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Forestry Product Calculator: Addressing Mismatches Between Energy Provision and Consumption

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I am a student from the Department of Computer and Information Science at NTNU. My task was to plan and develop a forestry product calculator application for handheld devices.

I would like to thank my adviser Heri Ramampiaro for his advice, help and feedback through the whole period. His help has been tremendous, and despite of the long distance between our workplaces, I have received quick responses to all my questions.

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The climate is a still growing problem. By making people aware that they can save money when heating houses using firewood, several people might start using firewood instead of other more polluting heating methods. But to calculate the kWh price of firewood is not something that most people know how to do, and it seems that there does not exist any tools that make this easy today.

Forestry products trading is usually done between forestry specialists and energy specialists. These professional groups do not share standards, thus having problems to understand one another. The *Forestry Product Calculator* calculates prices and amounts between all the necessary annotations.

In view of this, the main goal with this thesis is to develop an application that remove the problems regarding cooperation between different industries when trading forestry products. The *Forestry Product Calculator* should be so intuitive to use so that everyone participating in such tradings should enjoy using it. The application should be seen as a tool that makes the everyday work go a lot easier.

To evaluate the work done with the *Forestry Product Calculator* application there have been conducted several tests, all which provided valuable feedback. The test persons have also responded to an SUS-form that provided an SUS-score, revealing whether or not they were satisfied with the application. Forestry experts have also been contacted, and they are all looking forward to start using the application.

All requirements established at the beginning of this thesis is met, and some even better than anticipated. The response time of the application is better than hoped, and the users do not use as much time as expected. We believe, however, that the application can enlighten users about the energy amount in firewood, which makes it easier for the user to see the environmental benefits of firewood heating compared to other heating methods. We also believe that the application will make the regular workday for a forestry expert easier, as calculation annotations are done by the application.

Klimaendringer er fortsatt ett voksende problem. Ved å gjøre folk oppmerksomme på at de kan spare penger ved å varme opp husene med vedfyring, vil flere mennesker begynne å bruke dette som brensel i stedet for andre mer forurensende oppvarmingsmetoder. Det å beregne kWh prisen på fyringsved er ikke noe folk flest vet hvordan de gjør, og det finnes ingen verktøy som gjør dette i dag.

Handel av skogsprodukter til bruk i industri utføres vanligvis mellom skogspesialister og energispesialister. Disse benytter ikke de samme enhetene, og har dermed problemer med å sammenligne priser og kvantitet av produktene. *Forestry Product Calculator* beregner priser og kvantitet mellom forskjellige enheter.

I lys av dette, er hovedmålet med denne avhandlingen å utvikle et verktøy som løser problemene rundt kjøp og salg av skogsprodukter mellom de ulike aktørene. *Forestry Product Calculator* skal være intuitiv å bruke, slik at alle som utfører denne type handel ønsker å ta verktøyet i bruk. Dette verktøyet skal lette det daglige arbeidet til ansatte i skogbruks- og energiindustrien.

For å evaluere arbeidet som er gjort med *Forestry Product Calculator* er det gjennomført flere tester. Testpersonene fylte også ut ett SUS-skjema, som er benyttet til beregning av en SUS-poengsum. Denne poengsummen viser hvor enkelt og effektivt testpersonene oppfatter verktøyet. Skogbruksekspertene er forespurt om nytten av dette verktøyet, og flere ønsker å benytte verktøyet i arbeidssammenheng.

Alle spesifikasjonene som ble utarbeidet ved oppstart av dette arbeidet har blitt oppfylt, noen med bedre resultat enn spesifisert, blandt annet er responstiden. Det vil si at resultatene av beregningene som blir utført, vises tilnærmet umiddelbart. Verktøyet vil gi brukerne informasjon om energimengde i veden de kjøper, noe som gjør det enklere for brukeren å se de miljømessige fordelene ved oppvarming med ved sammenlignet med andre oppvarmingsmetoder. Vi tror også at verktøyet vil lette arbeidssituasjonen til en skogbruksekspert, ved at beregninger mellom forskjellige enheter utføres av verktøyet.

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CHAPTER 1

INTRODUCTION

This chapter briefly explains the motivation behind my work. It also explains the problem to be solved and why this problem is worth solving.

1.1 Motivation

The climate is always changing, but unfortunately not to the better. As the development goes on, people pollute more and more, and the climate is in the long term getting worse. To minimize pollution, people need to be aware of a more environmental, but still not more expensive, way to heat houses. People need to get help when comparing firewood and other energy products regarding price per kWh. The firewood part of the *Forestry Product Calculator* that is to be developed during this thesis does exactly that. It makes it easier to compare prices between different quantities and qualities of firewood as well as it provides the price per kWh of the firewood. In this way it becomes quite easy for the home owners to compare firewood to other kinds of heating products, such as electricity and kerosene.

Both regarding the climate and the constant resource reduction, the energy industry needs to start using other products when producing energy. Some of the products they increasingly use, are different forestry products. The problem today appears when the energy industries and the forestry product industries are trading products. The two different industries use different standards, and therefore they have problems calculating correct prices and amounts of one extension to another. This may often lead to problems in accounting, and that one of the parties ends up with the feeling of being cheated since they thought they bought more energy than they actually did. The industry part of the *Forestry Product Calculator* provides correct calculations between all the different extensions, and removes the problems regarding different standards in the industries.

1.2 Problem statement

The problem addressed in this thesis is whether it is possible to build an application which calculates between different annotations regarding forestry products. For instance, the forestry industry can talk about solid tons while the energy industry believes that this is the same as tons, which it is not. Solid tons and tons are two different weight annotations. The different parties in the process of purchasing forestry products do not use the same annotations. Can such an application make the trading easier?

A lot of people use firewood today, but do they really understand how much energy they buy, or what the price of the energy is? The possibilities of such an application, for use in the industry and for the regular firewood buyer, will be investigated.

An application called *Forestry Product Calculator* should be available on an open mobile platform, such as Android. If there exist any tools that make it possible for the application to work on iOS and Windows phones without too much extra work, the application should work on these as well. The problems regarding firewood purchase and energy, as well as the one regarding annotation problems when trading forestry product should be taken into account.

1.3 Outline of dissertation

The rest of this thesis is organized as follows:

Chapter 2 - Research context & method gives an overview of the different research methods and describes the one that have been used during this thesis, as well as the context of which the application is to be used.

Chapter 3 - Theoretical background contains an overview of today's social issues that the *Forestry Product Calculator* application can minimize, and describes the theory behind the application.

Chapter 4 - Related work gives an overview of other applications that are in some way similar to the *Forestry Product Calculator*.

Chapter 5 - System Development describes how the requirements were captured, what they are, and why they are important. It also includes design decision discussions, how the screen is structured, and tools that are used in the making of the *Forestry Product Calculator* application.

Chapter 6 - Experiments & empirical studies gives an overview of the different tests that have been conducted, all use cases for the application and empirical studies done in the forestry product industry before and after the application was produced.

Chapter 7 - Conclusion contains results achieved, and what should be done next.

Appendices

Appendix A - Licenses include licenses for the different tools used making the *Forestry Product Calculator*.

Appendix B - Requirements gives an overview of both functional and non-functional requirements.

Appendix C - Design guidelines contains the different operating systems guidelines that are used making a recognizable design.

Appendix D - User manual includes the user manuals for both the firewood and industry part of the application.

Appendix E - Functional tests contains the functional tests that are used during the experiments.

Appendix F - Usability testing gives an overview of usability testing, the tests itself and the results.

Bibliography

CHAPTER 2

RESEARCH CONTEXT & METHOD

This chapter explains in what context the different parts of the *Forestry Product Calculator* should be used, and why it should be used in those cases. It also presents three different research methodology paradigms, and which one that are used in this thesis.

2.1 Context

The application is divided into two parts, industrial use of forestry products and public use of firewood. These parts are to be used in different ways. The industry part is to be used by professionals in the forestry and energy industries, while the firewood part is going to be used by the everyday man when buying firewood. Both parts makes it easier to compare prices between different forestry products and quantity.

The industry part is to be used during tradings of forestry products, in order to make it easier for the different participants to understand what they are buying regardless of the standards used. Even though the two parties in a trade do not use the same standards, it should be easy for both parties to know how much product, or energy, is being bought or sold.

The firewood part will be used to make it easier for the everyday man to know which sack of firewood is the most valuable to buy. The application makes the energy content calculation for a sack of firewood to make it is possible for everyone, even those who do not know much about energy or firewood, to know how much energy they buy and how much they pay for it.

2.2 Research Methods

This section explains three research methodology paradigms. These are shown in figure 2.1, and compared in table 2.2. (Bryman, 2006, p. 97-113)

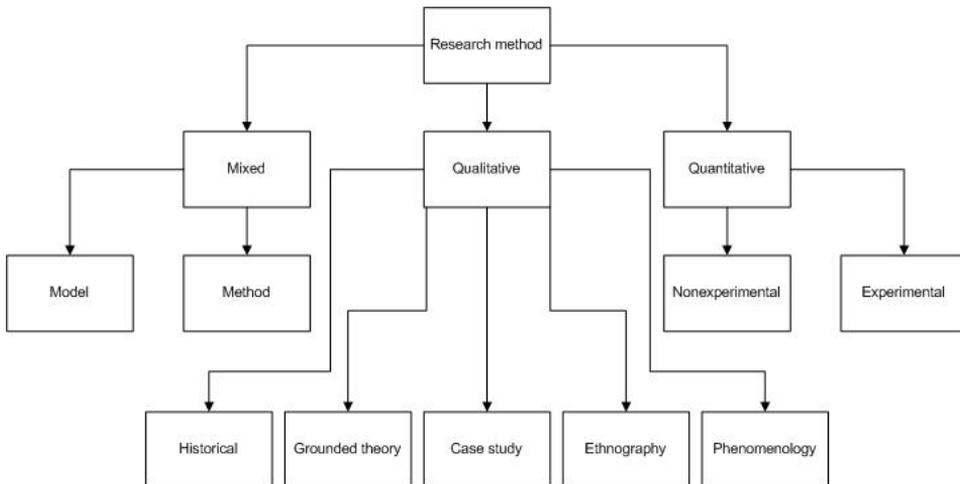


Figure 2.1: Research methods

2.2.1 Quantitative research

"Research that relies primarily on the collection of quantitative data." (Bryman, 2006, p. 97)

Quantitative data is data that deals with numbers. It is data that can be measured, such as length, height, weight and cost. For instance a picture can be described by the measurement 10" by 14", it weighs 8.5 pounds and cost \$300.

Quantitative research is based on the use of variables. There are different variable types that are used in quantitative research, as showed in table 2.1 below.

Quantitative research consists of two major types, experimental and non-experimental. In experimental research, cause and effect relationship are being studied. Experimental research actively manipulates independent variables and uses random assignment to create equivalent groups. With non-experimental research there are no manipulation of independent variables.

The research done in quantitative research decides what to study. It is done by asking specific and narrow questions regarding the topic in hand, meaning that usable quantifiable data can be collected from the users. All collected data from such surveys are to be analyzed, and further provide the developer knowledge about what should be researched.

Variable type	Key characteristic
Categorical	Made up of different types or categories of a phenomenon
Quantitative	Varies in degree or amount of a phenomenon
Independent	Presumed cause of another variable
Dependent	Changes the effect or outcome, based on another variable
Intervening	Comes in between other variables, helps to delineate the process through which variables affect one another, a mediator variable
Moderator	Delineates how a relationship of interest changes under different conditions or circumstances

Table 2.1: Common types of variables

Since this thesis is regarded around the forestry industry, using the quantitative research method would in some ways be beneficial, as the users are the ones that best know what is missing, and what the problems are today. By conducting surveys that addresses the problems regarding the forestry industry and the use of firewood it became clear what the issues that needed attention were. Based on the results from the surveys and the conversations with several forestry trading experts information about the problems decided what problems these should concentrate on minimizing.

2.2.2 Qualitative research

"Research that relies on the collection of qualitative data." (Bryman, 2006, p. 97)

Qualitative data is data that deals with descriptions. It is data that can be observed but not measured, such as colors, textures, smells, tastes and appearances. For instance the same picture as described with quantitative data, in section 2.2.1, can be characterized by blue colors, an old smell and a texture that show brush strokes (Roberts, 2012). Both descriptions explain the picture, but in very different ways. The best description depends on what information the user needs.

There are five major types of qualitative research:

- **Phenomenology:** The researches attempts to understand how individuals experience a phenomenon
- **Ethnography:** Focuses on describing the culture of a group of people
- **Case study:** Focused on providing a detailed account of one or more cases
- **Grounded theory:** Generating and developing a theory from data that the researcher collects
- **Historical:** About events that occurred in the past

During the surveys, the users provided different data regarding the main problems of trading, and the problems of understanding the energy content in firewood. They provided numbers regarding how hard they found it to calculate different annotations, as well as how high the energy content in the firewood are. This problem again leads to the ignorance of whether firewood or electricity heating provides the best environmental benefit.

2.2.3 Mixed research

"Research that involves the mixing of quantitative and qualitative methods or paradigm characteristics." (Bryman, 2006, p. 97)

Mixed research is a mix between quantitative and qualitative methods, techniques or paradigms to make one overall study. There exists two major types of mixed research:

- **Mixed method:** The researcher uses qualitative research paradigm for one phase of a research study and the quantitative research paradigm for another phase of the study
- **Mixed model:** The researcher mixes both qualitative and quantitative research approaches within a stage of the study across two or more of the stages of the research process.

2.2.4 Method applied for this thesis

The mixed method is the method applied during this project. Today's social challenges are looked into, and compared with my application considering how it can make some of the challenges smaller, or even disappear. To make this possible, a lot of information about the different problems is collected, and given a lot of thought on how to make some of them smaller. The problems form the base that decided that an application, that the people and society need, should be made.

The application is to be used by many different types of users, all of which may not have used too many applications before. Therefore the different kinds of users have been studied through testing of the application. Several people in different ages and sex contributed in the testing process, which proved that the design really needed to be easy if it were to be self-explanatory for all the users.

The application is twofolded and the firewood part is to be used to figure out which sack of firewood is the most economic for the user to buy. The application is to be used when someone is buying firewood, and it is to be used while the user is in the store looking at the different options, helping the user to make the best decision.

The industry part is to be used mainly by experts in the forestry and energy industries. They should use the application when trading forestry products, to be able to understand each other. The different industries use different annotations when measuring initial and final products, which leaves some trouble when trading and doing accounting.

	Quantitative research	Mixed research	Qualitative research
Scientific method	Deductive or "top-down"	Deductive and inductive	Inductive or "bottom-up"
View of human behavior	Regular and predictable	Somewhat predictable	Fluid, dynamic, situational, social, contextual, and personal
Most common research objectives	Description, explanation, and prediction	Multiple	Description, exploration, and discovery
Focus	Narrow-angle lens	Multifaceted	Wide-angle and "deep-angle" lens
Nature of observation	Attempt to study behavior under controlled conditions	Study behavior in more than one context or condition	Study behavior in natural environments
Nature of reality	Objective	Commonsense realism and pragmatic view of world	Subjective, personal, and socially constructed
Form of data collected	Quantitative	Multiple	Qualitative
Nature of data	Variables	Mixture of variables, words and images	Words, images, categories
Data and analysis	Identify statistical relationships	Quantitative and qualitative	Search for patterns, themes, and holistic features
Results	Generalizable findings	Corroborated findings may generalize	Particularistic findings
Form of final report	Statistical	Eclectic and pragmatic	Narrative with contextual description and direct quotations from research participants

Table 2.2: Emphases of Quantitative, Mixed and Qualitative Research

CHAPTER 3

THEORETICAL BACKGROUND

This chapter explains social issues connected to energy consumption and provision that can be minimized by the use of the *Forestry Product Calculator*, as well as theory that can be useful when designing the application screens.

3.1 Social issues

There are several social issues connected to energy consumption that can arise today. This section discusses some of these issues and elaborate on how the *Forestry Product Calculator* can make these issues smaller, or even disappear.

3.1.1 Bio-energy is less climate friendly than anticipated

Bio-energy from slow-growing forests and plants has always been categorized as climate-neutral fuel since the CO₂-emissions from plant mass can be absorbed by next generation plants. However, the time taken for new plants to be fully grown, and absorb all carbon dioxide emission, is long. Regarding this, new calculations show that bio-energy from plants and forests provide more carbon dioxide emissions than previously assumed (Foss, 2013).

The global warming potential (GWP) of combustion of bio-energy and fossil energy has been calculated over a hundred-year perspective:

	Bioenergy	Fossil energy
Former calculations	1 kilo CO ₂	0,4 kilo CO ₂
New calculations	1 kilo CO ₂	1,25-1,5 kilo CO ₂

Table 3.1: CO₂ combustion calculations

The numbers in table 3.1, state that the climate-effect from combustion of bio-energy, forestry products and plants, are higher than the climate-effect from combustion of fossil energy. This major change of results is due to the fact that former calculations did not regard the logging waste that was left in the forests, or the fact that mature forests are still growing, which means that it will take quite some time until the forests again absorbs the same amount of carbon dioxide.

Regarding the pollution from combustion of bio-energy, the numbers are not all positive. However, it is important to remember that these numbers only consider bio-energy that is obtained by increased logging. This means that if the forest is being logged anyway, for procurement of building materials or raw materials for the paper industry, the surplus masses are climate-neutral energy sources.

The *Forestry Product Calculator* can provide a price and energy amount on the logging waste, and in this way provide the logging companies an economical reason for using the logging waste as well as the building materials. This way, the logging materials stop being waste, and can instead be used as energy materials. This again may lead to less cutting, since the former logging waste can be used as firewood. The *Forestry Product Calculator* makes it possible to calculate the amount and price of the kWh in every forestry products able to create, which makes it easier for the producing industries to know how much they can earn on what they earlier has considered waste.

3.1.2 Research challenges for the energy nation

Regardless of its size, Norway is one of the largest energy nations in the world. The Norwegian energy deposits will, with successful use and proper development of the technological possibilities the deposits provide, probably be important success factors for years to come. It is therefore essential to research, develop and secure these resources, and their associated technologies, for the time to come (Havellen, 2007).

With the understanding of the growing importance of environmental impacts associated with extraction and use of energy, there exists four important areas of focus:

- Increased efforts to utilize bio-resources and commodities from the Norwegian agriculture and forestry, for energy purposes, both liquid and solid. It is decided that all the countries that are members of the European Union must collect at least twenty percent of its energy from renewable resources within the year of 2020.
- Major investments in offshore wind power.
- Long-term and committed work to best utilize the Norwegian thorium resources.
- Extensive efforts on reducing energy consumption and improve energy performance. Saved energy is more valuable than newly manufactured energy.

What can be done to reduce energy consumption, and at the same time make the everyday man aware of his consumption? The *Forestry Product Calculator* can be used to calculate how many kWh a specific amount of firewood consists of, as well as the price of it. By making it easy for the everyday man to calculate how much kWh his sack of firewood contains, he might be more aware of how much he is using, and in that way reduce his energy consumption.

3.2 Quality attributes

This section addresses theory related to the frontend design of an application, thus relevant for this project. It also explains how this theory have been used in the process of making the application as good as possible.

3.2.1 Usability

"Any darn fool can make something complex; it takes a genius to make something simple." - Albert Einstein

Usability is a quality attribute that says something about the ease of use and learnability of a human-made object for the intended users. The ISO definition is as follows: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

The usability consultant Jakob Nielsen and computer science professor Ben Shneiderman have defined usability to consist of five quality attributes (Nielsen, 2012):

- **Learnability:** How easy is it for the user to accomplish a basic task the first time he uses the design?
- **Efficiency:** How quickly does a user perform different tasks after he has learned the design?
- **Memorability:** How easy does the user reestablish the proficiency after he has returned from a period of time where he did not use the design?
- **Errors:** How many errors does a user make during a period of time? How severe are the errors, and how easily does the application recover after the errors have occurred?
- **Satisfaction:** How pleasant is it to use the design?

There are two different design paradigms that can be used to provide good usability to the design of an object:

- **User-centered:** the design is made with its intended users in mind at all times.
- **User-driven:** some of the users become members of the design team.

The user-centered design paradigm is chosen to be used when producing the *Forestry Product Calculator*. To some extent, the decision was made based on the fact that this is an assignment that is to be conducted by one person only. To include the user in the design-making process, it has been decided to perform user-tests during the entire process. The test plan is presented in chapter 6.

The hope is that a lot of different people, including the forestry product experts will use the tool, but not all are experts regarding the use of electronics and applications. As a lot of the users are beginners, regarding use of applications, an easy and self-explanatory user interface is essential. If the interface gets to complicated, many of the users are likely to be scared away. Hence, for this application, it is important to make an interface that invites users to try and to use the application (Bass et al., 2013, p. 175).

3.2.2 Performance

"An ounce of performance is worth pounds of promises." - Mae West

Performance is all about the time, and the system's ability to meet timing requirements. Whenever an event occur, the system must respond to that element within a certain time frame. For different reasons, most systems would like the response time to be low in order to avoid delay of other system processes, and let users get the best possible experience considering response time. Performance is about managing system resources to achieve acceptable timing behavior.

The response of a system can be characterized by latency, the time taken for a system to respond to any event, or throughput, the number of events completed during a given amount of time. Increased response time and reduced throughput are the key issues for performance (Design Fundamentals, 2014).

If the application uses a lot of time on each calculation the user will be bored, and it would end with no users at all. The application is supposed to be used when buying firewood or in the middle of negotiations. Therefore, all calculations should be done fast, as the answers are needed right away (Bass et al., 2013, pp. 131-145).

3.2.3 Availability

"Ninety percent of life is just showing up." - Woody Allen

Availability is about the systems ability to be available, even after a fault has occurred. The system needs to be idle, and to be able to execute the tasks when needed. Availability adds the notion of recovery, meaning that when the system breaks, it will recover itself. This means that it is all about minimizing downtime by mitigating faults.

To sum it all up, when thinking of availability, these questions must be considered:

- What makes the system break?
- How likely is that fault to occur?
- How much time is needed to repair it?

Considering this application, availability is a crucial quality attribute. If there are cases where the application does not work when a user needs it, users will be lost quickly. If the application breaks during a calculation, it is important that it will recover quickly and try again, with the same input that was typed in earlier. If the calculations take long time to complete, it is quite a big chance that the users get bored, and therefore quit using the application (Bass et al., 2013, pp. 79-98).

3.2.4 Testability

"Testing leads to failure, and failure leads to understanding" - Burt Rutan

Testability is about the ease with which software can demonstrate faults through testing. If there actually exist a fault in the system, the sooner that fault is recognized the better, and preferably through testing. The sooner a fault is detected, the costs of fixing that fault is lower, meaning that finding the faults as soon as possible is desired. To properly test a system it must be possible to control each component's input and observe the output, as well as being able to test portions of the system or the entire system. Testing can be done by many different people; developers, users or quality assurance personnel. Making sure that a system is easily testable makes payoffs in costs of testing as well as the reliability of the system.

Not only do the calculations done by the application need to be correct, but the underlying code should not include any mistakes either. The calculations can be tested by checking the results against the result we get from an Excel calculator made by COWI's forestry expert Knute Foss. If they match, the calculations are correct. To make sure that all the underlying code works as supposed to, and contains no errors, it is best to make it possible to test the different classes in the model separately. This class testing shall not be a concern as long as it is in the mind of the programmer from the beginning (Bass et al., 2013, pp. 159-172).

3.2.5 Modifiability

"Adapt or perish, now as ever, is nature's inexorable imperative." - H.G. Wells

Change happens in many different places and due to many different reasons. It is impossible to avoid changes, but it is possible to make the costs, in time and money, of making changes as low as possible. Modifiability is about change, and the interest of costs and risks associated with making changes.

There are a lot of different tactics for reducing change. To make a plan for modifiability these questions must be asked:

- What can change?
- What is the likelihood of the change?
- When is the change made and by who?
- What is the cost of the change?

All these questions were asked in regard of the *Forestry Product Calculator*. And some changes may appear, both with the design and with the input variations. There might be necessary to have several annotations, as well as multiple wood species to choose from. On one hand the needs for changes in the design can appear, but the probability of large changes after the application is finished are rather small. On the other hand, the needs for several wood species are expected to happen. But adding a wood specie should be considered when making the application, and then making it an easy change. That kind of change should only be necessary to perform in one place of the application code (Bass et al., 2013, pp. 117-128).

This chapter presents applications that are similar with the *Forestry Product Calculator*. The main goal is to illustrate the main motivation behind our calculator. We look into different calculators as well as applications concerning forestry products.

4.1 Calculators

The *Forestry Product Calculator* is primarily a calculator, and there exists a lot of other calculator applications today. Even though none of the calculator applications computes the same items as the *Forestry Product Calculator* does, they are similar to the *Forestry Product Calculator* in some ways. This section will look at some different calculator applications, and compare them to the *Forestry Product Calculator*.

4.1.1 BMI kalkulator



Figure 4.1: BMI kalkulator icon

The "BMI kalkulator" is a calculator which calculates body mass index and ideal weight based on height, weight, age and sex. As with the firewood part of the *Forestry Product Calculator*, only a few and known inputs are necessary to make the calculations needed. On the other hand, the BMI calculator needs input that describes the user, while the *Forestry Product Calculator* needs input that describes the sack of firewood the user considers. This means that in the *Forestry Product Calculator* users need to read the input off the firewood sack, while the users of the BMI calculator normally already know the needed input (smayer.net, 2013).

A good thing about the "BMI kalkulator" is that the necessary input is information already known by the user, and there are also very few input fields that need to be filled to make the calculation. This is very much like the *Forestry Product Calculator* in the sense that it does not require much input, but the input needed is not known by the users, they have to read it from the sack of firewood. On the other hand, the "BMI kalkulator" exists with many different menus. Each menu show a new view that calculate different body indexes, which makes the application a bit messy. The only menus the forestry calculator consists of is the firewood and industry parts, and they have very different areas of usage.

4.1.2 Financial Calculators

The Financial Calculators application is actually an application that makes use of many other different financial calculators that exist, while the forestry application does not. Both these applications are advanced applications regarding their science, and they are similar to some extent.

They are similar in the way that they both need a lot of information to make the correct and expected calculations, but the theme of the calculators are so different that they need entirely different inputs. They give very different results, since they are not calculating the same sciences. The results from the financial calculator are shown in a very different way than the ones from the forestry calculator. The financial calculator uses graphs for instance, while the forestry application only uses clear text (Bishinews, 2013).

One of the good sides of the financial calculators application is that it is very structured, making it is easy to find where to provide all the needed input to make the calculations. Even though there are a lot of choices, it is constructed to make it is easy to navigate between the available calculations. The results also appear just below the input choices made by the user, which is the same way as in the forestry products calculator.

On the negative side, there are too many choices that have to be taken in the financial calculator, but in the *Forestry Product Calculator* the input choices have been minimized. This means that only the necessary input must be provided.



Figure 4.2: Financial Calculators icon

4.1.3 Calories Burned Calculator

The Calories Burned Calculator is an application that calculates how many calories a user spends on daily activities and exercises. The user can plot what he has been eating, how much of it and what kind of exercise he has been doing, and for how long. Based on the input the user provides the calculator computes how much calories have been ingested and how much have been used. This application is similar to the *Forestry Product Calculator* in the way that they are both calculators. It can be compared to the firewood part in quantity of input needed to make calculations, which is quite small, and that they are both intended for the everyday man. Other than that the two applications have very little in common (Patel, 2013).

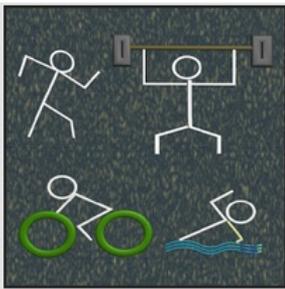


Figure 4.3: Calories Burned Calculator icon

One part of the calories burned calculator that is not likable is all the pictures and symbols that are used as buttons and menus. First, the pictures does not look good at all, and second, the different pictures make the design messy. Some of the users are believed to have problems understanding what the different pictures and symbols actually mean. No pictures or symbols will be used in the *Forestry Product Calculator*.

The likable parts about the calories burned calculator, are those who are quite similar to the design choices of the *Forestry Product Calculator*. The fact that only the necessary inputs are required, and that the results are listed just below the input possibilities makes it structured and recognizable for the users.

4.2 Forestry products

There exists some applications regarding forestry products, but to our best knowledge, none of them do the same as our *Forestry Product Calculator*. Most of the forestry product applications that do exist today regard timber, the size of firewood and how to cut down trees. This section will compare such applications with the *Forestry Product Calculator*.

4.2.1 Firewood Log Companion

The Firewood Log Companion states that it is a must for all wood burning addicts (ZORAC, 2013). The firewood log companion includes a list of all the known wood species, containing name and burning performance, which make it a bit similar to the *Forestry Product Calculator*. The difference is that the *Forestry Product Calculator* provides a number telling how much energy, in kWh, the sack of firewood contains, while the firewood log companion just provides poor, good, average etc.

The applications are very different in another area as well, namely the industry part of the *Forestry Product Calculator* which is not existing in the firewood log companion at all. This application does not contain anything similar to the industry part of the forestry product application. The Firewood Log Companion does, on the other hand, provide information of when to cut down trees, and how. It also contains the possibility of recognizing a wood specie by comparing pictures regarding bark and leaves.



Figure 4.4: Firewood Log Companion icon

The design consists of many buttons, which seems to make it chaotic. In the *Forestry Product Calculator* it has been decided not to use any buttons at all. At the same time, the results are displayed in a very organized way. The results in the firewood log companion consists of very much information and a lot of pictures. The way they have organized the results are very clean and tidy, and in the *Forestry Product Calculator* all the results are displayed very organized as a list.

4.2.2 Timber Calculator



Figure 4.5: Timber Calculator icon

The Timber Calculator can be used to generate the estimation quotation of timbers and related products. The calculator can for instance compare prices on timber products from different suppliers. This makes the application both similar and different from the *Forestry Product Calculator*. The forestry product application can also be used to compare prices, but regarding quantity, not suppliers. Another difference is the fact that the timber calculator only includes timber, and timber products, while the forestry product application includes firewood and other kinds of cut up trees (Principal Axis Android, 2012).

The Timber Calculator uses a small tab-menu to separate the three different main parts of the application, believed to be a clean and straightforward way to separate the different parts. It makes it very easy for the user to know where he is at all times. Still, there were a couple of things that were not that great, like the colors and the text-boxes. The colors that are used all melt together, and makes it quite hard to separate the different parts, leaving the colors to work against their purpose. It was also quite hard to understand which text-boxes to write in, and which were supposed to provide results from the calculations.

4.2.3 Firewood Calculator

As the name predicts, the Firewood Calculator does Calculations regarding firewood purchases, which makes the application very similar to the firewood part of the forestry product at first glance. But after taking a closer look at the application it is not as similar to the *Forestry Product Calculator* as expected. The Firewood Calculator can be used to figure out if the user actually have bought the amount of firewood that the seller said. By measuring the pile of firewood the calculator computes the actual amount of firewood bought, which is not the purpose of the *Forestry Product Calculator*. They can both be used to figure out whether it is good firewood that is bought or not. While the *Forestry Product Calculator* calculates price per kWh and the amount of energy, in kWh, bought, the Firewood Calculator tells you if the firewood bought is a good burning wood specie (BoxCrusher Solutions, 2011).



Figure 4.6: Firewood Calculator icon

The Firewood Calculator consists of some good sides, and some bad sides. It was really positive that the calculator only require the absolute necessary inputs. The results are shown underneath the input, and they are really systematized, which makes it easy to use and see the results.

At first, some trouble regarding the tab-menu in top of the application was experienced, because there were problems understanding that there were two different menus since they both use the same background symbol. If they wanted to use background symbols for the buttons, the symbols should reflect the menu behind the button. It was also hard to understand the meaning of the campfire pictures in front of the results. It was not possible to understand why those pictures where placed there, and it made the results a bit more messy and hard to read.

CHAPTER 5

SYSTEM DEVELOPMENT

This chapter explains how the requirements for the *Forestry Product Calculator* were captured, what they are, and their degree of importance. It contains information about the screen structure, how it evolved, and related tools that was used when implementing the application. Information about the implementation are also included.

5.1 Requirement Analysis

In order to create a new product that solves or simplifies problems that users experience regarding a specific situation, requirement analysis is needed to determine the needs or conditions that must be met. In addition, various interests may have conflicting demands that must be considered (Hay, 2003).

5.1.1 Capturing the requirements

The search for requirements started by talking with specialists who are involved in the trading of forestry products, to understand which problems existed. All of the contacted specialists had experienced the same problems regarding the use of different standards. The parties in the proceedings use different standards. Therefore, they have problems understanding what amount of forestry products they are buying or selling, and how much they actually pay for the annotation they are familiar with.

It was quite clear that all the problems developed from the use of different standards in the different industries. The parties in the proceedings do not know how to calculate between the different annotations, as they do not know how they interrelate. It turned out that a very few people did even know the correlation between many of the annotations, as well as how to calculate the amount of energy in all the different forestry products, which often led to at least one part of the proceedings feeling scammed.

After getting a grasp on what the problem was, two surveys were conducted. One for firewood buyers and one for industry workers, which can be viewed in section 6.2.1. Many people answered the surveys, viewed in section 6.2.1, and the application requirements were based on these answers.

5.1.2 Application requirements

- The application must be **easy to understand**, and users should not ever have problems when using the application. Since the application is to be used by many different people, it is crucial that the design is intuitive and clear making it impossible to misunderstand what to do. There should be a maximum of 3% user operating mistakes, decided in appendix B.1. This number is based on experience. If a user makes many mistakes, experience shows that most of them give up, and stop using the application, which is not desired.
- The application must be **easy to use**, and usage should go quickly. When using the application, the calculations have to run fast not letting the users get tired of waiting, but rather wants to use it again. The application should facilitate the work day for industrial workers and wood buyers, not make it harder. In the requirements, appendix B.1, it is stated that first time use should not take more than four minutes for either of the parts, firewood or industry. This is also a number based on experience, as many people stop using an application if it takes too much time.
- The application should be **for anyone to use**, and help provide insightful feedback to everyone that needs help calculating different annotations and prices. It is important that the application is useful for everyone, and not only people that know much about forestry products and energy.

5.1.3 Major requirements

All the requirements discussed in the section above are important, but the following requirements are what the entire *Forestry Product Calculator* is based upon.

- The **calculations must always be correct**, as the user should not get scammed by the application. If the user experience calculation flaws, even just once, the user might feel tricked and does not want to use the application again. The calculations must also be done within a latency of 3 seconds, shown in appendix B.1. Studies show that most people stop to use an application or a web-site when the latency gets close to 5 seconds or more.
- The application should remove the difficulties when trading forestry products to **make cooperation between different industries easier**. Problems with the use of different standards should be removed, and trading forestry products should not require knowledge of all different annotations that exists.

5.2 System Architecture

After the requirements were captured and totally understood, building the screen almost made itself.

This section explains how the screen architecture was captured and how it evolved during the forestry product life-cycle. It also describes tools that can be used as bases for the *Forestry Product Calculator*.

5.2.1 How the product was designed

The *Forestry Product Calculator* is an application that is made to work on different operating systems as well as on devices with different screen sizes. The different operation systems guidelines therefore works as bases for the application's design, see appendix C. All the guidelines are established by the different cooperations that initiated the different operating systems. By implementing these guidelines, the application should feel known to all the users, independent of the operating system in use. This way, the application behaves like other applications that the users are familiar with, which will lower the threshold to start using the application.

5.2.2 Development from the preliminary study

During the preliminary studies it was decided that the design needs to be clean and easy. These main characteristics have been kept through the entire process. It was also decided that the results should be displayed at the bottom of the screen, and divided on to different screens. The different results should be scrolled between horizontally. Even though the results are being viewed at the bottom of the screen, the grouping that led to horizontal scrolling has been forsaken. Instead, the results are listed below each other, and can be browsed using vertical scroll.

After three usability tests were conducted, appendix F, sections F.3.1 - F.3.3, it was decided to make one change. The three test participants had problems triggering the calculations. They managed to provide the correct input, but they did not understand how to do the calculations. As for now, the calculations were conducted if the user touched anywhere outside of the last input field, which was not as self explanatory for the users as predicted. A "Calculate"-button was therefore included underneath all input choices. The button does not hold any functionality, but it makes the user touch somewhere outside the last input-field. As seen in the last 17 usability tests, appendix F, sections F.3.4 - F.3.20, the button removed the problem regarding calculation execution.

5.2.3 Screen structure

Since the application is to be used by many different people, all of which do not use applications that often, the design had to be self explanatory and orderly. Therefore, the application needed a simple design securing that the user would not doubt what to do during usage of the application. To make the application meet all the decisions, it was important to fully understand what the users would use the application for, and how it would be most sufficient to use the application.

The continuation consisted of figuring out the formulas needed to make the necessary calculations, and to know what choices the users must make in order to get the required input. After this was interpreted, the development of the first part of the application could be started, the one consisting of the input choices. Which choices should the user make first? What is the most important choice? In which order would it be most natural for the user to make his choices?

The figure shows two side-by-side screenshots of a mobile application interface. The left screenshot is titled 'Vedkjøp' and the right is titled 'Industri'. Both screens have a dark background with white text and a light blue header bar.

Vedkjøp screen:

- Header: < Vedkjøp
- Vedmengde: Velg vedmengde... >
- Tretype: Velg tretype... >
- Fukt %: Fukt %
- Pris: Pris
- Beregn
- Sekken skal veie kg
- kWh:
- Pris/kWh:
- Pris 40 L sekk:
- Pris 60 L sekk:
- Pris 80 L sekk:
- Pris storesekk EU:

Industri screen:

- Header: < Industri
- Produkt: Velg produkt... >
- Tretype: Velg tretype... >
- Fukt %: Fukt %
- 1 Velg enhet... >
- Pris: Pris
- Beregn
- Lassverdi:
- MWh:
- Pris/MWh:
- Enhetspris table:

Enhetspris	Antall	Enhetspris
Lm3		
Fm3		
Tonn		
Tonn TS		

Figure 5.1: Choices

The order of the input choices was based on what was natural when testing the application, as shown in figure 5.1.

The last part of the application is the results part. It has been decided that this part should consist of several pages that can be swiped between. This part is located below the input part, as shown in figure 5.2.



Figure 5.2: Calculation

There are two different options to show the results from the calculations:

1. **Different views to group the results, scroll horizontally.** The input choices are shown at the top of the screen, and the results that are changing are underneath it, meaning that only the lower part of the screen is changed when swiping between the results. The results are divided on different views to let the grouping make it easier to find the results the user is searching for. The swiping between the result views is done horizontally.
2. **List of results, scroll vertically.** The input choices are still to be shown at the top of the screen, with the results underneath it. The results are grouped, but only by having the similar results closest in line. They are displayed underneath each other in a line, and can be viewed by scrolling vertically.

Both options agree that the input choices should be at top of the page, hence, that part of the application is decided. As far as the results go, there are two very good options, both with their own strengths and weaknesses. The first option groups the results in a very clear and easy way, and the user will find the results he is searching for quite easy, given that he understands that it is possible to swipe horizontally. Several studies state that many users have problems understanding the horizontal swiping, and they suggest that vertical scrolling is the only possible option to display information that needs more space than one screen. Even though option two uses vertical scroll only, satisfying the studies, it does not separate the different types of results as well as option one.

Even though the results are not grouped as well in option two, the scrolling choice of the application feels more natural. If the users do not understand how to view all the results, then how they are grouped is not too important. Hence, option two seems like the best the solution, as shown in 5.3.

Vedkjøp	
Tretype:	Selje ✓
Fukt %:	5
Pris:	80
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00
Pris 80 L sekk:	106.67
Pris storsekk EU:	1333.33
Pris storsekk Hyd...	2000.00
Pris favn:	4000.00
Pris storfavn:	15881.48

Industri		
Produkt:	Tørr sagflis >	
Tretype:	Selje >	
Fukt %:	5	
4	Fm3 >	
Pris:	1500	
kWh:	9078	
Pris/kWh:	0.17	
Enhet Antall enheter Enhetspris		
Lm3	12.12	123.75
Fm3	4.00	1500.00
Tonn	1.81	828.49
Tonn tørrstoff	1.72	872.09

Figure 5.3: Results

There does not exist any similar tool that can make these calculations. This tool is easy to use, and can revolutionize the way forestry products are traded today. With this tool the forestry product experts and the energy experts are able to calculate different annotations in order to fully understand each other. The design is standardized, making the threshold to begin to use this tool quite low as many of the users will identify several parts from previously used applications.

5.2.4 Implementation

The *Forestry Product Calculator* has been implemented using HTML5 and JavaScript. The application consists of four main components, namely the "Startpage", the "About" page, the "Firewood" part, and the "Industry" part. These components are related as shown graphically in figure 5.4.

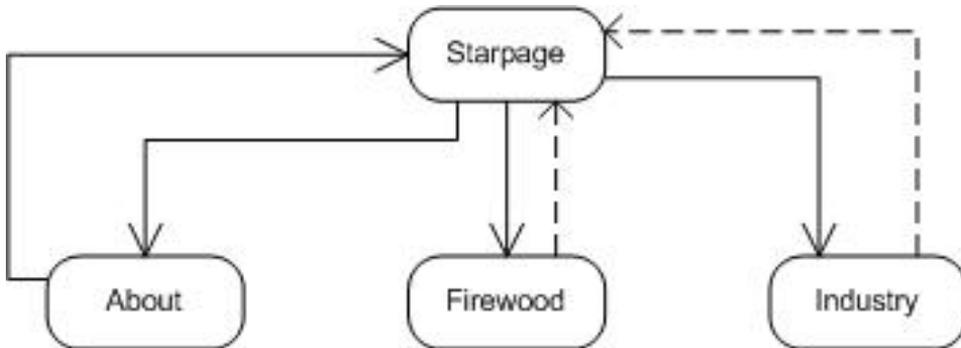


Figure 5.4: Interrelated components

Each component consists of two parts, frontend and backend. These parts are divided into two separate files, a HTML5 file and a JavaScript file. The frontend file is the HTML5 file, and includes all the text, input fields and buttons that the user can see. It makes the design that the users can see on their screen. The backend file is linked together with the frontend file, and this file contains everything that the user feels. All functions, calculations and lists are located here. The backend file is where everything happens. It registers the input provided by the user, and makes the calculations required to provide the correct results to the user. This structure is graphically displayed in figure 5.5 as a shell diagram.

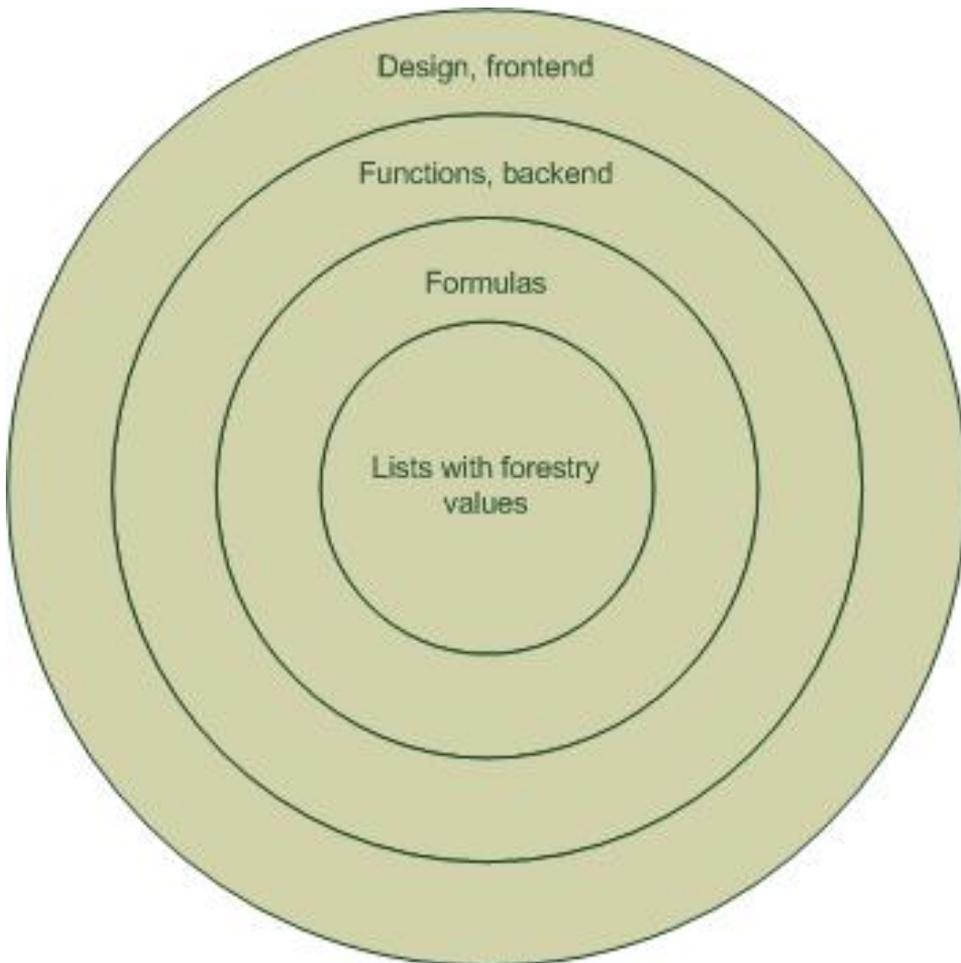


Figure 5.5: Shell diagram

The application opens at the startpage, where the user has several different opportunities for moving forward. Figure 5.6 shows what happens when the user presses the different buttons. The flow chart provides a graphical route of what happens as a person uses the *Forestry Product Calculator*, from start and until the calculations are done.

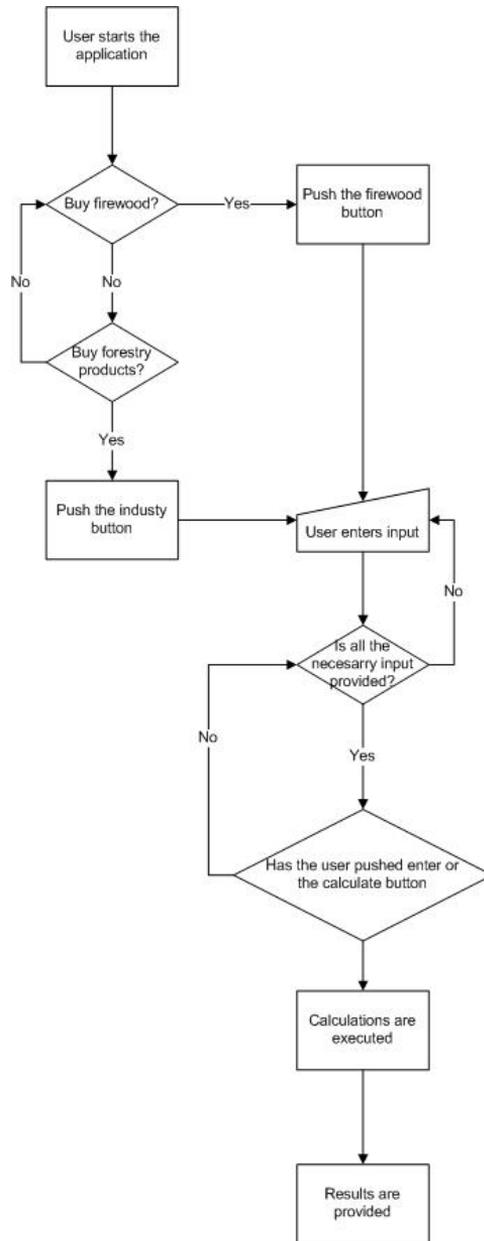


Figure 5.6: Flow chart

5.2.5 Related tools

This section presents tools that can be used to develop the *Forestry Product Calculator*, and how they make the implementation easier.

5.2.5.1 DevExtreme

DevExtreme is a cross-platform framework that can be used together with Visual Studio 2010, 2012 and 2013. Visual Studio is a comprehensive collection of tools and services that makes it easier for the programmer to make different applications (Microsoft, 2014). When using DevExtreme with Visual Studio it is possible to make native applications for different operating systems using HTML5, CSS3 and JavaScript. This means that applications can be made for iOS, Android, Windows Phone and Tizen without using multiple languages or frameworks (DevExpress, 2013).

DevExtreme offers built-in styling that detects what platform is used at runtime, and automatically applies the appropriate "native" theme on all widgets and navigation elements inside the application.

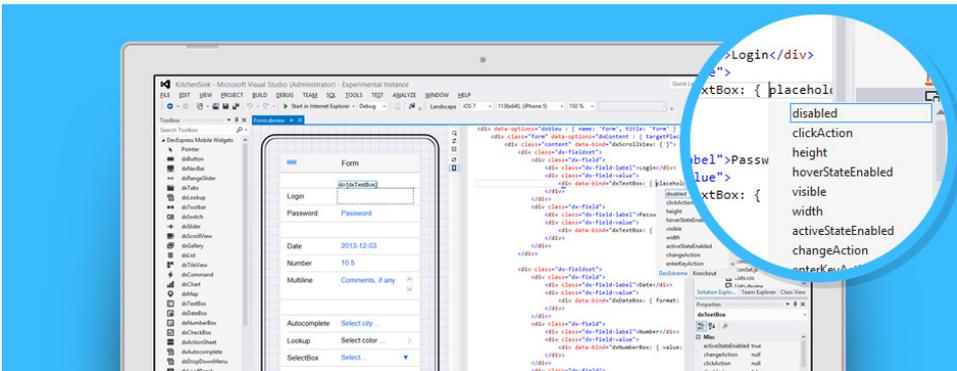


Figure 5.7: View Designer and code window

Many templates and wizards can be used in Visual Studio when an application is created with DevExtreme. This includes an integrated View Designer and a code window, see figure 5.7, that makes constructing views inside Visual Studio orderly as it provides the opportunity of drag-and-drop, and at the same time the possibility to make or render code.

Debugging is made easy with a built-in emulator inside Visual Studio. The emulator includes all the different devices or platforms DevExtreme offers when creating an application. This means that the application can be debugged on the different devices the application is supposed to work on, just by using the emulator on the computer.

There are two ways to build the application when using DevExtreme. You can either use the DevExtreme Courier App to execute the application using PhoneGap Build, or you can use the store-ready packages without SDKs or external services. DevExtreme offers packaging for App Store, Google Play, Windows Phone Store and Tizen store.

When making an application using DevExtreme, it is suggested to start with a DevExtreme project template, and add its built-in predefined layouts to simplify the generation of the application's UI. To make it your own you tweak it using design-time customization that includes drag-and-drop support, property grid and design and markup split views.

DevExtreme offers a comprehensive range of HTML5/JS Widgets perfectly styled for each target platform. These widgets are:

- **Data Visualization:** chart, gauge, range selector, sparkline, vector map, bullet
- **Navigation:** map, tab, navigation bar, panorama, pivot, slideout, toolbar
- **Actions and Lists:** button, action sheet, dropdown menu, gallery, list, lookup, autocomplete
- **Editors:** field set, check box, number box, text area, text box, date box
- **Forms and Multi-Purpose:** slider, range slider, switch, radio group, select box
- **Dialogs and Notification panels:** popover, popup, toast, load panel

DevExtreme also offers a wide range of supported platforms and browsers. These are:

- **Mobile platforms:** Android 4+, iOS 5+, Windows 8, Windows Phone 8, Tizen
- **Desktop browsers:** IE 10+, Safari 5+, Firefox, Chrome, Opera 12
- **Mobile OS Integrated Browsers:** Android 4+, iOS 5+, Windows Phone 8, Tizen

5.2.5.2 PhoneGap

PhoneGap is an open source web-based development framework based on Cordova (The Apache Software Foundation, 2011) for building native mobile applications using HTML, CSS and JavaScript. PhoneGap helps to make applications run on many different platforms, such as Android, BlackBerry, iOS, Windows Phone and Windows 8, by using standard-based web technologies to bridge web applications and mobile devices (Adobe Systems Inc., 2013).

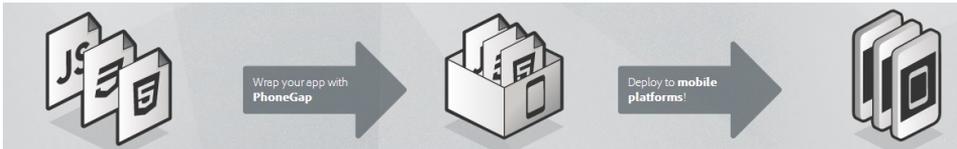


Figure 5.8: PhoneGap development life cycle

The development of such mobile applications is done by following the threefold life cycle of the PhoneGap development:

- First, the application is being built using regular web technology
- Second, PhoneGap is used to wrap the application
- Last, the application is deployed to the different mobile platforms

This life cycle is shown graphically in figure 5.8.

Before it is possible to develop an application for any platform, it is necessary to install the Cordova command-line interface. Then, to be able to develop any Cordova applications, it is important to install the Software Development Kits for all the different platforms you are targeting. Without these kits, the wrapping and deploying using PhoneGap will not work.

PhoneGap works as an abstraction layer on top of the native mobile phones operating system. The only part that needs to be implemented regarding the *Forestry Product Calculator* is what is inside the Web App box in figure 5.9. This means that the developer does not have to think about the differences between the operating systems as PhoneGap does that for them.

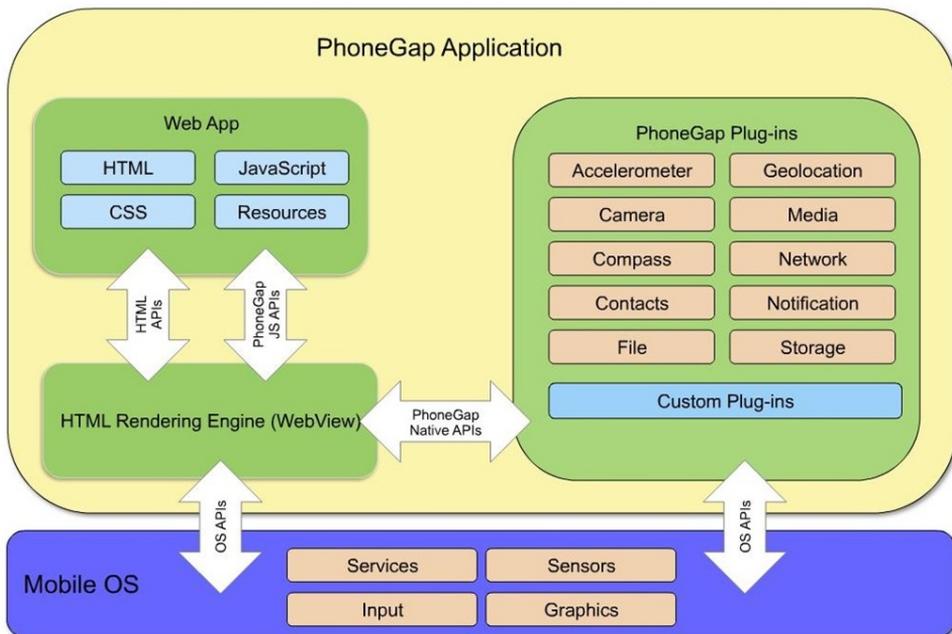


Figure 5.9: PhoneGap architecture(PhoneGap, 2013)

It is also worth noting that PhoneGap is a plug-in based application, which means that it is possible to extend it to fit your own use. The use of plug-ins makes it possible to access the file system and other underlying resources.

PhoneGap uses the Apache license, version 2.0 which states that PhoneGap is free of charge and for everybody to use. The entire license can be viewed in appendix A. Even though PhoneGap is a free of charge tool that everybody can use, it is possible to make a payment application as the pricing is not set in PhoneGap, but in the developer console in different application stores.

CHAPTER 6

EXPERIMENTS & EMPIRICAL STUDIES

This chapter describes the different experiments done during the *Forestry Product Calculator* life-cycle, how and why they were conducted, and what came from them. It also explains the empirical studies executed before and after the *Forestry Product Calculator* was released. Finally, it contains the information provided by the users who participated in the studies.

6.1 Experiments

Experiments will be performed during the development process, in order to validate the tool continuously. There are two types of experiments that will be conducted, prototype testing and black-box testing. The prototype testing is conducted on a few test subjects before any programming is started. This experiment is carried out for the purpose of identifying the users' understanding of the design, and how they think and use the tool.

The black-box testing is done by several test subjects, and normally over at least two cycles. The experiments are conducted in order to see if the tool meets all the requirements. It also experiments with the design and functionality interacting with the user. What did the user find self-explanatory, and what was confusing? The answer to these questions can be found in paragraph 6.1.2.2.5.

6.1.1 Prototype testing

In order to test the idea of the application, we started do develop a prototype on paper. This was done to figure out if the application could be used at all, and which parts that needed to be changed. Knowledge about what parts the users experienced problems with, revealed where they thought differently from us.

Prototype testing is testing executed on an actual user when there does not exist any application. Thinking about the application and its design, and making of some sketches was the start of the design. These sketches are to be used during the execution of the first test, the prototype test. This kind of testing reveals severe design flaws early in the process, since it is discovered before the programming has even started. Testing using a paper prototype means that the developer, test leader, works as the computer by laying down different paper sketches of the application while the user "presses" the buttons.

This testing makes it possible to change the design, if something is not as understandable for the user as the developer thought it would be. These tests are easy to conduct, and can be done several times, which means that individual parts of the design of the application easily can be changed and tested again. During a prototype test, as well as other test, the designs are being redefined based on the test results. Then, after some changes have been made, and tests have been conducted, the final design can be implemented. This saves the developer a lot of time and effort during the programming phase, and only small changes are to be done when the usability tests have been conducted using the application.

Prototype testing was conducted early in the design process on potential customers to see whether the design was intuitive or not. By execution of the tests, tables F.1 - F.6, it became clear which order the user found it logical to provide the different inputs, and which parts of the design were misunderstood. These results provided information that made us change the scrolling direction on the results, thus changing the grouping of the results as well. By finding these flaws early in the process, programming time was spared, since the changes were made before the design programming had started.

6.1.1.1 Test Results

A paper prototype testing of the firewood part was conducted at a couple of users. They provided useful and concrete feedback to the test personnel. They had some questions and input regarding headlines and text, as well as some design feedback. There were only a couple of misunderstandings: how to change between the different results? And that it needs to be an enter or continue button for the fields of moisture and price, as they are text boxes that the user write in. They need to let the application know when they are finished typing in numbers.

Headline and text feedback regarded the headlines on the result pages. The text of the headlines did not explain well enough what kind of results were displayed. On the other hand, the design feedback was that it would be nice to have a firewood pile as a background picture, and then use black text color.

6.1.2 Black-box testing

Black-box testing is a functional or non-functional behavioral software testing method (Software Testing fundamentals, 2012). This method is named black-box testing because the tester does not know anything about the internal structure, design or implementation of the item that is being tested, illustrated in figure 6.1.

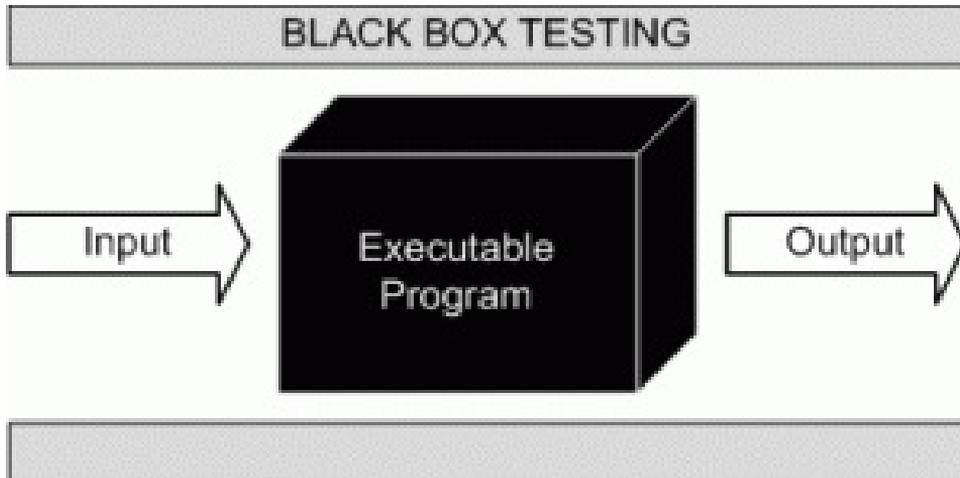


Figure 6.1: Black-box testing

Black-box testing is used to detect and correct incorrect or missing functions, interface errors, data structure errors, behavior or performance errors and initialization and termination errors early in the process. It is possible to conduct many tests without the entire application ready, which means that when the application is ready, most of the times the final tests will not fail.

The use of two forms of functional testing, functional testing and usability testing, is done because functionality and usability are equally important in the *Forestry Product Calculator*. It is crucial that all functionality work as intended, or else the application is useless. The usability of the application is best tested by testing intended users and running usability tests. Usability tests establish whether the design is intuitive for the user, or if there are some parts that do not communicate the way they were intended to.

6.1.2.1 Functional testing

Functional testing tests how the system works and what it does. Test cases are made based on the specifications of the software components, and how the system is supposed to work (Wikipedia, 2014).

In functional tests the input is fed into the program, and output is examined. The main focus is to discover whether the application works as it is supposed to, or if there are some faults with the functionality.

Functional testing is based on five steps:

- Identification of the functions that the software is expected to perform
- Creation of input based on the functions specifications
- Determination of output based on the functions specifications
- Execution of the test cases
- Comparison between the expected and actual results

6.1.2.1.1 Template for functional testing

The template for functional testing can be found in table 6.1.

Item	Description
Test case ID	id
Name	Short name for the test
Requirement	Requirement reference
Description	Description of test
Preconditions	The conditions of the application before the tests are started
Flow of events	The list of steps necessary to complete the test
Expected results	The expected end results
Actual results	The end result
Comments	What went wrong, what could be the cause
Status	OK (no errors), OK- (minor issues) and Failed (not working)

Table 6.1: Test case template

6.1.2.1.2 The tests

Functional tests use test cases meant to verify that the application works correctly, shown in test E.1 to E.6. The test cases can be found in Appendix E. The specific test should be carried out whenever a feature is finished, and all the tests should be carried out at the end of the project.

6.1.2.2 Usability testing

Usability testing is testing the application on possible end-users, and observe as they solve different tasks. The test leader measures time spent on each task, problems during the execution of the task, comments from the user as well as the test leaders thoughts. After the test have been executed the test subject fills out a SUS form.

6.1.2.2.1 System Usability Scale

SUS is an abbreviation for System Usability Scale (Wikipedia, 2013) and is a simple Likert scale of ten questions where the test persons shall give a score from 1 to 5 where 1 is strongly disagree and 5 is strongly agree. The purpose is to obtain a global view of subjective evaluation of the usability of the software.

The SUS score is calculated the following way:

1. Take the odd numbered questions and subtract 1 from these scores.
2. Take the even numbered questions and subtract the score from 5.
3. Add these scores together.
4. Take this sum and multiply by 2,5.
5. Then you have a SUS score between 0 and 100.

6.1.2.2.2 Usability goals

To have something to assess the usability up against, some usability goals were set before conducting the usability tests.

- The user should never spend more than three (3) minutes on a task
- The application should never crash
- The user should never make more than one (1) error during the tasks
- The user should solve task six (6) faster than task two (2) because of memorability
- The average SUS score should be above 70 since studies have shown that 68 is average (Sauro, 2011)

6.1.2.2.3 Templates

The SUS form can be found in appendix F.2.4, and the observation form can be found in appendix F.2.5.

6.1.2.2.4 The test

When a user is going to conduct a test, he or she first get some information about the application and the test. Then the subject is provided with a device where the latest version of the application is installed and a paper with six tasks, F.1 - F.6 in appendix F, that are to be performed.

20 persons participated in the testing, both male and female. The test persons range from 24 to 57 years old, though most of the subjects are in their 40s or 50s. This is beneficial because the expected users are in the age range from 35 to 55. They hold different educations, some only completed secondary school while others have completed a university degree. The *Forestry Product Calculator* has a wide user profile, and it is therefore important to get as many different users as possible to participate in the testing process to cover the entire user profile.

6.1.2.2.5 Results

The first three usability tests were executed May 15th, and all the test participants experienced trouble after the last input was provided. They had problems understanding how to execute the calculations, as can be seen in observation forms F.8 - F.10 in appendix F. Up until this point the user only had to click somewhere outside of the last provided input field to make the *Forestry Product Calculator* calculate the results.

This problem, regarding calculation execution, was solved by including a button after the input choices containing the text "Calculate". After this, none of the subsequent testers experienced that problem, as seen in observation forms F.10 - F.27 in appendix F. The button does not have to do anything, because clicking the button means that the user clicks somewhere outside of the last provided input field.

There were no problems in the last 17 tests regarding making the calculations, even though those who used the enter-button on the phone wondered why the calculate-button was included. This question arose since the enter-button makes the calculations as well. On the other hand, there were some testers that experienced some problems when providing the moisture input as they wondered whether or not to include the % -sign with the number. Overall, the testers were happy with the *Forestry Product Calculator*, and most of them would like to use it frequently.

6.1.3 Use cases

This section discusses the different actors that will use the application. Then it continues with showing a full use case diagram derived from the functional requirements. Finally, it lists the textual use cases to detail the use case diagram.

6.1.3.1 Actors

An actor specifies a role to be played by internal or external persons interacting with the application. In this case, there is only one actor, the end-user. The end-user is in this case different persons, but they do not necessarily have much experience with usage of applications on handheld devices. The industry part is to be used by forestry experts in a regular workday, while the firewood part is to be used by the everyday man.

6.1.3.2 Use case diagrams

For a combined figure of all the use cases, see figure 6.2.

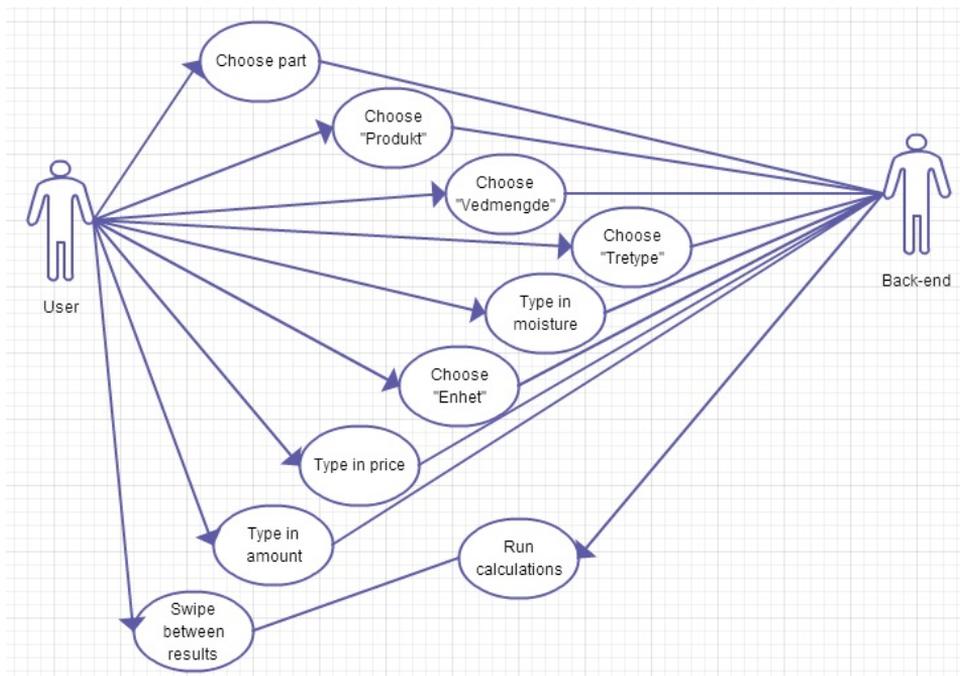
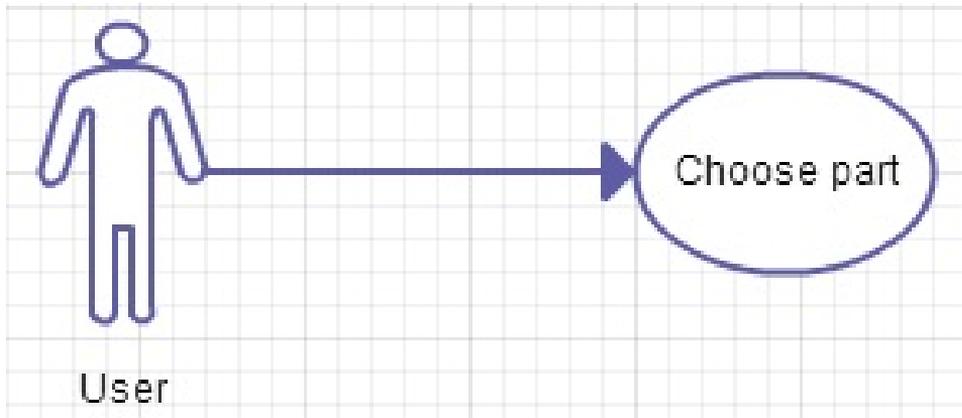


Figure 6.2: Use case diagram

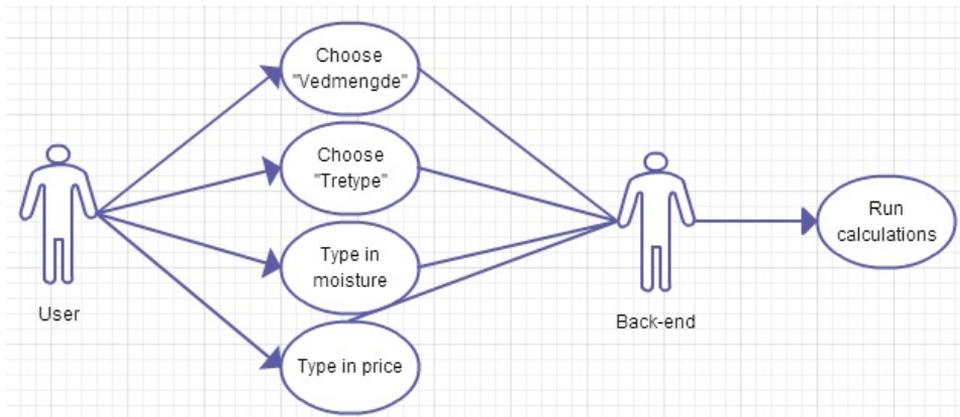
6.1.3.3 Textual use cases

Each of the use cases is described below, making the use case diagram easier to understand. See tables 6.2 - 6.4, starting below for a more detailed explanation of the use cases.



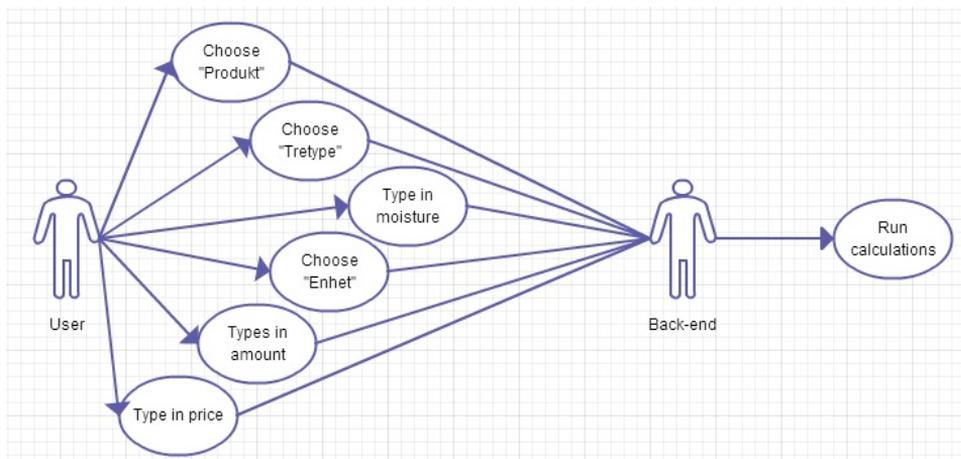
Element	Description
Use case name	Choose part
Requirement	
Goal	User chooses either "Vedkjøp" or "Industri"
Summary	The user sees a start screen and must choose between the firewood purchase part and the industry part
Preconditions	<ol style="list-style-type: none"> 1. The application is running
Flow of events	<ol style="list-style-type: none"> 1. User starts the application 2. User pushes either "Vedkjøp" or "Industri" button 3. User is redirected to the specified part
Exceptions	

Table 6.2: Textual use case - Choose part



Element	Description
Use case name	Make calculations, firewood part
Requirement	
Goal	Run calculations in the firewood part
Summary	The user fills all the input fields with correct data, and the application will run the calculations, and provide results to the user
Preconditions	<ol style="list-style-type: none"> 1. The application is running 2. The user has chosen the firewood part
Flow of events	<ol style="list-style-type: none"> 1. The user chooses "Vedmenge" from the drop-down menu 2. The user chooses either "Tretype" from the drop-down menu, or types weight 3. The user types in moisture in percent 4. The user types in price 5. The application runs the calculations and provides the user with the required results
Exceptions	The user does not fill in all the required input

Table 6.3: Textual use case - Calculate results, firewood part



Element	Description
Use case name	Make calculations, industry part
Requirement	
Goal	Run calculations in the industry part
Summary	The user fills all the input fields with correct data, the application will run the calculations, and provide results to the user
Preconditions	<ol style="list-style-type: none"> 1. The application is running 2. The user has chosen the industry part
Flow of events	<ol style="list-style-type: none"> 1. The user chooses "Produkt" from the drop-down menu 2. The user chooses "Tretype" from the drop-down menu 3. The user types in moisture in percent 4. The user types in number of units 5. The user types in amount 6. The user chooses "Enhet" from the drop-down menu 7. The user types in price 8. The application runs the calculations and provides the user with the required results
Exceptions	The user does not fill in all the required input

Table 6.4: Textual use case - Calculate results, industry part

6.2 Empirical studies

This section informs about the empirical studies executed before and after the making of the *Forestry Product Calculator*. What information this study provided, and how the information was useful for the implementation process.

6.2.1 Advanced studies

After understanding the problems regarding trading of forestry products, and the awareness of the energy content in firewood, two surveys were conducted to get a better understanding of the problems. One of the surveys dealt with the problems regarding industries, while the other regarded firewood buyers. The surveys provided a lot of information about the problems, why they exist and what the users need in such a tool.

6.2.1.1 Firewood purchase survey

The survey consisted of 9 questions, where the first four were to learn a bit about who answered the survey, and whether or not they were the ones doing the firewood purchase in their family. The next two questions involved difficulties regarding firewood purchase. Then, the last three questions covered the application we were planning to make, and whether they would use such an application and what they would expect from it.

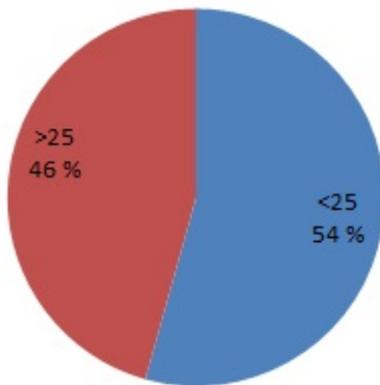
The survey questions were:

1. What is your age?
2. What is your sex?
3. Where in Norway do you live?
4. Are you responsible for the firewood purchase in your household?
5. Do you find it hard knowing how much energy (kWh) you actually get when purchasing firewood?
6. Do you think it is complicated to know which sack of firewood it is profitable to buy?
7. If there were to exist an application that could compare prices of the different sacks, as well as calculate how much energy you buy, would you use it?
8. What would be most important for you with such an application?
9. What would it take for you to use such an application?

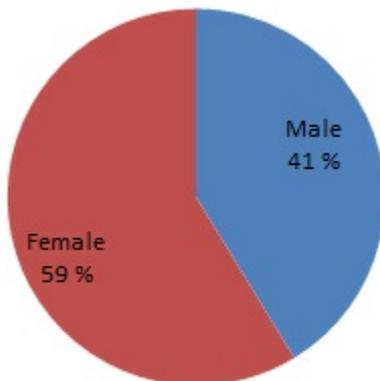
6.2.1.1.1 Firewood purchase survey results

The survey results were:

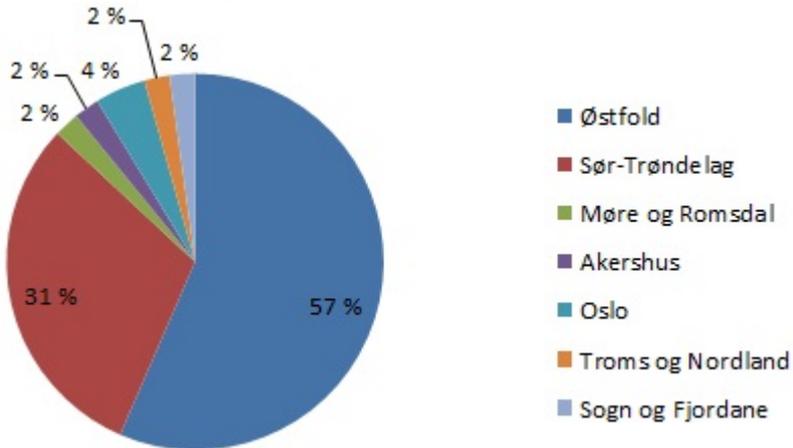
1. What is your age?



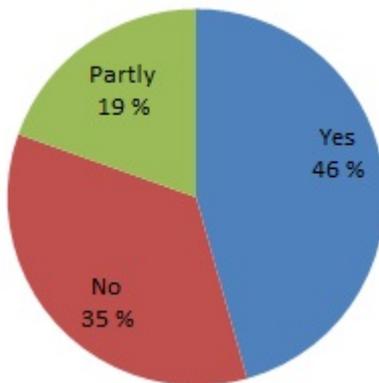
2. What is your sex?



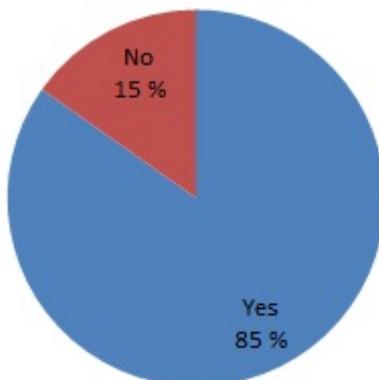
3. Where in Norway do you live?



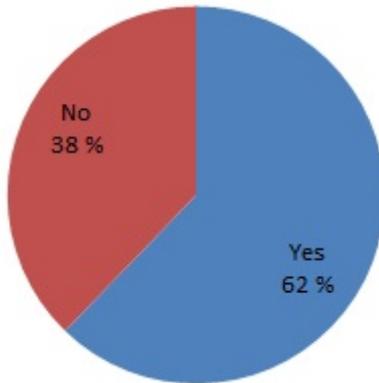
4. Are you responsible for the firewood purchase in your household?



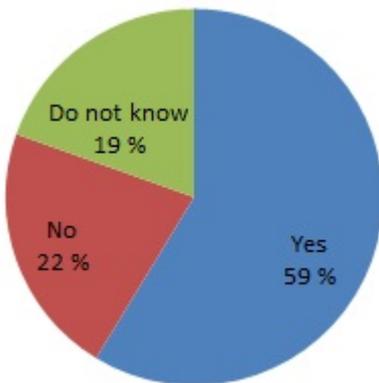
5. Do you find it hard knowing how much energi (kWh) you actually get when purchasing firewood?



6. Do you think it is complicated to know which sack of firewood it is profitable to buy?



7. If there were to exist an application that could compare prices of the different sacks, as well as calculate how much energy you buy, would you use it?



8. What would be most important for you with such an application?

- (a) Easy to use
- (b) Straightforward usability
- (c) Low price

9. What would it take for you to use such an application?

- (a) Easy to use
- (b) Correct calculations
- (c) A reminder that such an application exists

The firewood survey established the fact that very few firewood buyers know how to calculate the energy content in the firewood they are buying, hence they do not know the kWh rate of which they are paying. Not knowing such crucial facts, make the users unaware of whether or not heating with firewood is cheaper than other heating methods or which sack of firewood provides the best kWh rate. This leads to most of the participants also having problems when deciding which sack of firewood it is profitable to buy. For this reason, it seems that many are eager to use an application, like the one we are making, to make these choices easier.

If people are to use such an application, it is needed to focus on a usability that makes it easy for the everyday man to use it. They would also need a reminder that such an application exists, and that you could get it for free. The application must also make the right calculations, and convince the user that it is working correctly.

6.2.1.2 Industrial survey

The industrial survey was constructed for trained personnel employed in the forestry industry, with trading of such products as a profession. The survey consisted of six questions in total, where the two first regarded the background of the participants. The third question was about experiences regarding problems with trading forestry products. The rest of the questions concentrated on the use of such an application, and what was important regarding the use of the application.

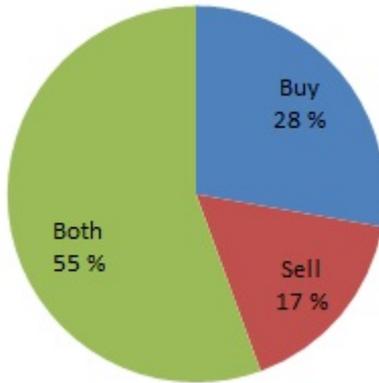
The survey questions were:

1. Do you work with selling or buying of forestry products?
2. For how long have you been employed in the industry of selling/buying forestry products?
3. Have you experienced problems when trading forestry products?
4. If an application that could calculate forestry product prices between the different annotations were to exist, to what degree would that remove the challenges around trading?
5. If such an application were to exist for your smart phone, would you use it?
6. What would be most important for you with such an application?

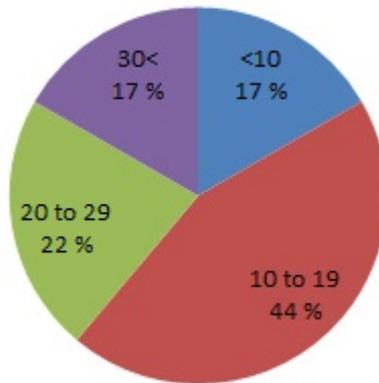
6.2.1.2.1 Industrial survey results

The survey results were:

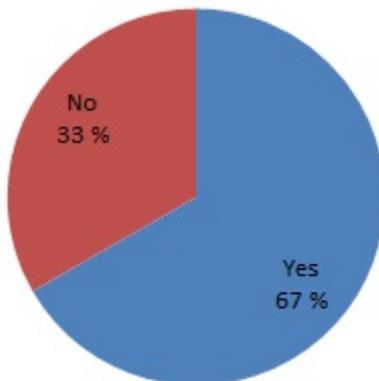
1. Do you work with selling or buying of forestry products?



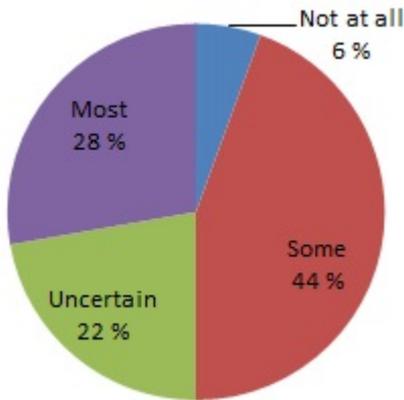
2. For how long have you been employed in the industry of selling/buying forestry products?



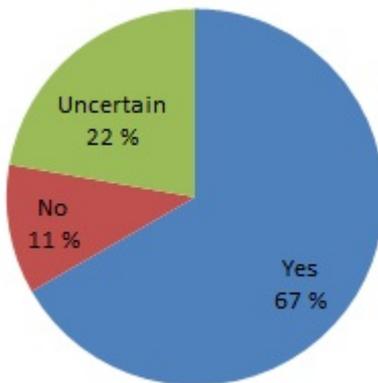
3. Have you experienced problems when trading forestry products?



4. If an application that could calculate forestry product prices between the different annotations were to exist, to what degree would that remove the challenges around trading?



5. If such an application were to exist for your smart phone, would you use it?



6. What would be most important for you with such an application?

- That it works correctly
- That it contains all the necessary input choices
- That it is trustworthy
- That it provides correct and accurate results
- That it is easy to use
- That it is accessible
- That it is widely used in the industry; become a standard

The industry survey provided information regarding problems in trading of forestry products. Usually, there are forestry industries on one side, and energy industries on the other side in a trading process. Even though the persons participating in such a trade are experts within their field, they do not use the same annotations. In one way it is correct to state that they speak different languages. For instance, the energy specialists deal with kWh and tons, while the forestry specialists use dry tons and solid cubic meters. The problems appear when none of the parts know how to calculate the different annotations.

Based on the results from the survey it can be concluded that most of the industry workers has experienced problems at some level regarding trading of forestry products. The majority of the participants believe that such an application can remove at least some of the problems that arise when trading. The most optimistic answer though, is that almost all of the participants would be willing to use the application.

The last question in the survey was the same as in the firewood purchase survey, and the results were very similar. All the participants from both surveys agree that the application should be easy to use and to get a hold of. They are all very concerned about the correctness of the calculations, and whether the application can be trusted.

6.2.1.3 Outcome of the studies

This knowledge about the users' troubles and wishes indicated the way forward. The firewood buyers need a tool that calculates the energy content in a specific amount of firewood, as well as the kWh rate. Such a tool should also contain a list providing the user with corresponding prices of firewood in regard to the amount bought. Such a tool would make it easier for the firewood buyers to know which amount of firewood to buy, in order to save money, and which heating methods are the most economic.

The understanding of the problem, as not speaking the same language, in the industry pointed in the direction of a conversion tool. Both parts of a trading needs a calculator that can calculate amount and price between the different annotations that are in use today. By making such an application, the trading process will be quicker, and hopefully several energy industries will understand the environmental and economic possibilities in using forestry products. This calculator also needs to contain a calculation of energy amount as well as kWh rates.

6.2.2 Arrears studies

At a forestry exhibition, the *Forestry Product Calculator* was shown to several forestry experts, and all of them were positive to this new tool. They were impressed about all the input choices and results provided. They felt like all conceivable areas of use were considered and included. Several experts stated that they believed that this tool could make a huge difference in the forestry trading process, and revolutionize the entire process by decreasing today's annotation problems.

6.3 Evaluation & Results

The DevExtreme plug-in for Visual Studio worked well, and made the application quite easy to implement. Everything about the development of the application worked well until it was time to publish. Both Android and Windows publication were straightforward, but iOS, on the other hand, was quite the opposite. After paying the developer license at Apple it became clear that the developer had to be in possession of a MAC in order to be able to generate the certificates needed to publish the application on AppStore.

After several usability tests were conducted, and the design was changed a couple times, the average user needed three minutes and four seconds to make calculations in both the firewood and industry parts. The time spent on making both firewood and industry calculations is way below the four minutes used on one part that was decided upon in the requirements. Some users experienced some troubles understanding how to provide input the first time input was requested, but the learning curve was steep, and each user used shorter time each time new input was provided. Most of the testers said that they were interested in using the *Forestry Product Calculator* regularly.

Both the *Forestry Product Calculator* and the executed tests includes some general limitations. It is required that the users possess a smartphone or a tablet in order to use the application. This limitation includes both individuals buying firewood, and forestry expert workers using it in the industry.

In addition, the equations that all the calculations are based on are made by Knute Foss. His knowledge and experience in the field form the basis for these formulas, as there do not exist any fixed rules for such calculations.

Regarding the conducted tests, we only had a limited number of test participants, but we tried our best to test on a wide audience.

The forestry product experts that were spoken with at the forestry seminar were all excited about the application and eager to start using it in their daily routines. They were all positive to the tool, and believed that it would help reducing the challenges of trading forestry products between the forestry industry and the energy industry. Even though there have been conversations with forestry product experts, there should have been done more testing with them as well. They are the primary audience, and the ones that are expected to use the tool the most.

After the tests were conducted the test persons filled in the SUS-schema, and the majority of the testers provided a SUS-score around 85 which is much higher than the required 70. On average the SUS-score was 79, which provides the knowledge of satisfied testers. This score says that the testers overall were pleased with the application, and that they would like to use it when buying firewood and other forestry products.

This chapter includes the application's status, the achievements made during this master thesis, and what work is believed to be done in the future.

7.1 Summary

During these 20 weeks the *Forestry Product Calculator* has evolved from paper to cellphones. The application is fully implemented, and it can be found at both Google Play, for Android, and Windows Store, for Windows phones. The application is unfortunately not available on App Store, for iPhones, yet. The native package for iOS is finished, but due to some certificate issues, it has not been published.

The application has been tested over several processes, and the last seventeen tests all provided good feedback from potential customers. They all believed that they would use the tool to calculate energy content in firewood, and they provided an average SUS-score of 79 which is much higher than the 70 that it was hoped for.

The forestry industry have also been contacted, and they were all very excited about the tool and how they believed it could make their workdays easier. They are eager to start use the calculator, which is a much better response than expected just a few days after publication.

7.2 Achievements

At the beginning of this thesis there were some things that were hoped to be achieved, as well as some application requirements that needed to be fulfilled. The requirements and how they were met are explained in section 5.1.2, and table 7.1.

Requirement	Fulfilling ways
Easy to understand	None of the test persons experienced serious problems, and they all completed the provided usability tests
Easy to use	All test persons explained the tool as easy and intuitive
For anyone	The tool was tested on many different persons, all which had different experience with both smart phones and forestry products, and they all provided very high SUS-scores
Correct calculations	The calculations have been tested against a huge excel-calculator, as well as tested by a forestry expert
Ease cooperation	All the forestry experts that have seen the tool are very excited and eager to start using it, which should mean that it has great potential in making trading forestry products easier

Table 7.1: Fulfillment of requirements

Besides the requirements, there were also a hope that the application would be published for Android phones when this master thesis was done. Not only is the application available for Android phones, but also for Android tablets and Windows phone. This achievement were only possible because of the DevExtreme plug-in, and hard and consistent work-flow.

In addition to all the other achievements, the most important goal, was to minimize the problems when trading forestry products between the forestry industry and the energy industry. Due to all the positivism and accolades received from the forestry experts we believe that these problems have been captured spot on. They are all eager to start using the tool, and they do all believe that this tool will make their ordinary workday a lot easier. Since these people are experts in trading forestry products we choose to trust them when they say that this tool will minimize the trading problems considerably.

We feel that these problems were handled from the center and out, and are pleased to see that the challenges regarding forestry product trading, and ignorance among the everyday man are to be reduced by the usage of this tool. Almost all the test subjects said that they would use this tool to make sure they knew how much energy they were buying, and for how much money, so that they easily can compare firewood with other heating methods. Hopefully, this will minimize the ignorance amongst people, and help them become more conscious of the environment.

7.3 Further work

Due to the limited time frame of this thesis, we have not been able to address all aspects. Some suggestions for future work are outlined in this section.

We recommend that the wood specie lists and the product list get alphabetized, making it easier to locate the right specie or product. During the testing, only one test subject used the search option, while the rest scrolled and looked for the specie "Furu" manually. Some of the test persons used quite some time locating the wood-specie.

We would also recommend to put a constraint on the different input-fields, for instance that the %-sign can not be entered into the moisture-input field. By including such a constraint the problems that arise when a user includes the %-sign are removed.

Finally, we would highly recommend that the application is included in the App Store for iPhones as well. To include the application in the App Store a MAC is needed to make certificates and provisioning profile.

Appendices

APPENDIX A

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APPENDIX B

REQUIREMENTS

This appendix describes the requirements stated for this thesis. Section B.1 outlines the functional requirements and section B.2 the non-functional requirements.

B.1 Functional requirements

The functional requirements for this thesis is listed in table B.1.

Req. ID	Description	Priority
FR1	Start the application: The user should be able to start the application.	High
FR2	Start the firewood part: The user should be able to open the firewood part by pressing the "Vedkjøp"-button.	High
FR3	Start the industry part: The user should be able to open the industry part by pressing the "Industri"-button.	High
FR4	Insert inputs: The user should be able to choose, or write the needed input.	High
FR5	Make calculations: The user should be able to press the "Kalkuler"-button, and display the correct results.	High
FR6	Scroll results: The user should be able to scroll to see all the different results.	High

Table B.1: Functional requirements

B.2 Non-functional requirements

This section explains the requirements for the application that do not add specific functionality to the product.

B.2.1 Quality requirements

The quality attribute requirements are listed and explained in the following sections.

B.2.1.1 Usability

Usability explains how the application is made in order to be effective to learn and use.

B.2.1.1.1 *U1 Ease of use*

The user should be able to use the application with few mistakes, such as pressing the wrong button because button labels are ambiguous or too small. The scenario is described in table B.2.

Portion of scenario	Values
Source	End user
Stimulus	Use system without problems
Artifact	System
Environment	At run time
Response	Provide clean and intuitive interfaces
Response measure	Maximum 3% of user operations should be mistakes

Table B.2: U1 Ease of use

B.2.1.1.2 *U2 Efficient use*

The user should be able to use the main features of the application by making few iterations. The scenario is described in table B.3.

Portion of scenario	Values
Source	End user
Stimulus	Use system efficiently
Artifact	System
Environment	At run time
Response	Organize the application so that it is easy to understand and use
Response measure	A user that have used the application before should not need to use more time than one minute executing the calculations. A new user should not use more than 4 minutes executing the calculations.

Table B.3: U2 Efficient use

B.2.2 Performance

Performance explains how fast and precise the application works.

B.2.2.1 P1 Latency

The user should be able to read the calculation results quickly after the "Kalkuler"-button is pressed. The scenario is described in table B.4.

Portion of scenario	Values
Source	End user
Stimulus	Wants to know the results
Artifact	System
Environment	After providing correct input, and the "Kalkuler"-button have been pushed
Response	The calculations are performed
Response measure	With a latency of maximum 3 seconds, the user should be able to look at the results

Table B.4: P1 Latency

B.2.2.2 P2 Correctness

The application should be able to provide the user with correct calculations. The scenario is described in table B.5.

Portion of scenario	Values
Source	System
Stimulus	Wants to have satisfied users
Artifact	System
Environment	After the user have provided correct input, and the "Kalkuler"-button have been pushed
Response	The calculations are performed correctly
Response measure	All the answers are correct each time

Table B.5: P2 Correctness

The *Forestry Product Calculator* is an application that is supposed to work on different operating systems, and at devices with different screen sizes. The different operating systems' guidelines therefore works as basis for the application's design.

C.1 Microsoft guidelines

Microsoft's guidelines for Windows phones are divided into 5 categories (Windows Phone, 2014):

1. **Pride in craftsmanship** means that the programmer should put a lot of time and energy into the small things that many users will see often. Which means that attention to detail is the most important. If the small details are perfect, then the application will be extraordinary.
2. **More with less** means that only the most relevant elements should appear on screen. The saying "Content over chrome", means that the content, and not the chrome are the most important part of the application. This allows the content to shine, and it becomes easier for the user to find the information needed.
3. **Fast and fluid** means that the user should be able to interact directly so that the application responds quickly to the user actions.
4. **Authentically digital** means to go beyond the rules and properties of the physical world to create new and exciting possibilities purely in digital space. Information is the primary goal and not the wrapping around it.
5. **Win as one** means to use common design models that are know for the users to complete end-to-end user scenarios. The programmer should not reinvent the wheel, but use models that are know to the user, so that using the application is familiar and easy to use.

C.1.1 Android guidelines

Guidelines for Android phones are divided into 3 categories (Android developer, 2014):

1. **Enchant Me** means using subtle effects making the user feel like using the application is effortless. Let the users add their personal touch to the application by directly touch and manipulate objects. Learn peoples preferences so that they do not need to take the same choices all over again.
2. **Simplify My Life** means using short phrases and pictures instead of long sentences. Divide information and choices into small chunks, so that it does not get overwhelming for the user. Discern functional differences by making them look the same, to provide the user with more confidence when use the application.
3. **Make Me Amazing** means using familiar patterns that the users know from other applications. Complex thoughts should be broken down into smaller steps so that the tasks are easily accomplished. Decide what actions are most important, and make sure that they are fast to use.

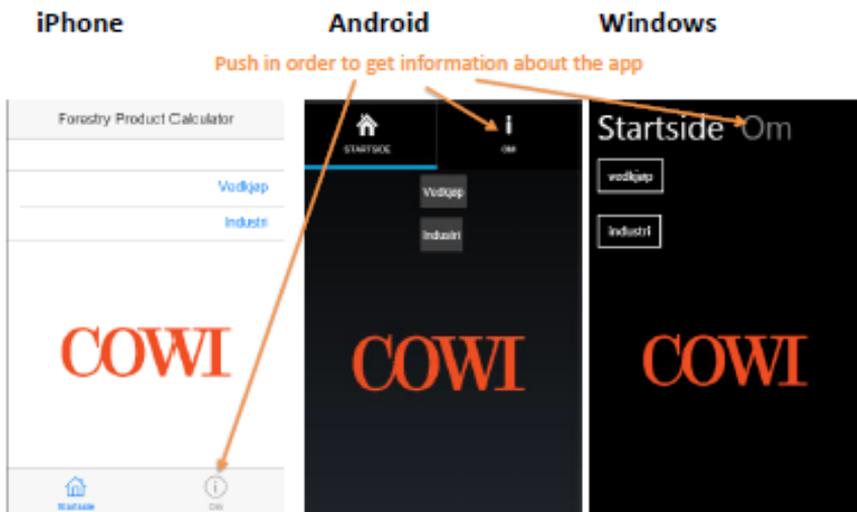
C.2 iOS guidelines

iOS guidelines are divided into 3 categories CITE:

1. **Defer to Content** means using the entire screen, do not use insets and frames anymore, which gives the application more space for the information to be shown. The UI should only play a supporting role, the information is what should be in focus. In this way the information are a lot easier for the users to find.
2. **Provide Clarity** means using a lot of negative space to make information pop. The negative space also make the application appear more efficient and focused. Color should be used to highlight and separate the most important states in a clean and orderly way. To make the application feel more homely for the user, the user should always be able to choose text size.
3. **Use Depth to Communicate** means that a translucent background should be used to separate folders containing different information from each other, and from the rest of the screen.

APPENDIX D _____

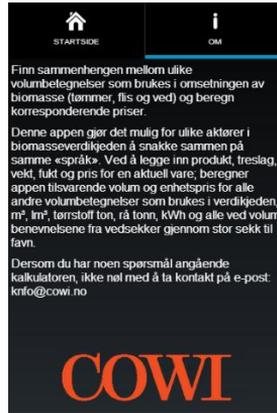
USER MANUAL



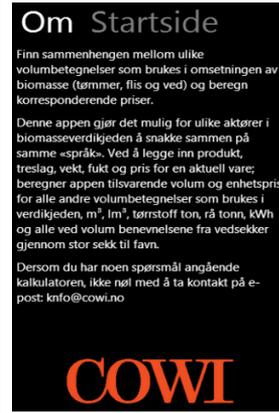
iPhone



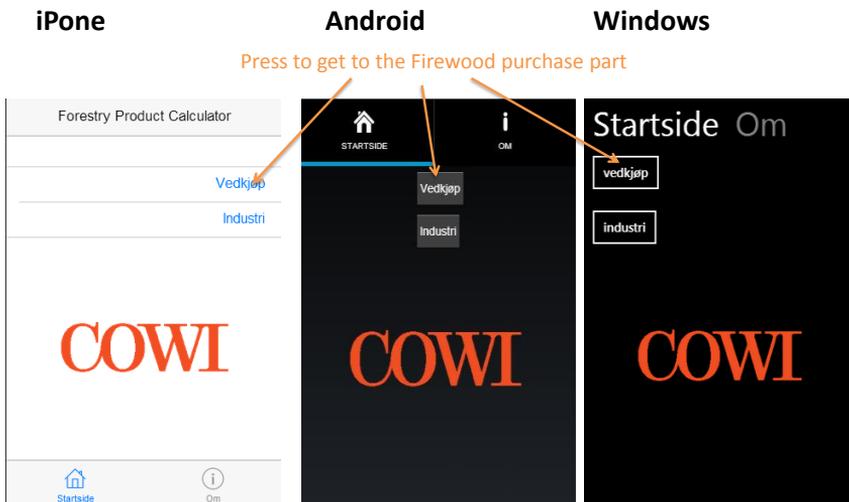
Android



Windows



Firewood purchase



iPhone

Android

Windows

Touch to get a drop-down-list with amount choices

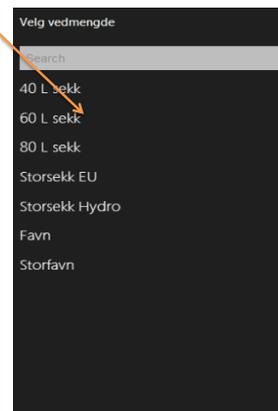
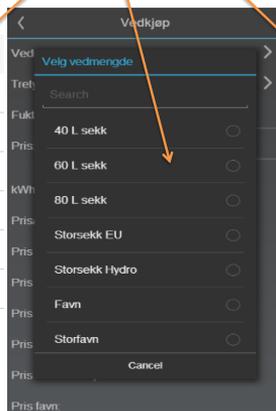
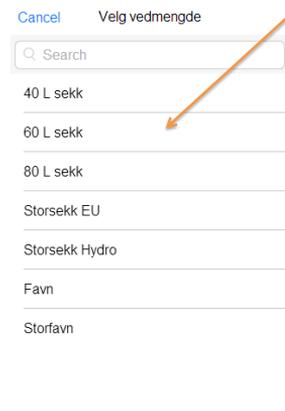


iPhone

Android

Windows

Touch one alternative to choose that amount

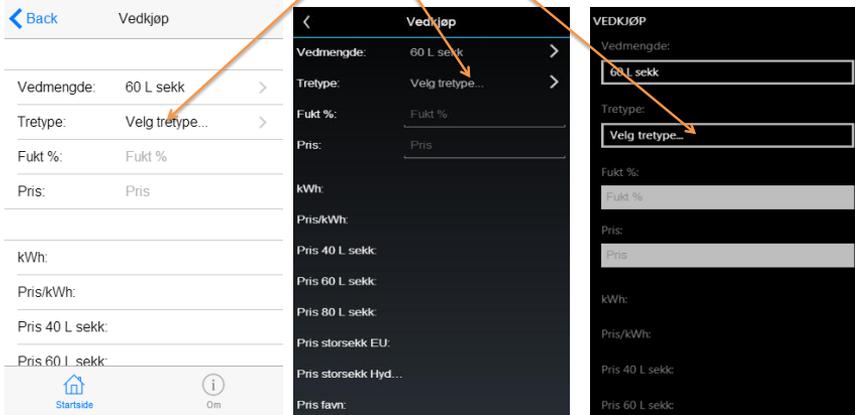


iPhone

Android

Windows

Touch to get a drop-down-list with wood species choices

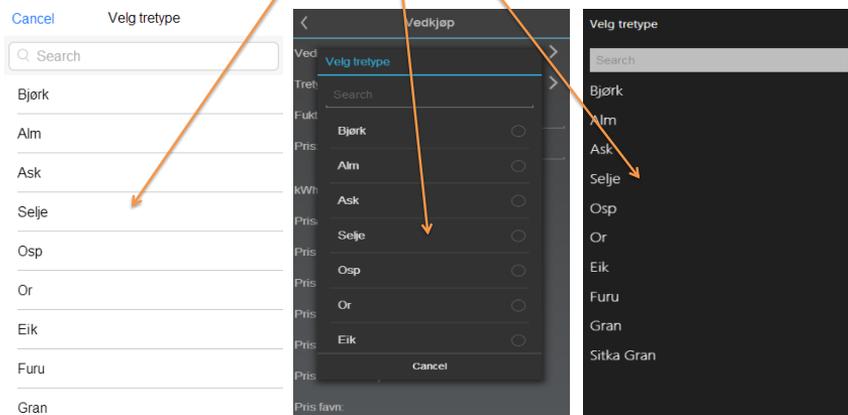


iPhone

Android

Windows

Touch one alternative to choose that specie

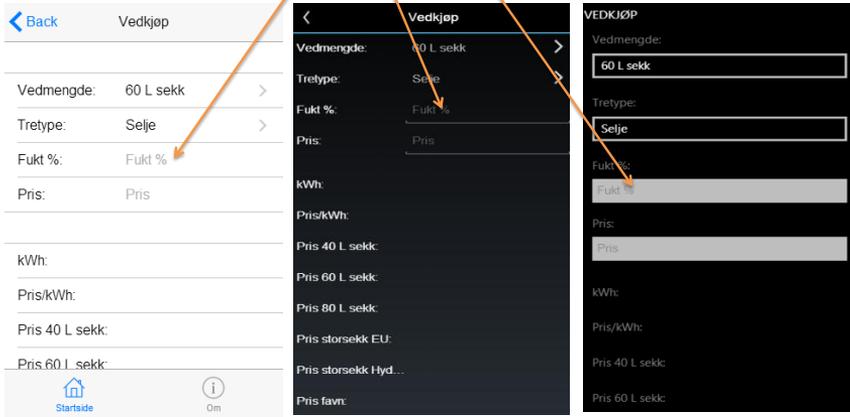


iPhone

Android

Windows

Touch to fill in moisture

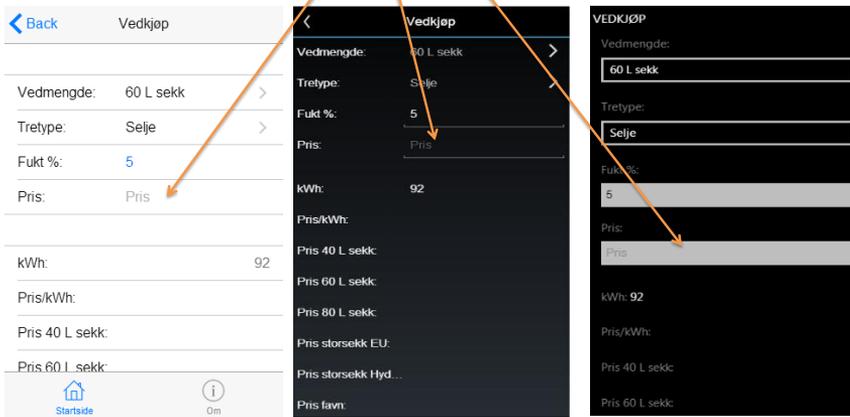


iPhone

Android

Windows

Touch to fill in price



iPhone

Android

Windows

Vedkjøp	
Vedmengde:	60 L sekk >
Tretype:	Selje >
Fukt %:	5
Pris:	80
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00
Pris 80 L sekk:	106.67
Pris storsekk EU:	1333.33
Pris storsekk Hyd...:	2000.00
Pris favn:	4000.00
Pris storfavn:	15881.48

Vedkjøp	
Vedmengde:	60 L sekk >
Tretype:	Selje >
Fukt %:	5
Pris:	80
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00
Pris 80 L sekk:	106.67
Pris storsekk EU:	1333.33
Pris storsekk Hyd...:	2000.00
Pris favn:	4000.00

VEDKJØP	
Vedmengde:	60 L sekk
Tretype:	Selje
Fukt %:	5
Pris:	80
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00

Scroll in the arrows direction to see all the results

iPhone

Android

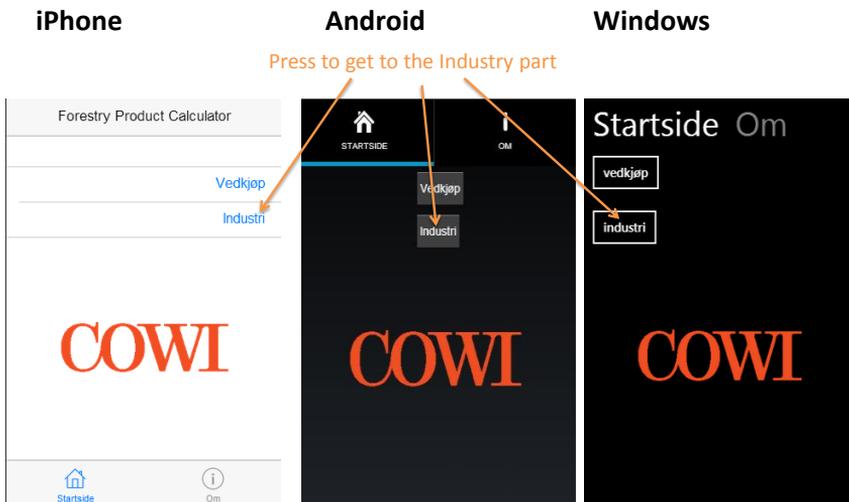
Windows

Vedkjøp	
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00
Pris 80 L sekk:	106.67
Pris storsekk ...:	1333.33
Pris storsekk ...:	2000.00
Pris favn:	4000.00
Pris storfavn:	15881.48

Vedkjøp	
Tretype:	Selje
Fukt %:	5
Pris:	80
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00
Pris 80 L sekk:	106.67
Pris storsekk EU:	1333.33
Pris storsekk Hyd...:	2000.00
Pris favn:	4000.00
Pris storfavn:	15881.48

VEDKJØP	
Pris:	80
kWh:	92
Pris/kWh:	0.87
Pris 40 L sekk:	53.33
Pris 60 L sekk:	80.00
Pris 80 L sekk:	106.67
Pris storsekk EU:	1333.33
Pris storsekk Hydro:	2000.00
Pris favn:	4000.00
Pris storfavn:	15881.48

Industry

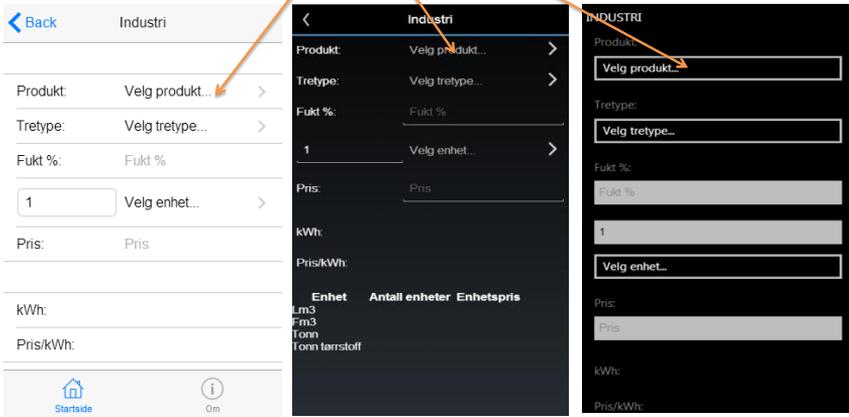


iPhone

Android

Windows

Touch to get a drop-down-list with product choices

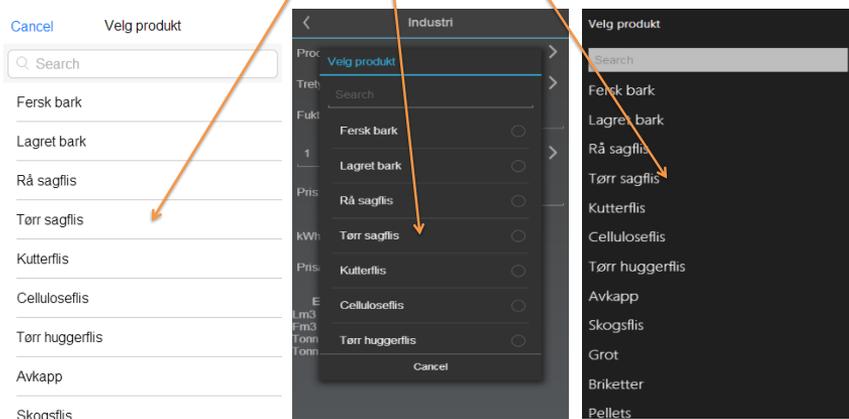


iPhone

Android

Windows

Touch one alternative to choose that product

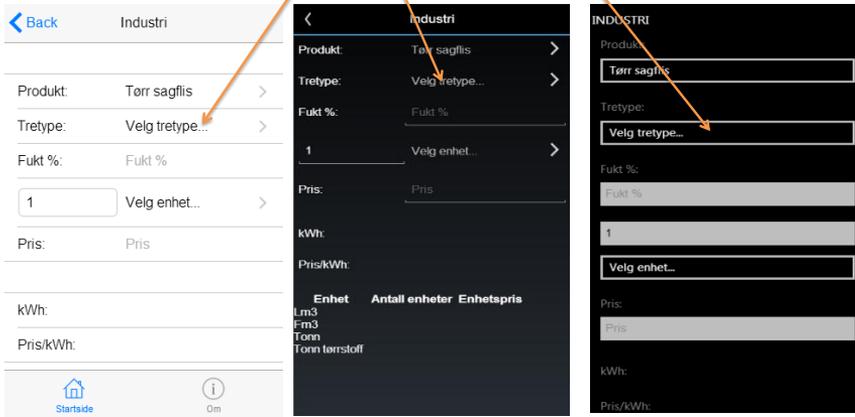


iPhone

Android

Windows

Touch to get a drop-down-list with wood species choices

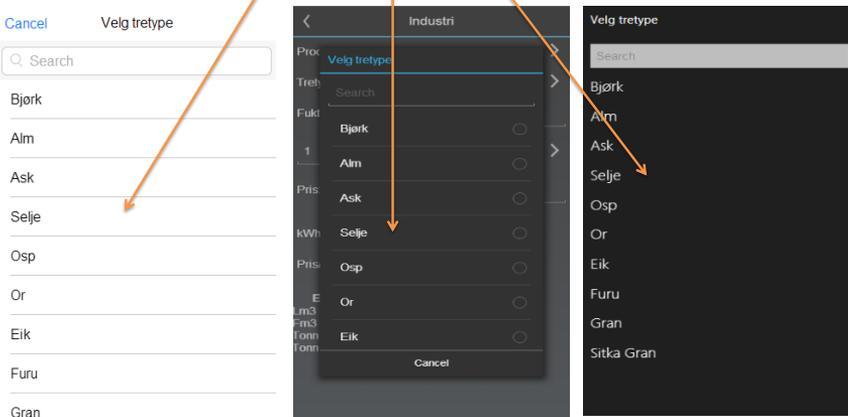


iPhone

Android

Windows

Touch one alternative to choose that specie



iPhone

Android

Windows

Touch to fill in moisture

Industri

Produkt: Tørr sagflis >

Tretype: Selje >

Fukt %: Fukt %

1 Velg enhet... >

Pris: Pris

kWh:

Pris/kWh:

Startside Om

Industri

Produkt: Tørr sagflis >

Tretype: Selje >

Fukt %: Fukt %

1 Velg enhet... >

Pris: Pris

kWh:

Pris/kWh:

Enhet Antall enheter Enhetspris

Lm3

Fm3

Tonn

Tonn tørrstoff

INDUSTRI

Produkt: Tørr sagflis

Tretype: Selje

Fukt %: Fukt %

1 Velg enhet...

Pris: Pris

kWh:

Pris/kWh:

iPhone

Android

Windows

Touch to fill in amount

Industri

Produkt: Tørr sagflis >

Tretype: Selje >

Fukt %: 5

1 Velg enhet... >

Pris: Pris

kWh:

Pris/kWh:

Startside Om

Industri

Produkt: Tørr sagflis >

Tretype: Selje >

Fukt %: 5

1 Velg enhet... >

Pris: Pris

kWh:

Pris/kWh:

Enhet Antall enheter Enhetspris

Lm3

Fm3

Tonn

Tonn tørrstoff

INDUSTRI

Produkt: Tørr sagflis

Tretype: Selje

Fukt %: Fukt %

1 Velg enhet...

Pris: Pris

kWh:

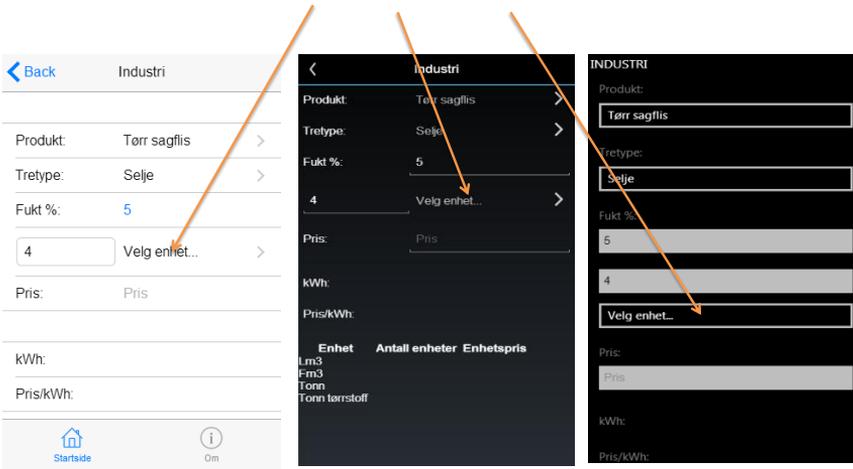
Pris/kWh:

iPhone

Android

Windows

Touch to get a drop-down-list with annotations

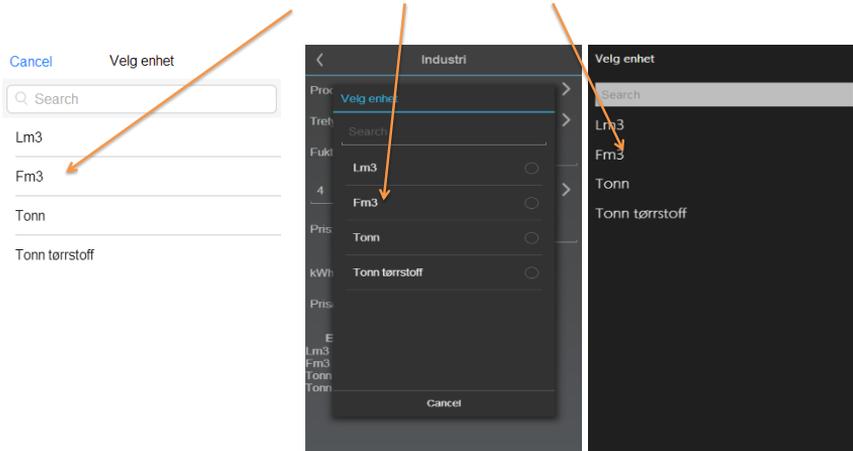


iPhone

Android

Windows

Touch one alternative to choose that annotation

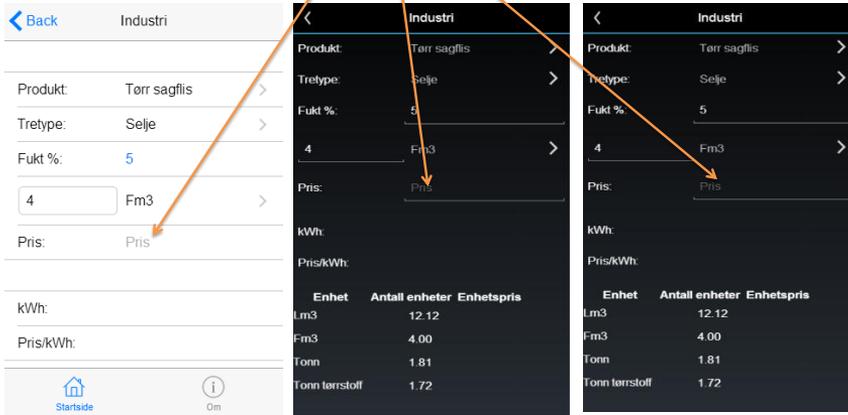


iPhone

Android

Windows

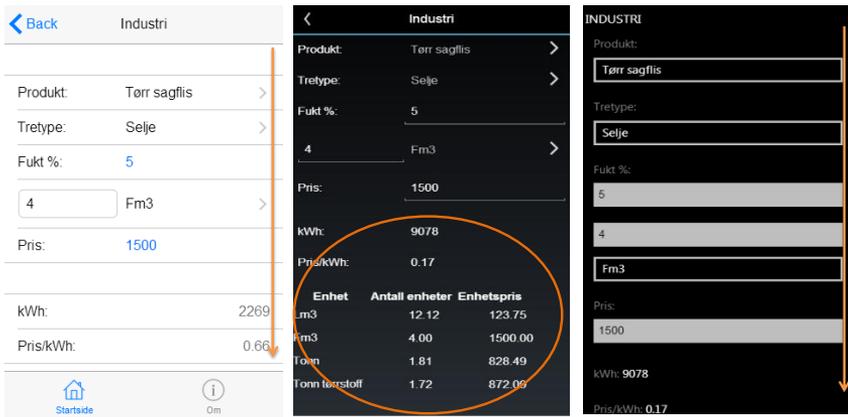
Touch to fill in price



iPhone

Android

Windows



Scroll in the arrows direction to see all the results

iPhone

Industri		
Pris:	1500	
kWh:	2269	
Pris/kWh:	0.66	
Enhet	Antall enheter	Enhetspris
Lm3	3.03	495..
Fm3	1.00	150..
Tonn	0.45	331..
Tonn tørrstoff	0.43	348..

Startside Om

Android

Industri		
Produkt:	Tørr sagflis >	
Tretype:	Selje >	
Fukt %:	5	
4	Fm3 >	
Pris:	1500	
kWh:	9078	
Pris/kWh:	0.17	
Enhet	Antall enheter	Enhetspris
Lm3	12.12	123.75
Fm3	4.00	1500.00
Tonn	1.81	828.49
Tonn tørrstoff	1.72	872.09

Windows

INDUSTRI		
Fukt %:	5	
4	Fm3	
Pris:	1500	
kWh:	9078	
Pris/kWh:	0.17	
Enhet	Antall enheter	Enhetspris
Lm3	12.12	123.75
Fm3	4.00	1500.00
Tonn	1.81	828.49
Tonn tørrstoff	1.72	872.09

APPENDIX E

FUNCTIONAL TESTS

See table E.1 - E.6 for test cases.

Test case ID	1
Name	Test firewood front page
Requirement	
Description	Push the "Vedkjøp" button on the start page
Preconditions	The application is running
Flow of events	1. Push the button named "Vedkjøp"
Expected results	The start screen disappears, and the firewood screen appears
Actual results	
Comments	
Status	

Table E.1: Test case 1

Test case ID	2
Name	Test calculations
Requirement	
Description	Fill in the required input to do the calculations
Preconditions	<ul style="list-style-type: none"> • The application is running • The user have chosen the firewood part
Flow of events	<ol style="list-style-type: none"> 1. Choose Vedmengde "40 l sekk" 2. Choose Tretype "Furu" 3. Enter Fukt % "5" 4. Enter Pris "100"
Expected results	The results appears at the bottom of the firewood page
Actual results	
Comments	
Status	

Table E.2: Test case 2

Test case ID	3
Name	Test view results
Requirement	
Description	Scroll to see energy and "Tilsvarende priser" results
Preconditions	<ul style="list-style-type: none"> • The application is running • The user have chosen the firewood part • The user have filled in all the required input • The application have calculated the results
Flow of events	<ol style="list-style-type: none"> 1. User scrolls down below the input choices
Expected results	The firewood input choices disappears, and the results appear instead
Actual results	
Comments	
Status	

Table E.3: Test case 3

Test case ID	4
Name	Industry page
Requirement	
Description	Press the "Industri" button at the start page
Preconditions	The application is running
Flow of events	<ol style="list-style-type: none"> 1. User presses the button named "Industri"
Expected results	The front page disappears and the industry start page appears
Actual results	
Comments	
Status	

Table E.4: Test case 4

Test case ID	5
Name	Calculations
Requirement	
Description	Fill in all the needed input and do the calculations
Preconditions	<ul style="list-style-type: none"> • The application is running • The user have chosen the industry part
Flow of events	<ol style="list-style-type: none"> 1. Choose Produkt "Fersk bark" 2. Choose Tretype "Furu" 3. Enter Fukt % "5" 4. Choose Enhet "Lm3" 5. Enter Pris "300"
Expected results	The industry results appears underneath the input choices
Actual results	
Comments	
Status	

Table E.5: Test case 5

Test case ID	6
Name	Results
Requirement	
Description	Look at the energy, and the two amount results
Preconditions	
Flow of events	
Expected results	
Actual results	
Comments	
Status	

Table E.6: Test case 6

APPENDIX F

USABILITY TESTING

F.1 The tests

Task no.	1
Task name	Firewood
Description	You are going to buy firewood, get to the firewood start page
Input	

Table F.1: Usability test - task 1

Task no.	2
Task name	Calculations
Description	Fill in all the input needed and do the calculations
Input	Vedmengde = "40 l sekk" Tretype = "Furu" Fukt % = "5" Pris = "100"

Table F.2: Usability test - task 2

Task no.	3
Task name	Results
Description	Look at the energy results and "Tilsvarende priser" results
Input	

Table F.3: Usability test - task 3

Task no.	4
Task name	Industry
Description	You are buying forestry products for your company. Go to the industry start page
Input	

Table F.4: Usability test - task 4

Task no.	5
Task name	Calculations
Description	Fill in all the input needed and do the calculations
Input	Produkt = "Fersk bark" Trettype = "Furu" Fukt % = "5" Enhet = "Lm3" Pris = "300"

Table F.5: Usability test - task 5

Task no.	6
Task name	Results
Description	Look at the energy, and amount results
Input	

Table F.6: Usability test - task 6

F.2 Test execution

The test leader plans a meeting with the test subjects, and they set up a meeting. Prior to the meeting the test leader does the required preparations, as explained in section F.2.1. Then the test subject is provided with information about the test, section F.2.2. Then the user is provided with the tests and a phone with the latest version of the tool, and the test begins. During the test the test leader takes notes regarding issues during the execution of the tasks. After all the tasks have been conducted, the user fills out a SUS form, and the test leader calculates the SUS-score.

F.2.1 Preparation for the test leader

- Make sure that you have the latest version of the forestry calculator on a phone.
- Have the tasks ready on paper or screen.
- Have the SUS questionnaire ready on paper or screen.
- Have pen and the observation form on paper or a computer ready to make notes on.
- Put an ID (e.g. the test leader's name) on both the observation form and the SUS questionnaire.

F.2.2 Information about the test given to the user

- This is a test to find out if the application is intuitive and user friendly, and not a test of you and your skills.
- The test consists of six (6) tasks and will take approximately 10 minutes.
- Read the instructions for each task and perform the tasks one by one.
- Each task has the same structure: A task number, a task name, a description of what you should do and input data that is needed to solve a task. If you find input fields in the application that do not have a value listed, you can enter an arbitrary value.
- If you cannot figure out how to solve a task this is not your fault, but the application that is not designed in a user friendly way. You can then move on to the next task, but notify the test leader.
- You can ask questions before and after the test, but we cannot help you during the test.
- You can quit the test anytime you want.
- It would be helpful if you could try to think along during the test. Try to explain what you see and why you make your choices. This makes it easier for us to figure out how users think and what could be done better in the design.
- After the test we would appreciate if you could fill out a questionnaire and give feedback if you felt that something worked well or not so well.

F.2.3 Information about the application given to the user

The *Forestry Product Calculator* is a tool that is to be used to calculate the energy amount in firewood, and to calculate different annotations used in the forestry industry.

F.2.4 SUS form

System Usability Scale

© Digital Equipment Corporation 1986.

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Figure F.1: SUS form

F.2.5 Observation form for usability testing

Test leader:

General information

Participant ID		Date of test	
Gender		Education	
Age		Experience with smart phones	

Test observation

Time	Task number	Observations
	1	
	2	
	3	
	4	
	5	
	6	

Question	Answer	Actual
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Sum		
SUS-score	x 2.5	

Table F.7: Observation form template

F.3 The results

This section includes the observation forms from all the tests conducted, as well as the corresponding SUS-calculations.

F.3.1 Test one

Test leader: Ida Katrine Thoresen

General information:

Participant ID	1	Date of test	2014-05-14
Gender	Female	Education	Nurse
Age	24	Experience with smart phones	iOS

Test observation:

Time	Task number	Observations
1 sec	1	Finds the firewood button at first glance
1 min 27 sec	2	Looking for the % button
13 sec	3	Scrolls to find all the results
45 sec	4	Uses the back button, then the industry button from the startpage
3 min	5	Problems understanding how to make the calculations
7 sec	6	Find the results as they are provided

Question	Answer	Actual
1	3	2
2	1	4
3	4	3
4	4	1
5	4	3
6	1	4
7	5	4
8	1	4
9	4	3
10	1	4
Sum		32
SUS-score	x 2.5	80

Table F.8: Test number one

F.3.2 Test two

Test leader: Ida Katrine Thoresen

General information:

Participant ID	2	Date of test	2014-05-14
Gender	Female	Education	Nurse
Age	25	Experience with smart phones	iOS

Test observation:

Time	Task number	Observations
1 min	1	Problems seeing the text
33 sec	2	Fills in the input, no problems
50 sec	3	Do not understand how to do the calculations
6 sec	4	Uses the back button on top of the screen
30 sec	5	Writes %-sign in the moisture-field first, so no calculations executes
8 sec	6	Expects where the results will be shown

Question	Answer	Actual
1	5	4
2	4	1
3	3	2
4	2	3
5	4	3
6	1	4
7	5	4
8	1	4
9	4	3
10	2	3
Sum		31
SUS-score	x 2.5	77.5

Table F.9: Test number two

F.3.3 Test three

Test leader: Ida Katrine Thoresen

General information:

Participant ID	3	Date of test	2014-05-14
Gender	Female	Education	Teacher
Age	24	Experience with smart phones	iOS & Android

Test observation:

Time	Task number	Observations
5 sec	1	Finds the button quickly
56 sec	2	Fills in all the input correctly
38 sec	3	Some problems getting the calculations to execute
2 sec	4	Uses the back button
41 sec	5	Remembers from task 2
7 sec	6	Learned from task 3

Question	Answer	Actual
1	5	4
2	1	4
3	5	4
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		40
SUS-score	x 2.5	100

Table F.10: Test number three

F.3.4 Test four

Test leader: Ida Katrine Thoresen

General information:

Participant ID	4	Date of test	2014-05-20
Gender	Male	Education	Technical college
Age	45	Experience with smart phones	iOS & Android

Test observation:

Time	Task number	Observations
7 sec	1	Found the button quite quickly
30 sec	2	Pushed outside the input-field, so the calculate-button did not provide any changes
10 sec	3	Scrolled to see the results
18 sec	4	Used the phones back button
1 min 10 sec	5	Learned from task 2
15 sec	6	Thought the results were straightforward

Question	Answer	Actual
1	5	4
2	2	3
3	4	3
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	4	3
10	2	3
Sum		36
SUS-score	x 2.5	90

Table F.11: Test number four

F.3.5 Test five

Test leader: Ida Katrine Thoresen

General information

Participant ID	5	Date of test	2014-05-22
Gender	Male	Education	Technical college
Age	52	Experience with smart phones	None

Test observation

Time	Task number	Observations
10 sec	1	Experienced some problems reading the text because of the black background
2 min	2	Looks for the %-sign quite some time
40 sec	3	Uses the enter button on the keyboard, so do not see any changes when pushing the calculate button
15 sec	4	Used the back button
3 min	5	Had some trouble getting the product list to show, touched outside the drop down list
15 sec	6	Learned from task 3 regarding execution of the calculations

Question	Answer	Actual
1	4	3
2	1	4
3	5	4
4	1	4
5	4	3
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		38
SUS-score	x 2.5	95

Table F.12: Test five

F.3.6 Test six

Test leader: Ida Katrine Thoresen

General information

Participant ID	6	Date of test	2014-05-22
Gender	Male	Education	Technical college
Age	57	Experience with smart phones	iOS

Test observation

Time	Task number	Observations
10 sec	1	Found the firewood button easy
2 min	2	Had problems understanding the difference in what was input fields, and what was the input fields label.
10 sec	3	Looked carefully at all the results
1 min	4	Looked for a home button, but did not find one. After a while he discovered the back button
1 min	5	Learned from task 2, but had some problems because he had already put a number in the moisture input, but he did not understand how to remove that number and put in a new one. Very little experience with using apps on smart phones.
2 min	6	Experienced problems understanding that MWh were energy results

Question	Answer	Actual
1	2	1
2	2	3
3	3	2
4	2	3
5	3	2
6	2	3
7	5	4
8	3	2
9	3	2
10	1	4
Sum		26
SUS-score	x 2.5	65

Table F.13: Test six

F.3.7 Test seven

Test leader: Ida Katrine Thoresen

General information

Participant ID	7	Date of test	2014-05-26
Gender	Male	Education	Technical college
Age	54	Experience with smart phones	Android & iOS

Test observation

Time	Task number	Observations
4 sec	1	Problems understanding he is already on the startpage
2 min	2	Problems seeing the screen because of the black background and sunlight.
20 sec	3	Scrolls to see all the results
9 sec	4	Found the back button quickly
1 min 27 sec	5	Learned from task 2, but is a slow toucher
3 sec	6	Sees the results as soon as the calculations are executed

Question	Answer	Actual
1	4	3
2	1	4
3	5	4
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	4	3
10	1	4
Sum		38
SUS-score	x 2.5	95

Table F.14: Test seven

F.3.8 Test eight

Test leader: Ida Katrine Thoresen

General information

Participant ID	8	Date of test	2014-05-26
Gender	Female	Education	Secondary school
Age	48	Experience with smart phones	iOS for 3 weeks

Test observation

Time	Task number	Observations
1 sec	1	Observes the button at once
1 min	2	Do not use the given input
16 sec	3	Pushes the button, and scrolls downwards
3 sec	4	Uses the back button right away
1 min 26 sec	5	This time she registers the input given
6 sec	6	Remember the button and scrolling from task 3

Question	Answer	Actual
1	3	2
2	2	3
3	5	4
4	2	3
5	4	3
6	2	3
7	5	4
8	1	4
9	5	4
10	1	4
Sum		34
SUS-score	x 2.5	85

Table F.15: Test eight

F.3.9 Test nine

Test leader: Ida Katrine Thoresen

General information

Participant ID	9	Date of test	2014-05-26
Gender	Male	Education	Printing college
Age	44	Experience with smart phones	Android & iOS

Test observation

Time	Task number	Observations
3 sec	1	Found the firewood button at first glance
52 sec	2	Experienced some trouble defining what was input fields
2 sec	3	Scrolled quickly to see all the results
7 sec	4	Used the back-button right away
43 sec	5	Learned from task 2
9 sec	6	Expected where to find the results

Question	Answer	Actual
1	3	2
2	2	3
3	4	3
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	4	3
10	2	3
Sum		34
SUS-score	x 2.5	85

Table F.16: Test nine

F.3.10 Test ten

Test leader: Ida Katrine Thoresen

General information

Participant ID	10	Date of test	2014-05-26
Gender	Female	Education	High school
Age	48	Experience with smart phones	Windows

Test observation

Time	Task number	Observations
25 sec	1	Uses some time finding the firewood button
30 sec	2	Wonders whether or not to write the % -sign
6 sec	3	Scrolls after pushing the calculate button
8 sec	4	Found the back-button easily
30 sec	5	Learned from task 2
6 sec	6	Expected the results to be underneath the input, so found them very easily

Question	Answer	Actual
1	3	2
2	1	4
3	5	4
4	1	4
5	4	3
6	1	4
7	5	4
8	2	3
9	5	4
10	1	4
Sum		36
SUS-score	x 2.5	90

Table F.17: Test ten

F.3.11 Test eleven

Test leader: Ida Katrine Thoresen

General information

Participant ID	11	Date of test	2014-05-26
Gender	Female	Education	high school
Age	54	Experience with smart phones	iOS & Android

Test observation

Time	Task number	Observations
26 sec	1	Having problems understanding that the app started at the start page
41 sec	2	Wonders whether she needs to write the %-sign
6 sec	3	Scrolled to find all the results
9 sec	4	Learned from last and used the start page button
33 sec	5	Learned from task 2
7 sec	6	Found the results quickly

Question	Answer	Actual
1	3	2
2	1	4
3	5	4
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		38
SUS-score	x 2.5	95

Table F.18: Test eleven

F.3.12 Test twelve

Test leader: Ida Katrine Thoresen

General information

Participant ID	12	Date of test	2014-05-26
Gender	Female	Education	Technical college, engineering
Age	33	Experience with smart phones	iOS & Android

Test observation

Time	Task number	Observations
2 sec	1	Found the button at once
31 sec	2	Filled in the input as she had done it thousand times before
4 sec	3	Scrolled to see all the results
3 sec	4	Used the back button
35 sec	5	Went smoothly
4 sec	6	Knew already where to find the results when pushing the calculate button

Question	Answer	Actual
1	3	2
2	1	4
3	5	4
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		38
SUS-score	x 2.5	95

Table F.19: Test twelve

F.3.13 Test thirteen

Test leader: Ida Katrine Thoresen

General information

Participant ID	13	Date of test	2014-05-26
Gender	Male	Education	High school
Age	47	Experience with smart phones	iOS

Test observation

Time	Task number	Observations
1 sec	1	found the firewood button at first glance
55 sec	2	Do not use the input provided
10 sec	3	Some troubles with the scrolling at first
6 sec	4	Uses the back-button immediately
1 min 31 sec	5	Stops and wonders what the industry annotations means
8 sec	6	Learned from task 3, scrolls right away

Question	Answer	Actual
1	4	3
2	1	4
3	5	4
4	1	4
5	5	4
6	2	3
7	4	3
8	1	4
9	5	4
10	1	4
Sum		37
SUS-score	x 2.5	92.5

Table F.20: Test thirteen

F.3.14 Test fourteen

Test leader: Ida Katrine Thoresen

General information

Participant ID	14	Date of test	2014-05-26
Gender	Female	Education	High school
Age	24	Experience with smart phones	Android & Windows

Test observation

Time	Task number	Observations
4 sec	1	Found the firewood button quickly
19 sec	2	Filled inn all the input needed without any problems
9 sec	3	Scrolled to be able to look at all the different results
3 sec	4	Used the back button
34 sec	5	Filled inn all the input provided, even though she did not understand what all of them were
6 sec	6	Found the results quite easy

Question	Answer	Actual
1	5	4
2	1	4
3	5	4
4	1	4
5	4	3
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		39
SUS-score	x 2.5	97.5

Table F.21: Test fourteen

F.3.15 Test fifteen

Test leader: Ida Katrine Thoresen

General information

Participant ID	15	Date of test	2014-05-30
Gender	Male	Education	Master-degree, university
Age	51	Experience with smart phones	None

Test observation

Time	Task number	Observations
5 sec	1	Found the firewood button easy
46 sec	2	Filled in all the input needed without any problems
7 sec	3	Scrolled to view all the different results
14 sec	4	Used the back-button
42 sec	5	Used the enter button, so did not understand what happens when pushing the calculate-button
11 sec	6	Looked at all the different results quite thoroughly

Question	Answer	Actual
1	2	1
2	1	4
3	4	3
4	1	4
5	4	3
6	1	4
7	5	4
8	1	4
9	4	3
10	1	4
Sum		34
SUS-score	x 2.5	85

Table F.22: Test fifteen

F.3.16 Test sixteen

Test leader: Ida Katrine Thoresen

General information

Participant ID	16	Date of test	2014-05-30
Gender	Female	Education	Finance college
Age	50	Experience with smart phones	Android & Windows

Test observation

Time	Task number	Observations
1 sec	1	Found the firewood button quickly
30 sec	2	Experiencing some issues finding the correct specie, since the list is not alphabetized
4 sec	3	Scrolled to see all the different results
9 sec	4	Used the phones back-button
40 sec	5	Filled in all the input require, no troubles
7 sec	6	Looked at the results in the table and found them very orderly

Question	Answer	Actual
1	4	3
2	1	4
3	5	4
4	1	4
5	4	3
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		38
SUS-score	x 2.5	95

Table F.23: Test sixteen

F.3.17 Test seventeen

Test leader: Ida Katrine Thoresen

General information

Participant ID	17	Date of test	2014-05-30
Gender	Female	Education	High school
Age	28	Experience with smart phones	Android & iOS

Test observation

Time	Task number	Observations
3 sec	1	Locates the firewood button fast
1 min 8 sec	2	Wonders whether or not the %-sign is needed
12 sec	3	Scrolls to see all the different results
3 sec	4	Used the back-button
34 sec	5	Learned from task 2
11 sec	6	Looks at the result table, and the energy results, but wonders what load value is

Question	Answer	Actual
1	3	2
2	2	3
3	5	4
4	1	4
5	4	3
6	1	4
7	4	3
8	2	3
9	4	3
10	1	4
Sum		33
SUS-score	x 2.5	82.5

Table F.24: Test seventeen

F.3.18 Test eighteen

Test leader: Ida Katrine Thoresen

General information

Participant ID	18	Date of test	2014-05-27
Gender	Male	Education	Technical college
Age	48	Experience with smart phones	iOS

Test observation

Time	Task number	Observations
2 sec	1	Pushes the firewood button at once
3 min	2	Touches the input text not the input field
11 sec	3	Uses some time before he scrolls
6 sec	4	Used the back-button
1 min 25 sec	5	Learned from task 2 regarding the input, but forgets to choose unit
12 sec	6	Carefully studies all the different results

Question	Answer	Actual
1	3	2
2	1	4
3	4	3
4	1	4
5	5	4
6	1	4
7	5	4
8	1	4
9	5	4
10	1	4
Sum		37
SUS-score	x 2.5	92.5

Table F.25: Test eighteen

F.3.19 Test nineteen

Test leader: Ida Katrine Thoresen

General information

Participant ID	19	Date of test	2014-05-30
Gender	Male	Education	College
Age	30	Experience with smart phones	None

Test observation

Time	Task number	Observations
17 sec	1	Some problems understanding that the app started at the start page
1 min 34 sec	2	He is just a slow worker, had no problems providing the input required
11 sec	3	Scrolled to see all the different results
18 sec	4	Used the back-button
2 min 20 sec	5	Having problems understanding where the input are to be provided, as to where the results are going to show. Sees the units further down at the screen.
4 sec	6	Looked at all the results

Question	Answer	Actual
1	5	4
2	2	3
3	3	2
4	3	2
5	4	3
6	2	3
7	5	4
8	1	4
9	3	2
10	4	3
Sum		30
SUS-score	x 2.5	75

Table F.26: Test nineteen

F.3.20 Test twenty

Test leader: Ida Katrine Thoresen

General information

Participant ID	20	Date of test	2014-06-01
Gender	Male	Education	High school
Age	19	Experience with smart phones	iOS

Test observation

Time	Task number	Observations
1 sec	1	Spotted the firewood button at once
36 sec	2	Filled in all the necessary input
9 sec	3	Understood the scrolling right away
4 sec	4	Used the back-button
43 sec	5	Filled in all input required
5 sec	6	Looked at all the results

Question	Answer	Actual
1	4	3
2	1	4
3	5	4
4	2	3
5	4	3
6	2	3
7	4	3
8	2	3
9	5	4
10	1	4
Sum		34
SUS-score	x 2.5	85

Table F.27: Test twenty

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