service, 73% picked Yr.no. When only being allowed to pick their favorite, 62% picked Yr.no.

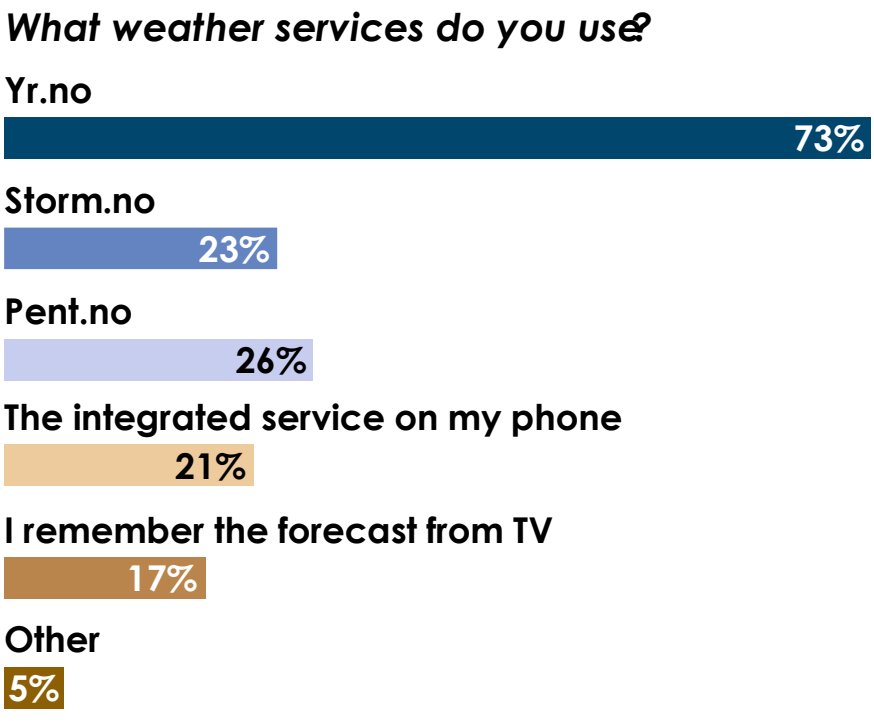


Figure 11: When being allowed to pick multiple options, users showed a clear preference towards Yr.no. (n = 190)

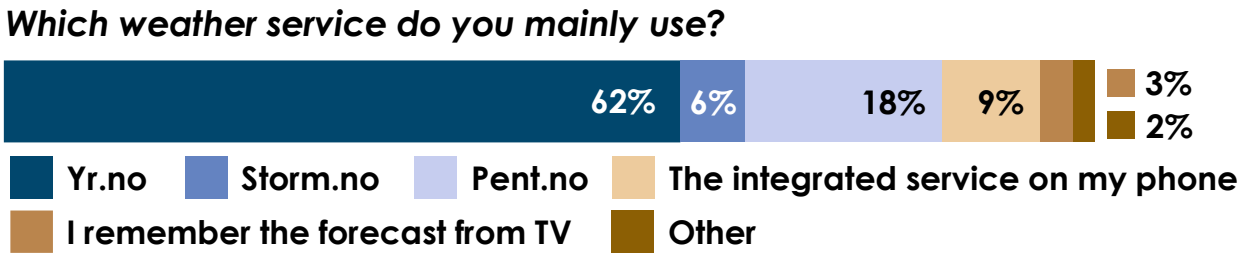


Figure 12: The Yr.no preference persisted when participants were only allowed to pick one of the options. (n = 185)

30% of participants checked weather services several times a day, while 36% checked once a day, and 25% checked a couple times a week. The rest of the options had less than 10% each and covered more sparse options like “a couple times a month” (6%), “less than once a month” (2%) and “never” (0.5%). This shows that users do make use of weather services quite frequently, with a good portion checking as much as several times a day.

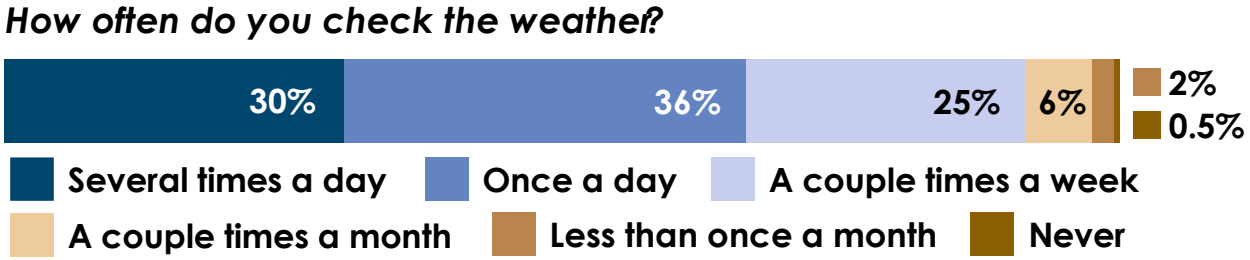


Figure 13: Most users check the weather at least a couple times a week. (n = 190)

Easy navigation and as much information as possible in one place were features a big portion of participants thought were very important in a weather app (see figure 14). This shows that users are aware of their own needs and have high expectations for the experience a weather forecast should give them. The ability to see the probability of the forecast being correct was very important for half (49%) of the participants, while it was somewhat important to the other half (43%). This indicates that the feature is needed, but not urgently. Meanwhile, aesthetically pleasing graphics were somewhat important to 64%, while 22% felt indifferent about the graphics. This signals that users are more concerned about function over aesthetics, but still may appreciate good looking graphics. Lastly, the ability to see a 90-minute rain prediction and having a rain map were both perceived by half of the users as somewhat important, which is an indication that these are not vital features.

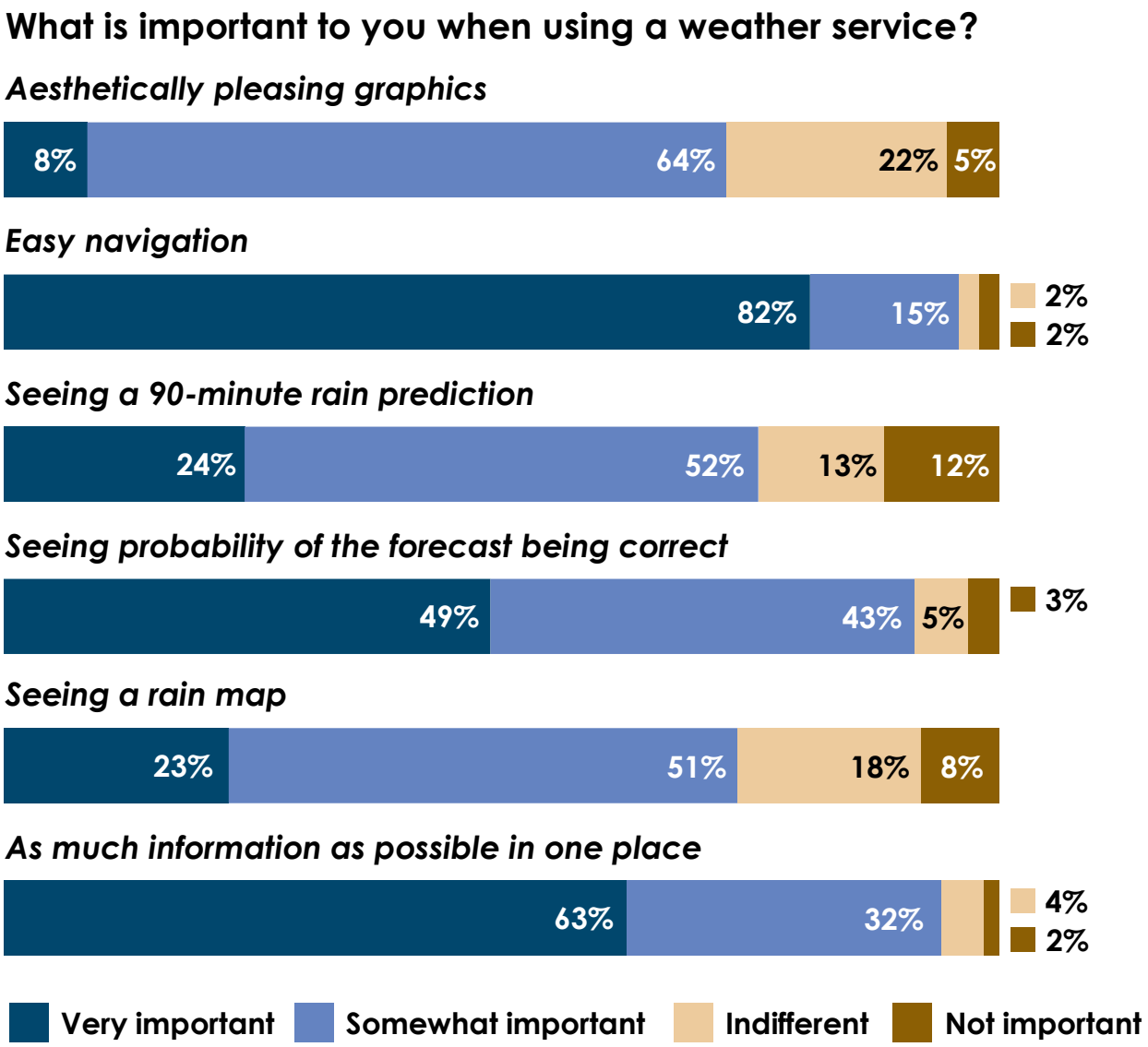


Figure 14: Users thought easy navigation and as much information as possible in one place were the most important features of a weather service. (Note: Percentages may not sum to 100% due to rounding. n = 190)

Participants were also given the option to type out a reply to the question “Is there anything else that is extra important to you in a weather service?”. Six of the comments revolved around the accuracy of the forecast, while four comments focused on an understandable design. Some comments expressed a need for a specific timespan, like 3 days or as far as possible forward. One comment also mentioned the need for text that explained what symbols meant, which is a great way to enhance the usability.

“What is usually the reason you check the weather?” was the next question on the survey as a multiple-choice question. 61% of participants ticked “I am doing an activity outside”. This option could have been specified more, as it is too general to draw any specific conclusions. Though it could still be a pointer towards the mentality of users. It could mean that 61% usually know and

plan for outside activities with weather in mind, while the rest may not plan to the same degree. 38% ticked “I am doing a regular activity, like work/school/leisure activities”, while 33% ticked “I am doing a spontaneous activity like going for a walk or buying groceries”. 17% of survey-takers ticked both of the two aforementioned options, which could represent users who use weather services more intensively. 21% of participants picked the option “I am planning a bigger outing”. 26% answered that they checked the weather out of habit, while 25% checked out of curiosity. Only 3% of participants usually checked out of boredom. 6% picked the “other” option where they could write out a reply. Some had work-related reasons, others were generally more concerned with what to wear, and some pointed towards spontaneous leisure activities like boating.

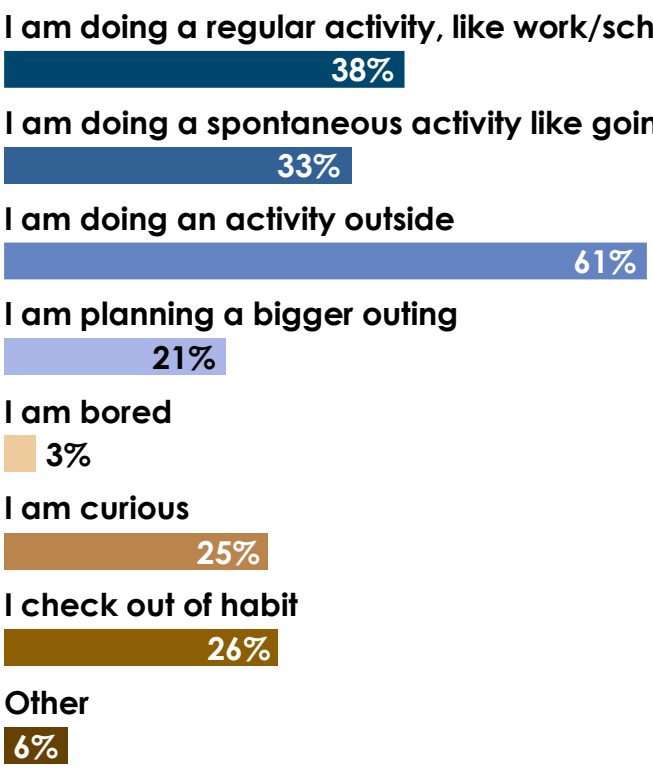


Figure 15: Most participants check the weather because they are doing an activity outside. Around a third of users usually check the weather when doing a regular activity as part of their daily routine. (n = 190)

Because of the ongoing pandemic at the time, participants were also asked if they checked the weather more during the period of “corona and quarantines”. 62% of the survey-takers replied that their habits were approximately unchanged. 15% checked a little less than usual, while 11% checked a little more than usual. 10% checked much less than usual, and 2% checked much more than usual. This data is representative of the timespan 17th of April - 8th of May 2020. Norway started taking action against the COVID-19 virus via lockdowns on the 12th of March 2020 (Ministry of Health and Care Services, 2020). Which means behavioral patterns may have changed in the time after, especially with the increase of people working from home. Though

another survey asking about weather service usage could be interesting for comparison, it is likely hard for most people to think back more than a year when asked a quantitative question about their habits.

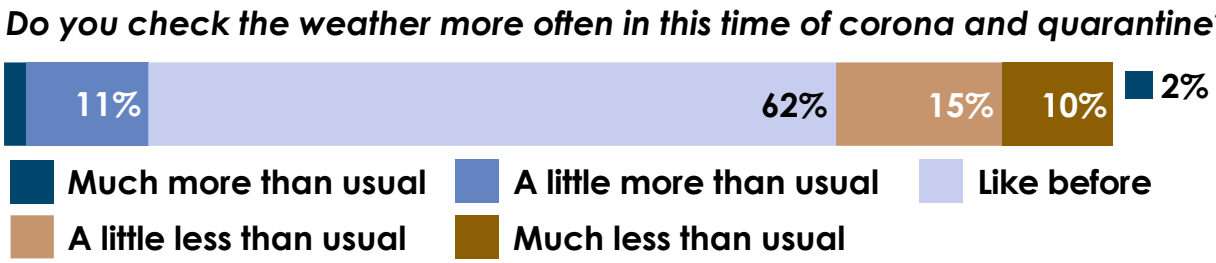


Figure 16: Most users had not changed their weather-checking routines during the first months of the COVID-19 pandemic. (n = 189)

The last two questions had 109 replies, as they could only be accessed if the participant answered “yes” to a question about reading BT digitally. The first question asked about the frequency of visits to the site, in which 54% answered that they visited BT digitally several times a day. The last question asked in what situations the participants read BT. The participants were allowed to pick multiple options. 59% picked “while I relax on the sofa”, while 40% picked “in the breaks at work/school”. The options “in bed before I get up”, “while I eat food” and “in bed before I go to sleep” were picked by around 20% of participants each.

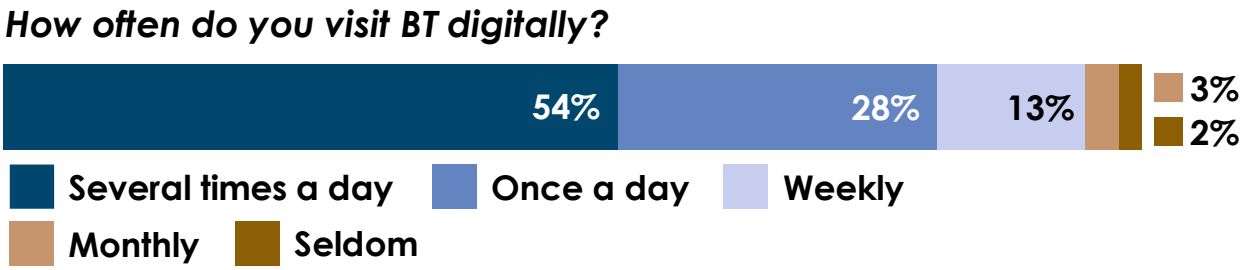


Figure 17: Of those who did read BT, the majority visited their digital platforms several times a day. (n = 109)

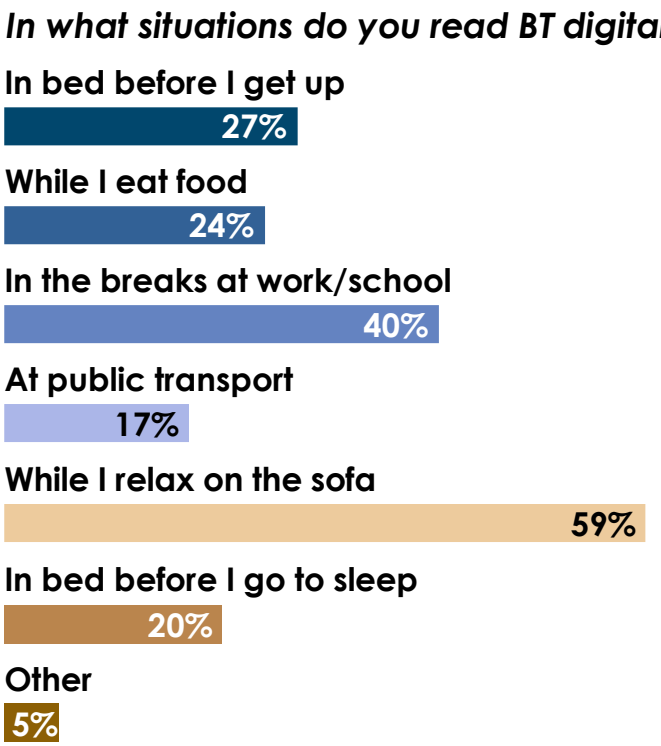


Figure 18: BT was read the most on the sofa while relaxing, but also during breaks at work and school. (n = 109)

For the second part of the field study, 6 interviews were conducted over the video conference tool Whereby and recorded with the participants' spoken (and recorded) consent. 3 males, 3 females and a varied age group were recruited. 4 were living in Bergen, while 2 lived outside Bergen. Observation was utilized in the form of asking the interviewees to share their screen and demonstrate how they would check if it would rain that evening. Participants displayed a clear preference towards Yr.no, reasoning it with Yr.no having a simple and clean design with multiple locations being displayed at once, and a three-day forecast being present on the home page. Some hinted towards their choice being due to habit, and did not have any strong reason behind their preference. When asked what was important to them in a weather service design wise, most participants stated that they liked icons and a lot of info in one place.

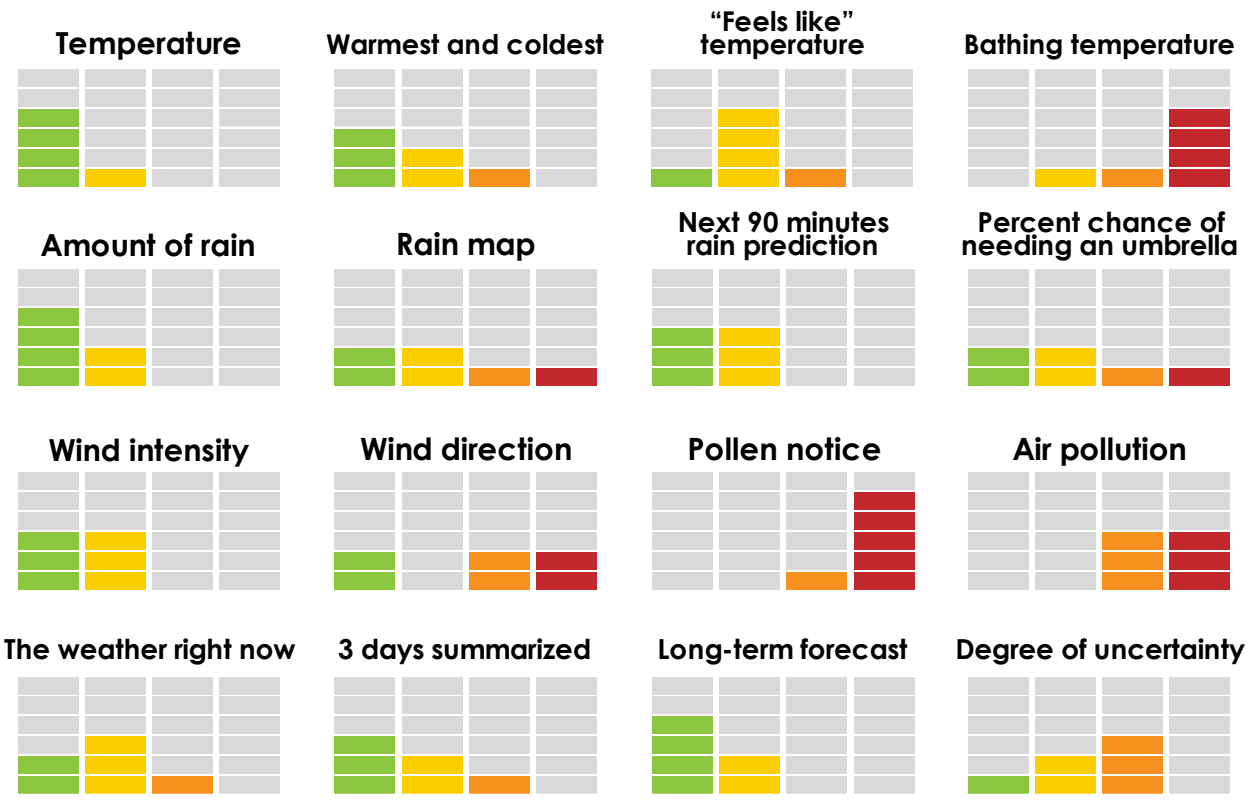
In the opening of the interview, participants were asked if they knew what the weather would be like the next day. Some had a habit of checking the weather each evening before bed, while others had not checked any weather services in a month. Others had a more mixed approach where they checked the weather after their needs or weather-dependent plans. Because of the different lifestyles of the participants, they had different relationships to weather services and were interested in different features. Some were interested in wind measurements, while others never cared for it unless there was a storm happening. Several participants estimated they checked the weather the most in the spring and autumn, as these were more unstable months. **Seasons were a big factor to how the participants used weather apps.** One participant did not care to check the weather as much in the winter, except when they needed to know if the roads would be slippery when driving. Another interviewee noted that in the winter they did not

have to care much about precipitation, as it would mostly snow and not rain. Thus, they were only interested in the temperature to make sure they put enough clothes on.

When it came to extreme weather, most of the participants checked the weather more frequently if a weather phenomenon should arise. Though some were more interested in experiencing something like extreme winds, than to look at the metrics. Extreme heat made participants more probable to look at long-term forecasts.

4.1.2 Post-it exercise + interview

This study collected insight on user needs related to their use of weather services. Five participants plus a pilot participant were asked to place 24 weather functions on a 4-part scale from “essential” to “very rarely needed”. **The main finding from this part of the study was a confirmation that people do have vastly different needs, as none of the 24 options were placed in the “essential” category a full six times.** When it came to the more niche functions, there were also different needs. While some functions depend on the season, their degree of relevance varied from person to person. Some had allergies to pollen, some liked to bathe outside, and some kept an extra eye on the freezing temperatures in the autumn because of their car.



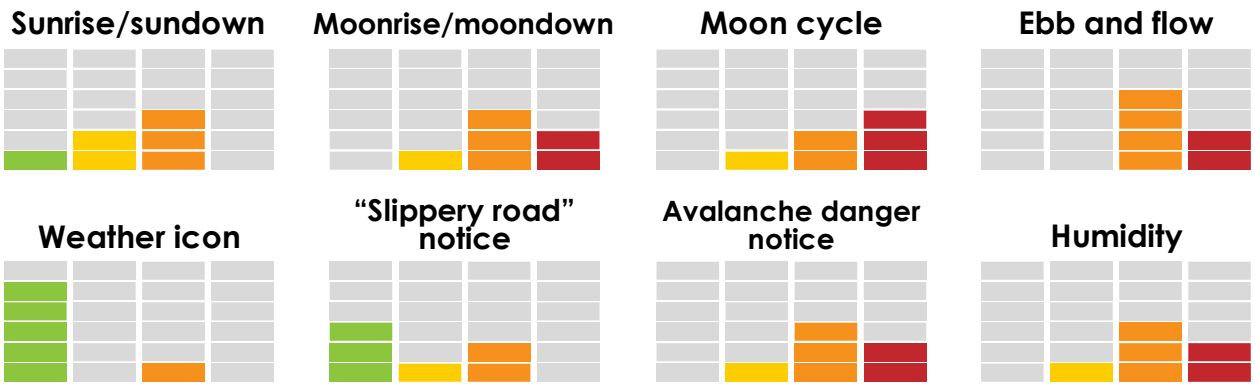


Figure 19: Visualization of data from the interview. Green represents the participants deeming an option "essential", yellow represents "good to have", orange represents "seldom needed" and red represents "very rarely needed".

The most needed functions of the 24 were temperature, weather icons, amount of rain, wind intensity, long-term forecast, and 90 minutes rain prediction. This may be connected to the features being the most prominent on the Yr and Storm pages along with other apps, but proves that having them be prominent matches the needs of the users.

Even though some options were scored as less frequently needed by the participants, this could depend on situations and seasons. The least needed function was the pollen notice, as few of the participants had pollen allergies. The participants who did have pollen allergies deemed it seldom needed because it was only a short part of the spring season, and their allergies were not so strong that they needed to keep track. Air pollution also scored low, as many of the participants did not live near places with excessively high traffic. Bathing temperature also scored low, as few of the participants liked bathing, or they did not feel like the weather was ever warm enough for it. None of the participants scored it as essential, but one scored it as "good to have" as they loved to bathe in the summer.

Several participants pointed out that they did not need "the weather right now" because they could just look out the window. Yet no one put it on the very rarely needed section, and only one put it in the seldom needed section, proving that it may still be needed. The function with a percentage chance for needing an umbrella that day had mixed opinions. Some never used umbrellas and preferred dressing for the rain instead, while others always carried an umbrella outside just in case.

Among the 24 functions there were three options that had to do with the time span of the weather prediction. The weather right now, 3 days summarized, and long-term forecast. All options scored high, but the long-term forecast scored highest. Some expressed the need for up to 12 days if possible, as they wanted to look as far forward as possible, while others did not see the need to go that far because of the uncertainty and preferred around 5 days.

The participants' needs were varied, as two participants had as much as 10 features in their "essential" field, while one only had the need for 4. From these 6 participants the average

amount of features placed in the essential field was 7. In the “very rarely needed” field one participant placed 8 features, while another placed 1. The average amount of features placed in this field was 5. The degree of weather knowledge and interest varied in the participant group too. One participant was knowledgeable about how the wind direction played into the temperature of the wind, while another had not heard about the rain map function.

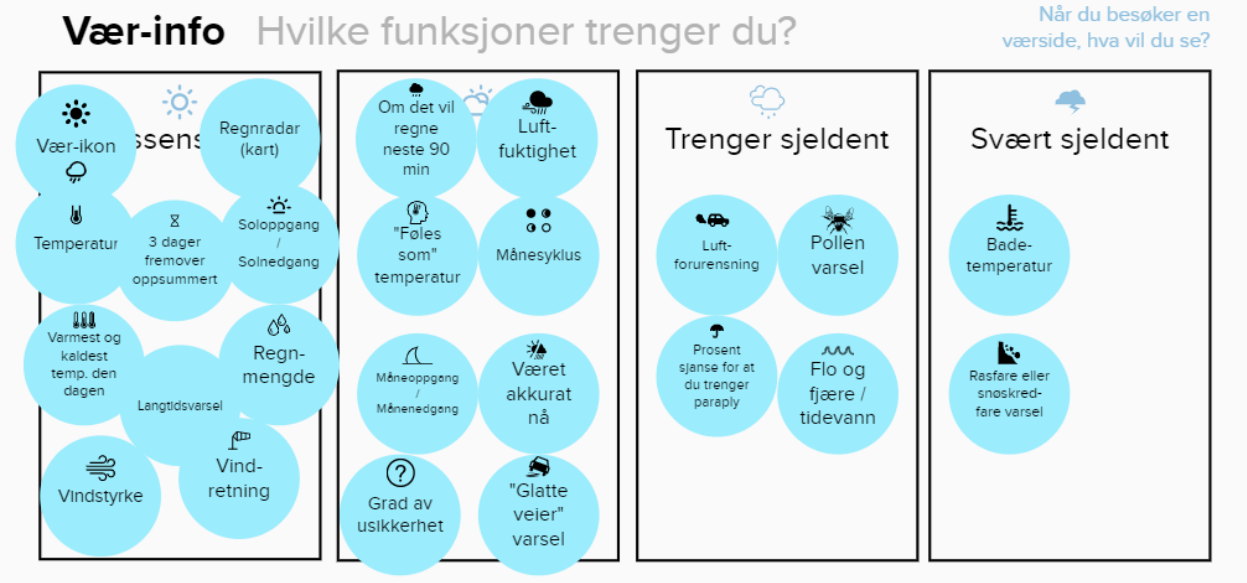


Figure 20: A filled out sample from one of the participants. Two of the participants placed as many as ten features in the “essential” field, while one participant only had four.

The interview continued with questions about their relationships with checking the weather and reading news. Some participants stated that they checked the weather for planned outdoor activities, but not minor activities like commuting or going to the store. One user stated that they sometimes caught themselves checking the weather out of boredom. Another user checked the weather mainly to figure out what to dress their children in. When asked about routines around checking weather, participants had varied patterns. Most checked in the morning, some in the evening before bed, some both morning and evening, while one participant only checked when needed. All users had a preference towards Yr.no, and most checked via mobile. As for what timespan the users checked, most users did not check much more than a week. One user noted that they would check the long-term forecast as far forward as possible if they planned to travel away from home, while also checking it frequently to make sure to catch any changes. Another user expressed the same use of the long-term forecast, but in the context of work-related travel.

All six participants read Bergens Tidende to some degree of intensity and frequency. When asked to explain the reason why they read news, most participants expressed a need to keep updated on the world around them, both on a world-wide scale and a local one. Routines regarding news were varied. Some read the paper as part of their morning routine, while others had a more scattered and varying behavioral pattern. One user read the paper when they struggled to sleep. Participants were also asked which occasions they checked both weather and news simultaneously. One participant said they sometimes checked both separately in the

morning, while another said they liked checking both when there was extreme weather or other weather phenomena. This could be extra nice weather, where they gave the example of “The beach is extra busy today” type of articles. Or in the case of high amounts of snow, or frost for the first time in the autumn.

When asked about their behavior in the case of extreme weather, some would check weather services to see what they could expect, while others were more interested in getting information via the news, or a mix of the two. One participant checked the news because they felt like the articles were just as useful and detailed as a weather page. The articles usually had written info on how long it would last and the intensity, which was the same as a weather page would present.

For the last part of the study participants were asked about their thoughts around some mockups of what the front-page widget could look like (see figure 21). There were 4 alternatives, where they were asked what they liked, did not like, or wanted to change. The alternative that depicted the whole day was the most popular. One participant commented that they would have liked BT to tell them “this is how the day will be” via the widget. This statement works well together with the notion that 27% of 109 survey takers in the field study answered that they read BT in bed before getting up in the morning.

Figure 21: Several mockups of what the front-page widget could look like with variations related to both timespan and presentation.

The umbrella function showing the likeliness of needing an umbrella got some critique. Some thought it was neat, while others had no need for it when they already got the same information from the millimeters of the rain portion of the widget. One participant expressed that they had a hard time understanding the millimeter contextually, which would make the umbrella option serve them better. This may be a sign that the umbrella function could be an alternative option for how to show rain instead of having both options be present. The second widget option had a local expression for amount of rain (øs-pøs), which participants seemed to think was a fun idea.

This could also be an alternative to those who do not clearly understand millimeters. The concept would be further explored in the user testing.

4.1.3 Heuristic evaluation

Nielsen and Molich's lists 10 heuristics to ensure the reduction of usability problems (Nielsen, 1994). Because this project does not involve a full system, but a design within an already established system, we will look at the ones that are relevant.

1) Visibility of system status
This heuristic is covered by giving the user a clear image of where they are and what the consequences of their choices will be. The choices that can be made in the prototype do not have very big consequences, but are conveyed via graphics to indicate that a choice can be made. For example, the downward arrows convey that the user is able to interact with the weather widget.

Figure 22: The downward arrows show the user that they can interact with the different parts of the widget.

2) Match between system and the real world
It is important that the user's mental images and familiar terminology match that of the design's. By giving the user a choice of how they want to be presented with data, their match between system and the real word is more easily met. Not everyone can picture how much rain 14mm represents. Simply suggesting if an umbrella is needed, using local expressions, or using vernacular language might fit some users better.

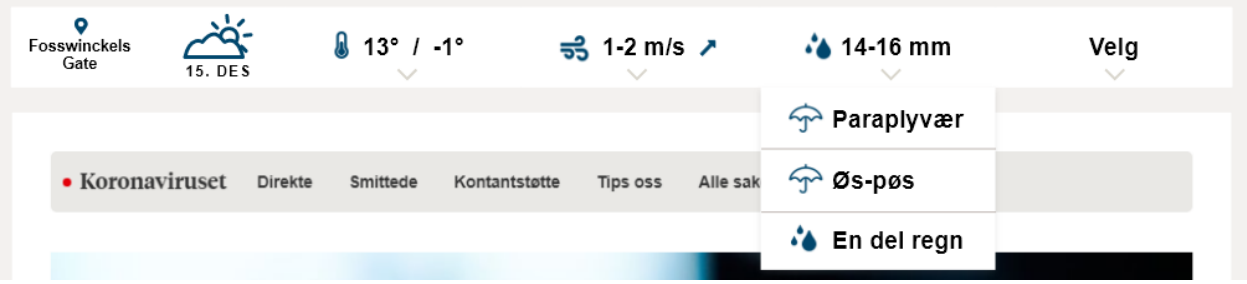


Figure 23: The front-page widget lets users decide how they want the data presented to them. The options under precipitation are millimeters, umbrella requirement, local terminology, and a simple description which in this example is saying "some rain".

4) Consistency and standards
This heuristic calls for a design that does not force the user to learn something new. By making sure to follow the established design of the newspaper, we do not require the user to interact with something drastically different or new.

6) Recognition rather than recall
With this point, we seek to minimize the user's cognitive load by not making them memorize information, but instead let them recognize it. An example of this could be the tabs menu of the theme page widget. If the menu had to be expanded to change tabs, it would require users to remember how to make the menu appear again. By having it there as a constant, users recognize instead of recall.

7) Flexibility and efficiency of use
This point includes letting users tailor frequent actions. The ability to turn on GPS to use the location where the user is finding themselves at the moment, is a form of personalization. The widget has customization in the form of being able to type in or pick the location in some cases. The front-page widget also provides the ability to customize how the user wants to be presented the weather data.

8) Aesthetic and minimalist design
To help keep focus on the primary functions of the widgets, it is important to keep the design minimal and free of visual distractions. This was followed by having it in the back of the mind when designing the prototype to be user tested, while the user testing helped weed out unnecessary elements or info.

4.1.4 User testing

Six participants from 23 to 76 years old were interviewed and guided through the prototype while being asked questions. In addition, one shorter pilot was conducted beforehand to ensure the quality of the questions and instructions.

In the interview, users were asked what they thought made checking a weather forecast a "good" experience and what made it "bad". Participants named accuracy of the report and the quality of the weather itself as factors making the experience good or bad when checking the weather. Some also pointed at navigation as an important factor. They had to be able to find the info they were after easily.

The testing itself aimed to capture first impressions and expectations towards buttons, content and functions. The prototype was altered slightly for each two participants, though the overall concept was never changed drastically.

Some of the users had different interests that affected how they used the weather services and their wants and needs from one. One user was very interested in skiing, while another had a special interest in sailing. Other participants had a more relaxed relationship to weather. Though all six participants checked the weather at least a couple of times a week, while four of the participants said they checked every day.

Alterations

The first iteration of the prototype had an “air quality” tab in the detailed theme page widget. This early iteration also had placeholders in the form of elements copied and pasted from Yr.no and the backside of BT. Though only the winter forecast and sea tab sections were mainly affected. This was due to time constraints. In the second iteration of the prototype the placeholders were switched out for a design made to match BT’s brand and colors.

In the third iteration the graph on the theme page widget changed places with “hour by hour”, making hour-by-hour the first information the participants saw. The “seasonal forecast” tab had the rest of the seasons added to expand the examples and test if the users’ expectations were met for each season. After a suggestion from one of the participants, seasonal information about food and plants being able to be planted or harvested was added for spring, summer and autumn.

Front-page widget

When being introduced to the front-page widget, users were first asked about their thoughts around their first impression of it. Secondly, they were asked what they thought laid behind the last option on the widget, which was named “other”. With this option, participants could choose between several other more niche weather options to be displayed. They were also taken through the drop downs of the temperature, wind and precipitation, which when hovered presented a choice to switch out the metrics with different options. Participants were then questioned on their preferences of these options and their reasonings behind these choices.

Two of the participants, who were both within the 20- to 30-year-old range, were very positive to the simplified weather language options and stated that they would change out the metrics for the simple options, with the exception of temperature. The participants that were 35 years or older were for the most part used to the metrics and wanted to stick to those. Though some stated they would still have a look at the other alternatives. Participants were happy with the highest and lowest temperatures, and occasionally looked at the “feels like” feature. Though it should be noted that the temperature selection did not have alternatives like “very hot” or “a little cold”.

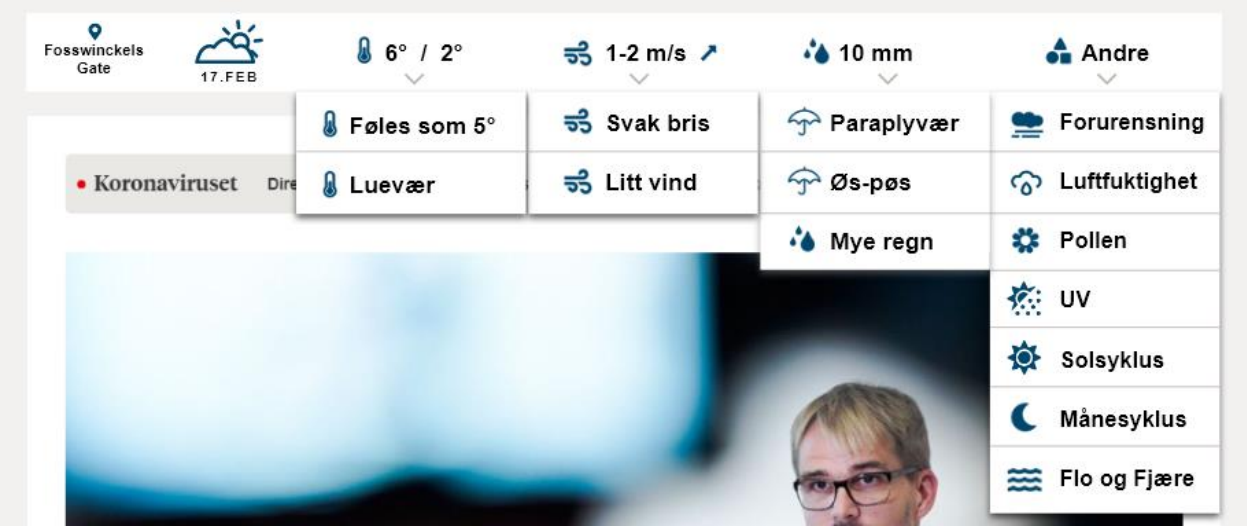


Figure 24: All options of the different dropdowns. Two of the youngest participants were interested in using other terms than metrics when looking at the forecast summary. (Note: Only one dropdown can be triggered to show up at a time. This image is only meant to illustrate what all the options look like.)

Most participants found the culturally loaded øs-pøs option in the precipitation drop-down intriguing and fun. Though it should be noted that one of the participants did not grow up in the western part of Norway, and thus may not relate to some local norms, customs and words.

Users understood that the two numbers on temperature represented the lowest and highest temperature that day, or alternatively understood it as day and night. No users felt that the temperature description involving clothes was useful to them. One user pointed out it was too inaccurate and the consensus about what was “shorts-weather” was highly subjective. Some suggested it would be useful for children, though. It could be argued that this meant increased accessibility for those who may not understand weather concepts or temperature, but it could also be argued that it landed too far outside the target users. This would need an evaluation or to be tested more. Though, the addition of simple descriptions of the degree of “hot” and “cold” could likely work just as efficiently.

The last alternative on the widget bar represented a choice between several other niche weather data, like ebb and flow, sun cycle or pollen. At first this was named “choose”, but the wording was confusing for the two first participants who thought they would be able to choose more ways to perceive the weather. The wording was changed to “other” for the four last participants. One of these participants guessed correctly and suggested, among other guesses, that it would be ebb and flow and the moon cycle. The participant pool was too small to know for sure if the change of wording was a true improvement, but one could argue that “other” points more directly to other weather data than “choose”, which is a word much more open to interpretation. An alternative that was not tested, but could be considered, was “flere” which roughly translates to “additional”.

When it came to the alternatives themselves, which were pollution, humidity, pollen, UV, sun cycle, moon cycle, and ebb and flow, every participant found use or interest in at least one of the options. Pollen was of course very important to the participants with allergies, as they wanted to keep track of the pollen type and levels. Ebb and flow was seen as useful for contexts like boating or fishing trips. UV was interesting to some, though some participants' opinions may have been colored by the test taking place in the winter and early spring months. Pollution was considered by the participants, but most concluded that it was too seldom relevant to them unless they found themselves in areas known for high air pollution. Sun cycle was deemed somewhat useful to some of the participants. Moon cycle and humidity were less popular options among the roster of participants, but could still be useful to certain people and lifestyles.

As for the timespan, some participants interpreted the widget as conveying the whole day, or an average of that day's weather. While others saw it as the current weather. This was a clear indicator of the users being confused about the timespan. More work would have to be done for users to achieve one common mental model around the amount of time covered by the widget.

Weather theme page

Next, the users were presented with a theme page for weather, which started off as only a detailed weather widget with different tabs, but had three boxes for highlights added in its second version. The early version also had a graph on the first tab that met the user. Though this proved a bit hard to understand. Users were confused about the placement of wind information and found the overall graph to be a little too detailed. Though some did state that they thought it could be useful for people who liked or were used to read graphs.

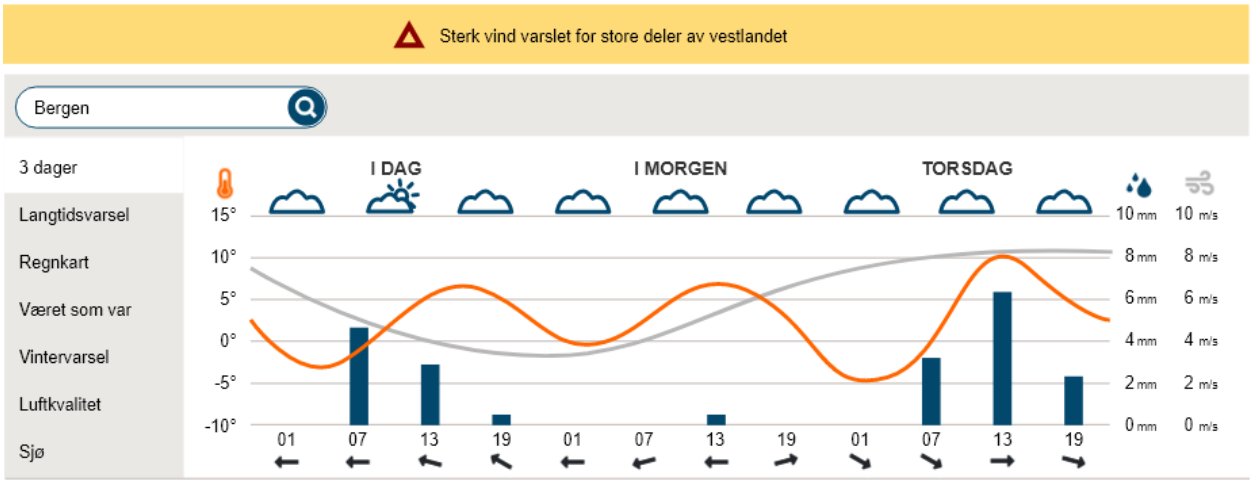


Figure 25: The graph on the first version of the weather page was confusing to the users.

For the two last participants, the graph was switched out with an hour-by-hour tab. Their feedback was that it was a little too detailed, or came off as too much info at once. This could be explored in a future prototype by removing or switching out some information or adding the ability to choose what rows they want to see.

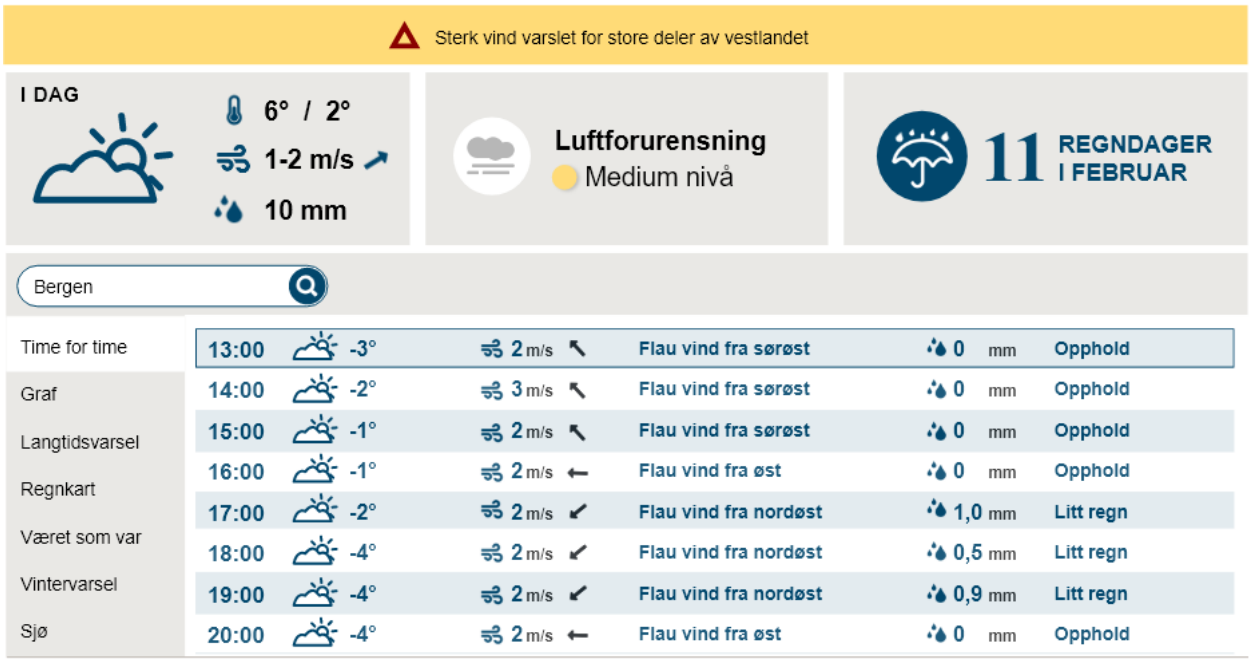


Figure 26: The weather page after the graph was switched out for "hour-by-hour" in the third iteration. An upper section representing summaries and highlights was also added in the second iteration.

Participants were asked what their thoughts around a separate weather page was, in which most were positive, while some explained it was of little use or interest to them. However, the ones who were not as positive did find the concept of a weather themed page useful regardless.

Before being allowed to click anything in this part of the prototype, users were asked to guess what information they were going to find under the "winter forecast" tab. All users expressed a need for information regarding driving in the winter, like the condition of the roads and mountain passes. This need was also seen in previous interviews, as some interviewees noted they used the night temperature to make a prediction of driving conditions. Other guesses involved general snow forecasts, pollution, and skiing conditions.

After having guessed, participants were prompted to click the winter forecast tab (See figure 27). Users were happy with the information that appeared, as it corresponded with the needs they had expressed. Especially the road condition and mountain passes, like all of them had mentioned. Several participants also expressed that the snow section showing depth and type was useful, though not on an everyday basis. This indicates that the snow section could be moved to be the third in the row, so that the road-related information comes first. All locations, including those in other seasons, would in a finished product be sorted by closest proximity based on the user's location.

Two users also suggested to keep track of roof avalanches or slippery pavements, though this would be hard to do as the condition of the roof or the pavement varies depending on human maintenance like shoveling or salting. One user was especially interested in information

regarding skiing, like an app they had downloaded, where they could see when the skiing track was last prepared. Additionally, they were interested in more information related to the quality of the snow so that they could prepare their skis with the right equipment. Though they admitted this may be a little niche for those who go skiing a lot.

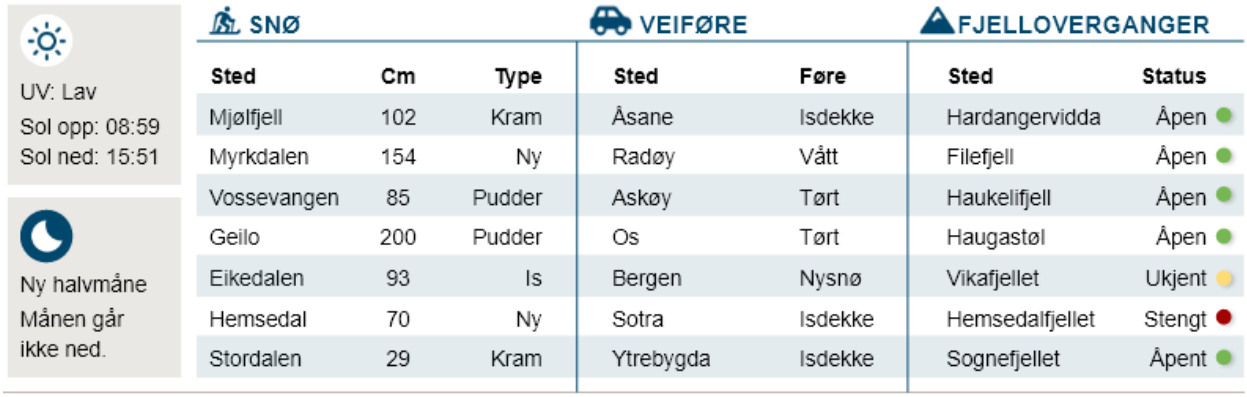


Figure 27: The design that appeared when users clicked the winter forecast tab. It had an overview over snow, road conditions and mountain passes. (Second iteration.)

Spring, summer and autumn forecast tabs were added in the second iteration of the prototype. These would in practice be dynamic and appear when the right month or weather came, but for the prototype the transitions were faked so that the participants could give opinions on them. The spring forecast had a pollen section that did not get finished but displayed a very rough concept of what the section could look like (See figure 28). The road condition would stay, as the spring months also bring slippery roads and frosty nights. The concept of “food seasons” would also be introduced in the spring. This section would ideally take into account the usual food seasons and the past and upcoming weather and give a recommendation to what kind of crops could be planted. As the seasonal tab would be dynamic, the food season section would likely not appear before May, and exchange places with the mountain pass section which could be present in March and April.

Participants liked the concept of having color codes like “traffic lights” to insinuate the pollen levels (and other data). Though users had some critique for the food season section, like the fact that some crops would need to be planted inside first before being taken outside, which could be hard to know for beginners. A solution for this could be to have hover tooltips containing some quick tips for each type of crop. One user also pointed out that the harvest seasons of crops like apples could vary greatly from garden to garden. This could be handled by alternatively not including the harvest notion for domesticated crops as these usually give their own visual clues. It can also be argued that the food season section is merely a pointer, but this would of course have to be made clearer.

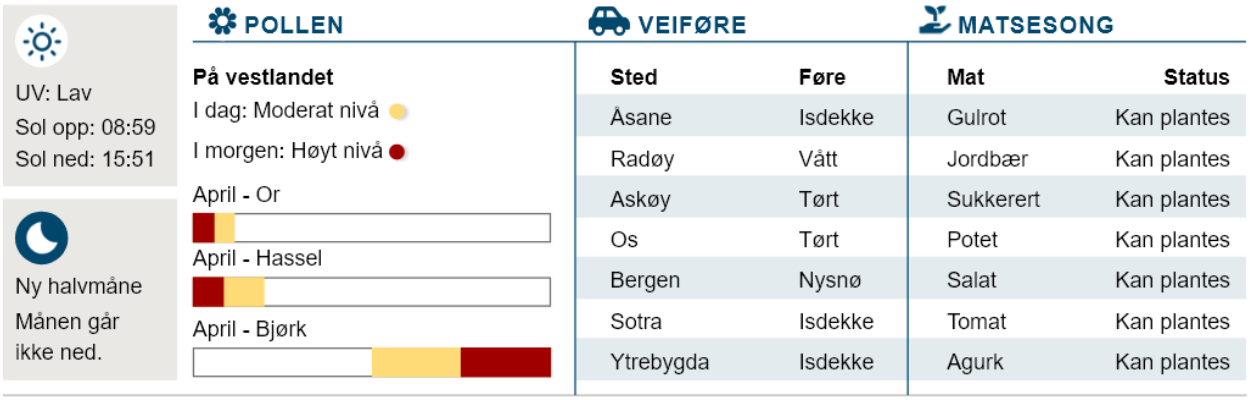


Figure 28: The spring version of the seasonal forecast tab would have pollen, road conditions and food season sections. (Note that the pollen section did not get finished and is only a rough sketch.)

Next, the four participants had a look at the summer version of the seasonal tab (See figure 29). It had an overview of the bathing temperatures, fire hazard status and food season. Users expressed mixed needs related to the summer season, though fire hazard was useful to most. One participant stated that they would simply go outside and feel the grass if they wanted to know if there was a danger of wildfire, but could see the use of it related to travel.

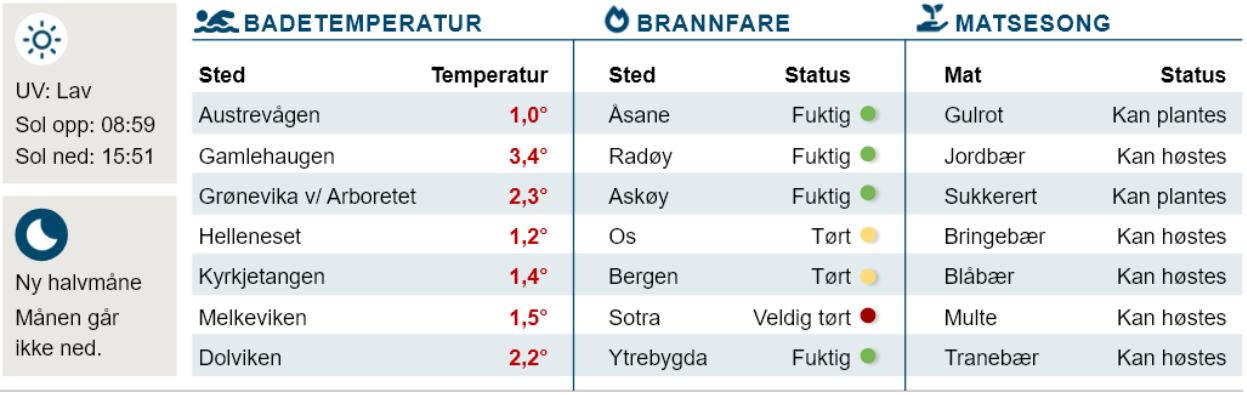


Figure 29: The summer version of the seasonal forecast tab would have bathing temperatures, local fire hazard warnings and food season sections.

The last seasonal tab represented autumn and covered bathing temperatures, road condition and food season (See figure 30). These would, as previously mentioned, be changed out as it fit the months. Bathing temperature would potentially stay until the weather reached a threshold and got too cold, where it could be switched out with something like mountain passes. Users also noted this, as one user suggested keeping it until the start of October if the weather allowed it. Users tended to find the food season section a bit more interesting when it gave info about harvesting wild growing food like berries and mushrooms. One user felt that the notion “can be harvested” on the food season section was too bombastic, and suggested lighter terms like “ripe” or “is ripening”. This comes back to clarity around the food section’s purpose and accuracy.

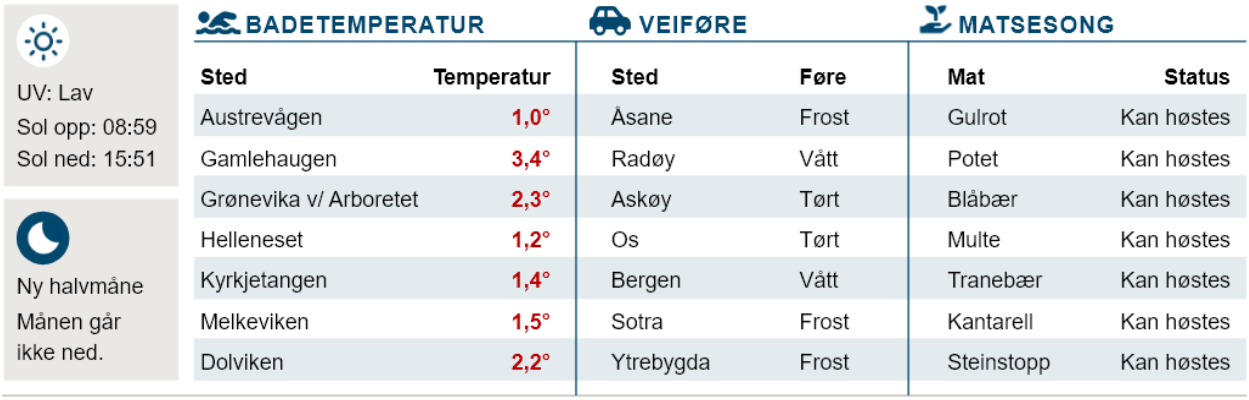


Figure 30: The autumn version of the seasonal forecast tab would have bathing temperatures, road conditions and food season sections.

The participants were then free to click around the other tabs and give their opinions of each one. Note that the first iteration had a tab named “air quality” which was switched out with “hour-by-hour” in later iterations, moving the air quality data like pollution and pollen to other places. The next tab available to explore was the “long-term forecast” tab. One user commented that they preferred the long-term function before the graph when comparing the two. Otherwise, users only had minor notions about design elements like the icon’s placement for discoverability. One user stated that they only needed temperature, precipitation, and wind, while another said they mainly wanted to know the temperature and the weather type via icons.

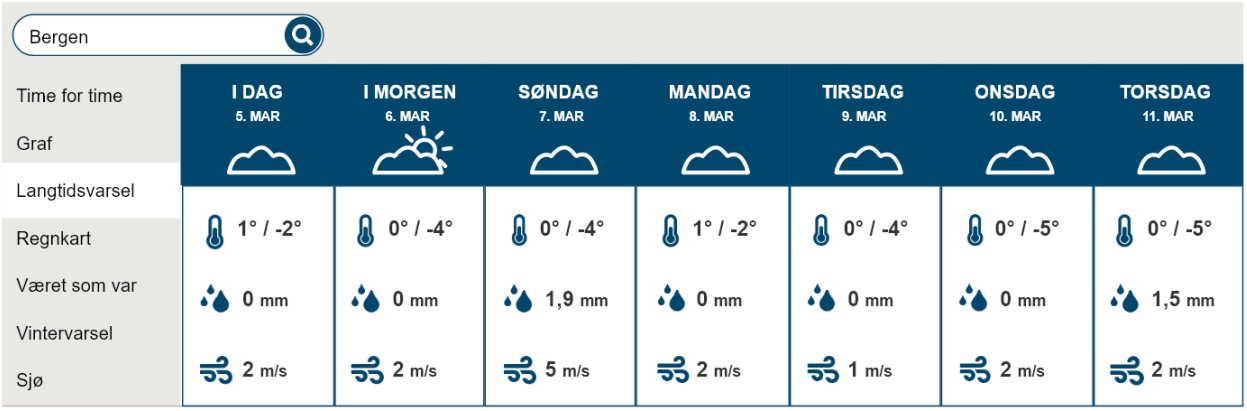


Figure 31: The long-term forecast displayed seven days, starting at the current day and going forward. It displayed the day of the week, the date, a weather icon, temperature, precipitation and wind for each individual day.

For the rain map, the prototype simply consisted of a screenshot of the function on Yr.no, as it was not feasible to make it function in the prototype made in Adobe XD. Their version consists of a grey map with animated cloud formations in different shades of blue depending on the amount of rain they hold. The animations of the clouds are tied to a timeline representing a current timespan. The timeline can be interacted with, though not in the prototype. Participants did not have a lot to say about this function as they did not use it much, but some users

commented that they found some value in it and regarded it as a precise form of forecast. Others had never seen or used such a function before and were not aware it existed on the Yr.no site.

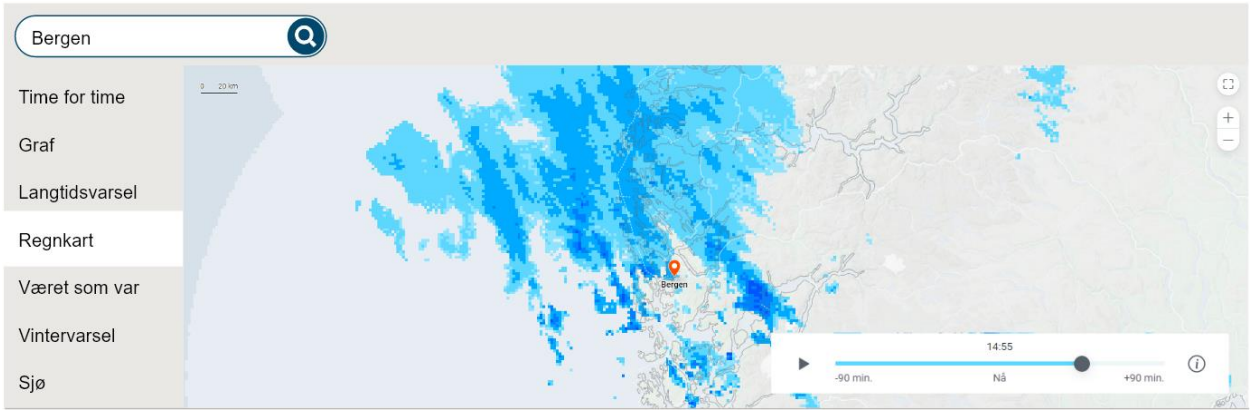


Figure 32: The rain map tab was made up of a screenshot of the rain map from Yr.no.

“Past weather” was the next tab and had an identical visual design to the “long-term” tab. This concept was not asked about in the post-it exercise, but was added in the prototype. Participants did not hold a strong need for this function. Still, some stated it could be interesting for a bet or for tracking weather. One participant said, “It could maybe be interesting to see how the weather has progressed, but I associate checking weather with checking the current or future weather.” The tab could be removed, but because of a lack of broader data regarding the need for such a function, it would need to be explored more. It could alternatively contain summaries of longer periods of time, like months or years instead of days.

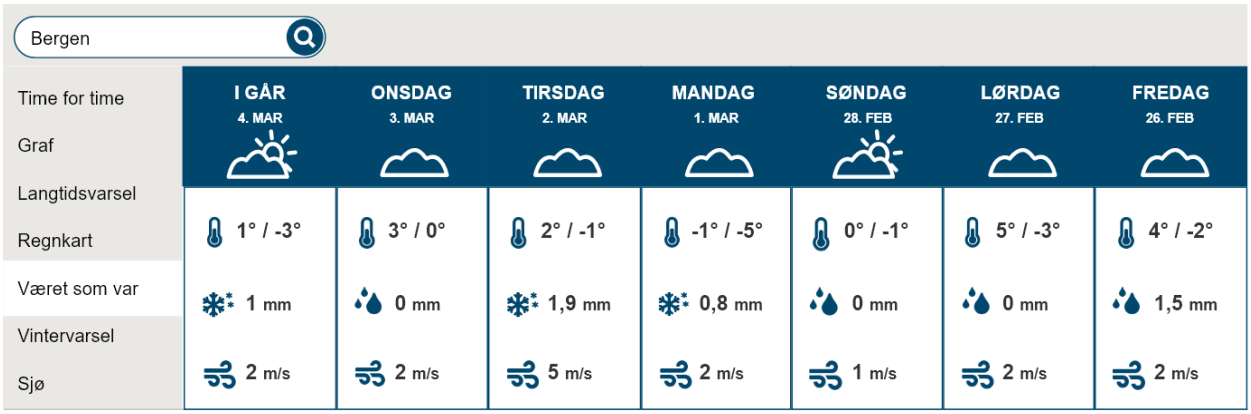


Figure 33: The tab for past weather contained the same info as the long-term forecast tab, but displayed the past seven days instead.

The sea tab was the last one on the theme page widget. In the first iteration it contained a section for the North Sea platforms and bathing temperatures (See figure 34). Bathing temperatures were added to this tab to cover the needs of bathing enthusiasts year-round when the function disappeared from the seasonal tab in the colder months. There was also a likely expectation for the bathing temperatures to exist in this tab, as it is related to the sea. One user

suggested switching it out for a forecast specifically for nearby fjords, especially in the warmer months when the boating season would be active as well as the bathing temperatures appearing in the seasonal tab anyway. Though this would remove some consistency and could potentially end up disturbing the user's ability to navigate the widget. It would have to be addressed in further testing.

In the second iteration, two design versions for ebb and flow were added to do a short A/B test. Version A displayed the four timestamps a day where the sea would start going from ebb to flow, and the other way. Version B had a more dynamic concept, where a body of water would be rising and lowering along with the real sea level, so that the user could follow the status live. Only two participants were involved in the testing, which gave enough insight to give a rough pointer, but was not the ideal number of participants to get a clear picture of which of the options were preferable. The first participant liked the dynamic part of option B, but did not have much experience with or use for the function. The second participant, who had more experience with activities at the sea, preferred option A. The next two participants only got to see option A, but one of the participants stated that they were initially confused if the timestamps represented the duration of each state, or if it was time of day. Thus, this function would need more testing.

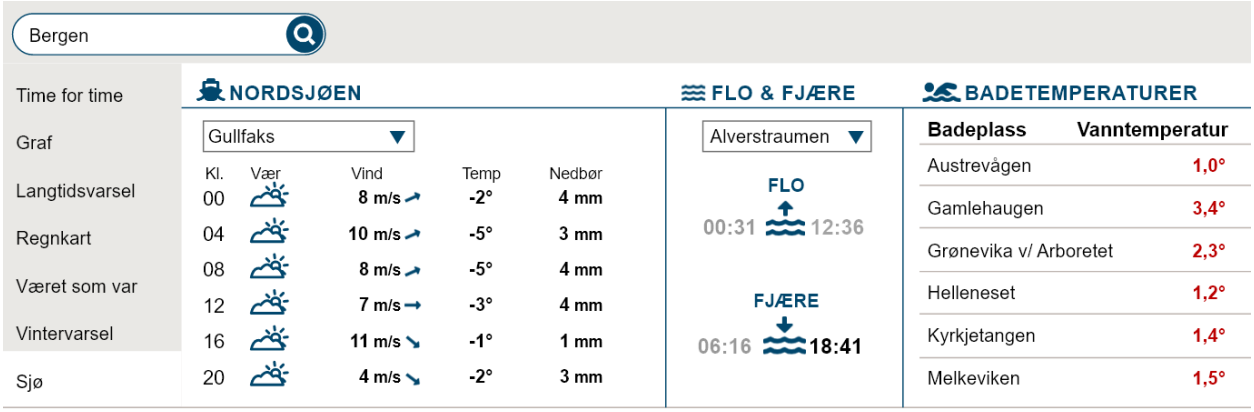


Figure 34: The first section of the sea tab contained basic info about the weather of the selected gas and oil field in the North Sea, where many Norwegians work or have relations to someone who works there. This was an element that was present on the backside of BT's physical newspaper. The next section presented ebb and flow of a chosen nearby location, while the last section had bathing temperatures. Though bathing temperatures could potentially be switched out for a section covering the weather at different fjords.

Closing questions

To wrap up the testing, some closing questions were asked. When asked if they thought they would use these weather functions in BT if they were added, replies were mixed. Some participants already had strong preference towards Yr.no, while others thought they would make use of BT's version. One participant pointed out that forecasts and status for mountain passes was lacking and hard to find on other pages like Yr.no, but liked how it was set up in the prototype. Users who had a pollen allergy were also very interested in the specific pollen

tracking features. Of course, there might have been bias from some participants potentially feeling a pressure to say yes as to not hurt the test organizer's feelings.

When asked if extreme weather would affect this, some of the users replied that they did like the concept of having those kinds of weather news in one place together with a forecast and appropriate warning.

4.2 Changes and lessons learned

When looking back in hindsight, some things could have been done differently during the various stages of collecting insight. Better questions could have been asked and some questions could have been followed up on more closely. Some lessons were also learned about what to keep in mind when collecting insight, as to not disturb the participant's experience and opinions.

In the survey done for the field study, there was a missed opportunity to ask what span of time the survey-takers preferred their forecast to represent. As the survey had around 180 participants, this data would have helped pinpoint what type of forecast should be the first to greet the participants when they entered the weather themed news page. Location preference was also something that could have been asked about, as it would have been good to know if users preferred to only use GPS location, or if they would have liked to get a broader overview of different places.

For the post-it exercise + interview, there were some questions that were added after the first pilot, like "Do you ever check the weather and news at the same time?". This question helped tie together the relation between weather and news. Some of the functions the users could pick in the post-it exercise were also added later, namely "Degree of uncertainty", "Rain map" and "Long-term forecast". The participants who did not cover with these were contacted postliminary to fill in the gaps. The four fields representing the users' degree of need for the different features had a field named "unnecessary" at first, but this seemed too harsh, so it was changed to "seldom needed".

During the post-it sorting there could in hindsight have been asked more questions. Especially when it came to the more "usual" categories like temperature or rain. Though we already know they are useful as a standard, it could have been constructive to gain an impression if they could be enhanced in any way. Two options that could have been useful to have the participants sort and evaluate, was UV and weather history. These were later included in the prototype.

In the last part of the post-it study, the participants were asked to look at several different versions of the front-page weather widget, each representing a different timespan. A lot of information was presented to the participants at once in this part, which may have resulted in some participants finding it hard to form opinions of the options separately. Lastly, on a general level, asking the follow-up question "Why?" more often could have helped get deeper insight.

When it came to the user testing, there was, as aforementioned, not enough time to test all aspects needed to make the design as user friendly as it could be. Some general features, like the pollen warnings, would especially need testing. But also more niche aspects, like if bathing temperatures are useful year-round for outdoor bathing enthusiasts and how they would use this feature. Or if the sea tab was fitting for those who needed it, especially those who work at sea or own a boat.

Realism proved to be a challenge in the user testing. While the design appeared realistic, some of the data was not, which made participants get caught up in details irrelevant to the study. For example, in the first iteration, the temperature displayed “13 / -1 “ degrees, which usually is unrealistic and uncommon. Throughout the testing, the rain amount was 10mm, while the dropdown alternatives said “a lot of rain”, which is also a mismatch. Though, only two participants noticed and pointed this out. This provided a lesson of making sure to have close to accurate and relevant placeholder data. Ideally, all displayed data should be matched to that day’s forecast for maximized immersion.

A technical issue with the user testing was the limitations of prototyping with Adobe XD. Elements sometimes took a while to load, which potentially disturbed the immersion for some users. In addition, it was not very evident how to make the prototype cover the screen properly. Thus, most of the participants looked at the prototype in a smaller version than intended. This may have given inaccurate feedback on sizing, especially font size. But since the smallest font size was matched with what the paper currently uses, the issue was avoided.

As aforementioned, the prototype went through revisions between every two participants. This may have caused some opinions to be lost, as fewer people were tested on the newer iterations. Not a lot of elements were changed per iteration, though. During the interview part of the user testing, users could have been asked more questions about their relationship to- and opinions around weather and news being connected. Such as how frequently they read weather themed articles. Though this did shine through when they were asked what they thought about a theme page for weather. Additionally, the users might have gained a false sense of understanding navigation as a consequence of being guided through the app. Though this user test did not focus on navigation, it would be needed to uncover additional insight about usability.

Some of the suggested solutions and designs in the prototype may not be as realistic to implement as others. Especially concerning the type of data that would be needed for some of the sections in the seasonal tab to work optimally. This thesis merely presents an ideal solution based on user insight. BT would be able to downscale or remove any feature deemed too complicated to implement. Additionally, some functions would potentially be of ambiguous accuracy, like the condition of the road. Though it could be argued that weather forecasts in general have varying accuracy, and should be interpreted with this in mind.

Chapter 5. Conclusion

5.1 Answering the research questions

RQ1: What different needs do the users of weather services have? And how can we cover these needs in a customizable weather widget?

Through various methods of evaluation in the forms of a survey, interviews, heuristic evaluation and user testing, insight on the needs of weather service users were collected. The survey conducted in the field study revealed that most participants checked the weather at least a couple times a week. While a third of users checked once a day, and almost as many checked several times a day. This indicated some users having a need for frequent updates. Participants also voiced a strong need for understandable navigation, with the majority labeling this as very important.

In the post-it exercise, temperature, weather icons, amount of rain, and wind intensity were among the features ranked as most essential. These are also among the most commonly present features of weather services in general. Interestingly, participants deemed none of the 24 weather features presented to them as fully essential, as none of the options were placed in the essential category by all 6 participants. This confirmed that users have varied needs.

As per BT's wishes to have "a personalized weather forecast on the front page", a front-page widget was prototyped. To meet the need for frequent updates, the widget would have to have a clear timespan and to push updates whenever relevant. This is something that is not fully present in the prototype, but should be worked on in further development. The need for easy navigation was met by having the widget be on top of the front page, and having signifiers signalizing that the different features could be interacted with. To make sure that the need is properly met, user testing focused on navigation would have to be conducted.

As the post-it exercise had shown, temperature, precipitation and wind were the most important features to users, along with weather icons. Thus, these were the main data shown on the front-page weather widget. The degree of variation on user needs were met by having the widget be customizable. This way users could decide for themselves how their needs would be fulfilled. Both in the sense of being able to choose the way the aforementioned data is presented, but also to be able to pick between different niche weather alternatives, like ebb and flow or pollen. In the user testing of the front-page widget prototype, all participants with pollen allergies found the pollen option to be very useful.

Table 1: A summary of user needs and what solutions should be applied.

USER NEEDS	**SOLUTIONS**
Seeing latest weather data	Frequent updates to the weather data
Understandable navigation	Signifiers and user testing

To see temperature, precipitation, wind and weather icons	Include these elements, especially when making weather summaries
Varied needs around weather information	If possible, let users choose how information is presented to them, and what kind of niche weather information they want to see

RQ2: What makes a good summarized local weather report?

From the highly relevant essay *What is a good forecast? An essay on the nature of goodness in weather forecasting* (Murphy, 1993), we have learned that "goodness" of a weather forecast can be objectively identified by consistency, quality and value. As for the local part of this research question, Meze-Hausken's (2007) study of BT's front page articles have revealed that the locals of Bergen pride themselves on living in the wettest city. This can in special cases make Bergensers excited about rain, which to others could be perceived as bad weather. An example of their excitement could be competing with another city, like Oslo, to set a rain record. The study also made a point about the experience of what felt like "good weather" could depend on the seasons. Moderate temperature and some sunshine could be considered wonderful weather if it follows a bad weather period.

What makes a good summarized local weather report naturally ties in very closely with users' needs. The insight from interviews throughout the study revealed that users value accuracy of the report and the quality of the weather itself to have a good experience when checking the weather. The conditions for a good weather report could be affected by the seasons, as some users had specific seasonal needs. Some users were extra concerned with the condition of the roads in regards to frost. And some had pollen allergies that they wished to keep track of in the relevant months. Meeting these needs could subjectively enhance the "goodness" of a weather report for specific user groups.

Thus, to meet the demands for the "goodness" in a good summarized local weather report, I would recommend implementing personalization into the design. Possibly taking the concept of customization even further than the presented prototype of this project. In addition, adaptability tied to the seasons is recommended. For example, status of road conditions is more needed in the winter than in the summer.

RQ3: How can we use user-centered design to gain insights to create different weather forecast designs?

User-centered design is all about placing humans in the center and taking a dive into human behavior, needs and capabilities (Norman, 2013, p. 8). As aforementioned, evaluation methods have been used to explore these factors in the form of interviews and surveys. Followed up by creating a prototype using Iterative and incremental development methodology, which involved user testing.

a

b

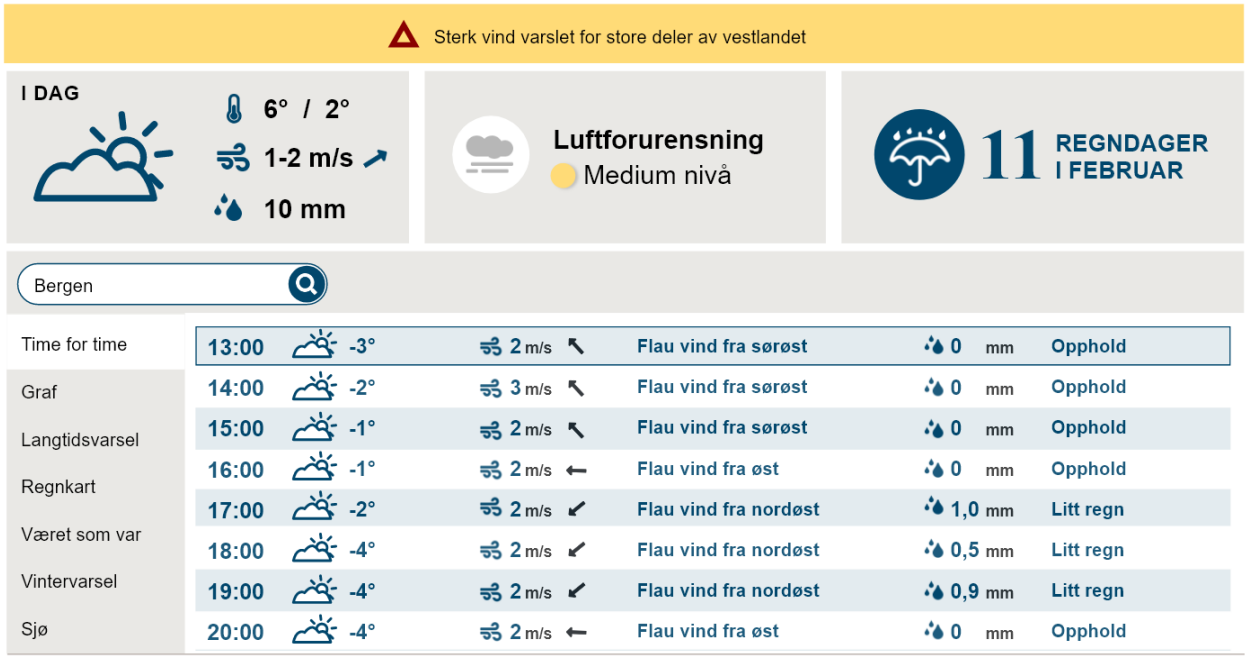


Figure 35 a & b: The insights from the different studies helped create a summarized front-page widget design (a) and a more detailed weather widget design for a weather theme page (b).

With the use of these user-centered design methods, we have gained a lot of insight around user needs and behavior. We know that they value options and accuracy, which implies a need for access to information they individually find useful and to be able to trust said information. In addition to the insights the evaluation methods have provided us, we have also looked at previous knowledge in the form of other weather-related studies and theory related to user-centered design.

All this insight has the potential to be adapted into a variety of widgets, which means it can be of help to both BT internally, but also others who want to develop local aimed weather services. For example, in addition to the different prototype designs made in this study, the insights can be used to fulfill BT's wish to supplement weather articles with weather data. This was a design that was not given focus due to time constraints.

5.2 Summary and conclusion

In this master's thesis we have introduced three research questions:

- **RQ1.** What different needs do the users of weather services have? And how can we cover these needs in a customizable weather widget?
- **RQ2.** What makes a good summarized local weather report?

- **RQ3.** How can we use user-centered design to gain insights to create different weather forecast designs?

Along with the knowledge obtained from previously conducted related research and theory, we utilized design science research methodology by using methods such as surveying, interviews, heuristic evaluation, prototyping and user testing. Using such methods allowed us to answer the research questions and identify users' needs related to weather forecasts as well as weather-related news.

Overall, it has been found that user-centered design is valuable and efficient for meeting user needs and can—in the context of a weather forecast—contribute to the perceived "goodness" of a weather report. Besides user-centered design principles and universal design, the most prominent user need is the need for customization, as weather forecasts have many niche categories. In the prototype we met this need by providing options for how users wanted to be presented with summarized weather data, like seeing vernacular words for amount of rain instead of metrics. Users were also able to view and pick a more niche weather feature from a list in the summary that would best suit their own interests and needs, such as pollen levels for those with allergies. Although some parts of the prototype may not take full advantage of the ability for customization, this is something that can be expanded on in the next iteration of the prototype.

The findings of this thesis will help future projects that aim to explore the design possibilities around local weather forecasts, especially connected to news platforms. As for the assignment issued by BT, the next subchapter will describe how the resulting prototype has fulfilled their proposal.

5.3 Bergens Tidende's request

Let us return to the original request from BT.

1) A personalized weather forecast on the front page.
A good way to make a feature personalized without making use of algorithms, is to let the user pick the options that fit them on the go. The front-page widget lets the users switch out the way temperature, wind, and precipitation are presented to them. Furthermore, they are given a slot where they can pick a more niche type of weather data – such as the pollen or moon cycle – to fit their needs.

Figure 36: What the front-page widget looks like if pollen has been selected in the "other" section.

2) Enriching articles tagged with weather with relevant data (rainfall, wind, long-term forecast, etc.)

Although there was not enough time to build this part of the prototype, the concept has been explored by asking users about their relationship to weather articles and thoughts around news connected to weather. By collecting insights about user needs and attitudes, we lay the foundation to design a widget that adds relevant weather data to an article.

3) Visualizations of theme pages about weather and/or climate.
Just like BT has theme pages for sports, culture and other themes, a weather theme page has been prototyped. Like other theme pages it collects relevant news articles about weather and climate, but it also displays a detailed weather widget.

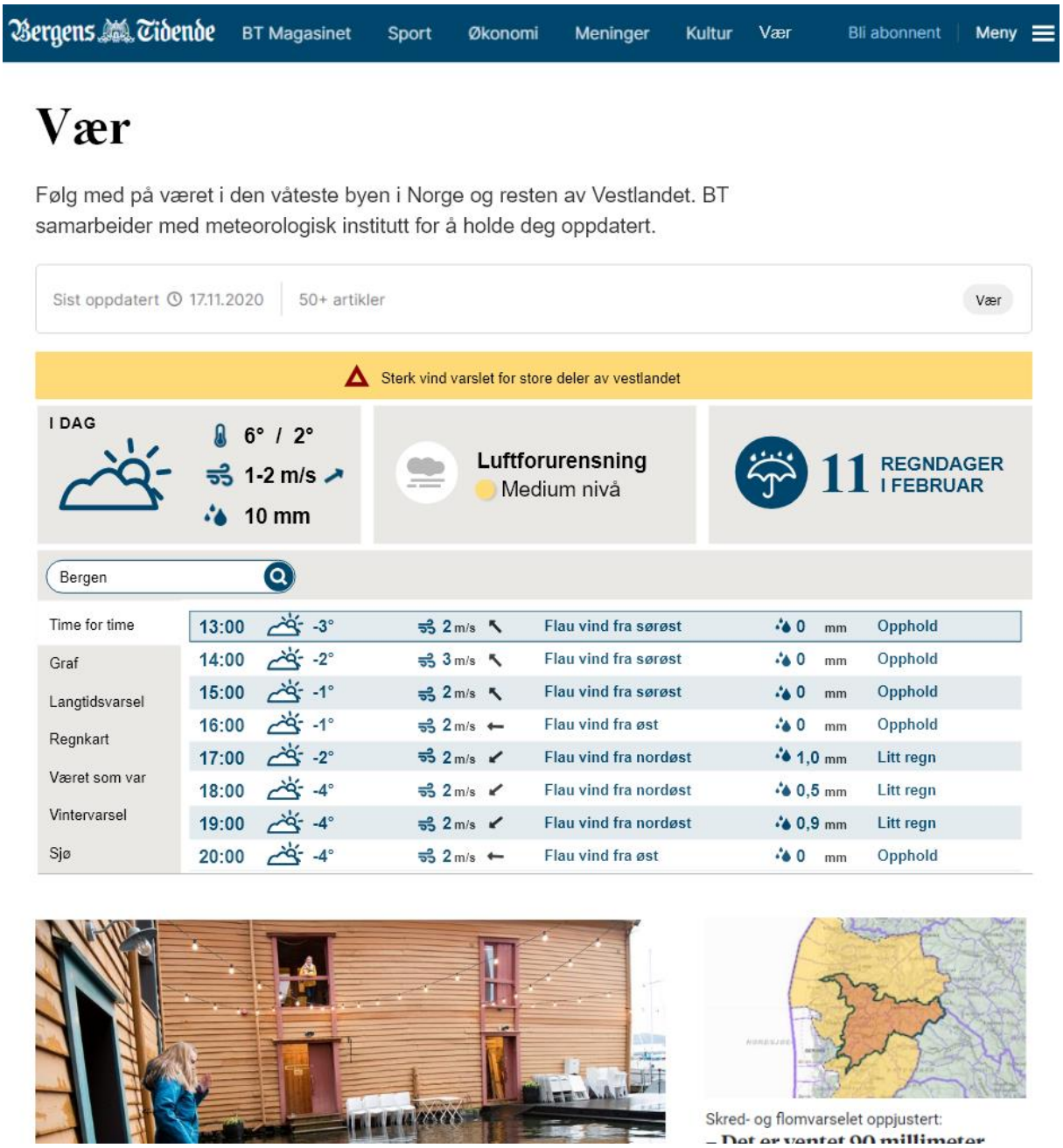


Figure 37: A visualization of a weather theme page containing a description, a weather widget,

and recent weather and climate news articles. Note that the features above the yellow wind warning are standard elements that appear on every theme page on BT.

4) Unique alerts in extreme weather.
Included in the theme page prototype was an extreme weather alert, along with a section that highlighted the most abnormal weather data for the day. Pop-up alerts on mobile and tablet devices could be a future expansion of this point, but was not worked on in this project.

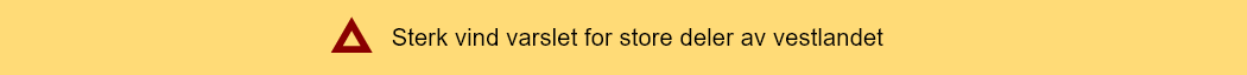


Figure 38: An alert informing the user about strong winds being anticipated in the west of Norway.

5) Bathing temperatures etc. (In the summer.)
BT's wishes to have bathing temperatures included were fulfilled, along with a potential for displaying them during other seasons than summer too.

BADETEMPERATUR

Sted	Temperatur
Austrevågen	1,0°
Gamlehaugen	3,4°
Grønevika v/ Arboretet	2,3°
Helleneset	1,2°
Kyrkjetangen	1,4°
Melkeviken	1,5°
Dolviken	2,2°

Figure 39: An overview over bathing temperatures at nearby outdoor bathing locations.

In the end, we have answered the research questions by exploring user needs related to weather. With this information we made a prototype tailored to user needs. At the same time, we were able to provide solutions to BT's wishes in creating widgets that fit their digital spaces.

5.4 Future work

Although 91% of the field study survey takers checked the weather via their phone, the prototype in this study was made for PC screens. A phone and tablet version of the prototype were planned, but were unfortunately not made because of time restrictions. The convenience of remote testing on a bigger screen size also played into the decision, as it would be optimal to test mobile and tablet versions directly on their respective devices, which is complicated to do remotely. Thus, converting the PC version into a mobile and tablet version would be an ideal part of future work.

Generally, the project would need more user testing, especially testing focused on accessibility and navigation, as the users were only guided through the prototype to give opinions this round. The most crucial features besides general navigation would be users' understanding of icon designs and the pollen part of the widget when completed. Icon designs were planned to be custom made as part of a user friendly and true to brand design, but there was unfortunately not enough time. Yr.no offers weather icons free for commercial use with credit ("Værsymbolene på Yr", n.d.) which unfortunately were discovered too late to add to the prototype, but could be implemented by BT. Another feature that would require more testing would be the graph, as it was confusing to most users. Minor issues like the need for clothing as a temperature indicator on the front-page widget, and who uses expressions like "weak breeze" could also be explored. Additionally, the dropdown options under the "other" section on the front-page widget could be showing the actual data of the niche categories, and not just the names, so that the user can open the menu and get a complete overview. As well as other tweaks and changes mentioned in the findings.

As mentioned in the conclusion of RQ3, the insights of this study can be used to expand the prototype in ways that BT sees fit. Their second request, concerning weather data supplementing weather themed articles, seems like a natural next step.

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