An online marketplace to help reduce the wastage of Swedish wool

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Abstract

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Over 1800 metric tons of wool is produced in Sweden on a yearly basis, only 300 is used. This project involved creating an online marketplace where wool producers and the general public alike could turn to regarding the purchasing and selling of Swedish wool, as well as general information regarding wool. The goal of this project was to reduce the wastage along with the negative effects it has on the environment, partially by making it easier to buy and sell wool, but also by tackling surrounding problems such as localization and subjectivity when selling. To further understand the wastage, but also wool and its properties, multiple contextual inquiries were conducted alongside a survey. The result is a marketplace, more specifically, a web application, which consists of a section to buy wool and a section to sell wool. Furthermore, the web application also consists of a section with general information regarding Swedish wool and a map showing wool nearby.

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Sammanfattning


Det övergripande målet med projektarbetet var att minska svinet av svensk ull samt dess negativa effekter på miljön. Detta genom att underlätta handeln av lokalproducerad ull samt förebygga problem som den subjektivitet som kan uppstå vid försäljning, vilket i sig kan ses som en följd av avsaknaden av ett klassificeringssystem. Projektet resulterade i en väl fungerande webbtjänst med stöd för handel av ull.
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1 Introduction

Over 1800 metric tons of wool is produced in Sweden on a yearly basis, but only 300 is used [Let18]. In a world where increased focus and effort lies on managing natural resources efficiently, Swedish wool is one resource that has not been handled accordingly. Interviews undergone by the stakeholder [Sö18], show that the majority of the buyers and sellers of wool in Sweden are split and unsure on how the wastage of wool can be prevented. Furthermore, interviews with people in the wool community showed a lack of knowledge surrounding the topic, enhancing the need to spread information regarding wool.

At the time of writing, there exists a few initiatives with the goal of reducing wastage. *Ulförmedlingen* [Sö18] is such an initiative. It strives to combine the spreading of information regarding wool with a reliable way of buying and selling wool. This project is a continuation in the form of a web application. The web application aims to assist users by providing the support and information that are necessary when buying and selling wool. To further understand the wastage, but also wool and its properties, contextual inquiries were conducted alongside a survey. Additionally, to enhance the importance of being environmentally friendly, ads with *Swedish KRAV* marked produce are labeled. KRAV is a branding that guarantees that a product fulfills certain standards regarding animal care, health, social responsibility and climate effects [KRA17].

2 Background

Wool is a textile fiber obtained from sheep and other animals often used for its isolating properties. In an article published by *Sveriges Radio*, Sweden’s national radio, Claudia Dillman, a member of the board at *Svenska Fåravelsförbundet*, a Swedish company with the purpose of maintaining and overseeing sheep related matters in Sweden, states that around 80% of Swedish wool gets thrown away or burned, which correlates to approximately 1800 metric tons of wool [Let18]. Dillman also mentions that, despite the wastage, companies that utilize wool are still importing it from foreign countries. Swedish farmers have expressed their concern surrounding this problem. In the same article, shearer Patrik Jönnson explains, that the economic profit from shearing sheep and selling wool, have been reduced to such an extent, that it barely covers surrounding expenses. In another article [Wik17], Dillman further explains that the reason for the perishing wool industry can be attributed to the lack of a classification system that highlights differences, properties and qualities, which instead leads to wool being classified subjectively. She also mentions that farmers find it hard to locate buyers due to
a lack of a common platform. Furthermore, she highlights that wool in general has a lower priority as the economic demand lies on meat and skin, with wool being seen as a by-product. With Swedish laws requiring that sheep are to be sheared a minimum of once a year [Jor17], reduced wastage is unlikely, if nothing is done about the problem.

A few initiatives have tried to improve the state of the Swedish wool industry and reduce the wastage, none however, established enough to make substantial impact. One of these initiatives, which also happens to be our stakeholder, is Ullförmedlingen [Sö18]. Ullförmedlingen is a startup company with a mission to reduce the wastage of Swedish wool by acting as an intermediary between buyers and sellers. The company continuously tries to identify the causes behind the wastage to be able to prevent it. Ullförmedlingen utilized Facebook, using it to build a digital community where people can promote and sell wool.

3 Purpose, aims, and motivation

The purpose of this project is to reduce the wastage of Swedish wool by creating an online marketplace. The marketplace is to be used as a base, where one can purchase, request, sell and gather information regarding wool.

The aim of this project was to create a fully functioning prototype for a web application using both front-end and back-end development. Functionality built will include the ability to identify where wool is being sold on a map, the ability to find wool using a search function, as well as the option of buying or selling wool. The prototype will also include a page used to spread information regarding Swedish wool.

The sole fact that on average, only 20 percent of all Swedish wool is used on a yearly basis [Let18], is in itself alarming. This is a problem the company Ullförmedlingen has been trying to tackle over the past years, together with those involved in the wool industry. With such a high wastage-to-usage ratio, it is also easy to see why frustration and confusion arises among farmers, journalists [Jar18] and others, when wool, in large amounts, is still being imported from abroad.

With Swedish laws requiring that sheep are to be sheared a minimum of once a year [Jor17], the chances of reduced wastage is unlikely, if nothing is done about the problem. The extraction of wool requires time as well as resources, so wastage in general translates into missed profit.

For the time being, the Swedish wool industry is unstructured and uneconomical [Let18]. With no larger corporate or government involvement, a clear way of handling business
in the Swedish wool industry is non-existent. After years of research and experience, Ullförmedlingen believes that an online marketplace is one of many steps in the right direction.

### 3.1 Delimitations

Considering the fact that the project consisted of building a prototype for a web application of future use, in addition to time constraints, a few restrictions were made.

The first restriction made for this project involved security, more specifically, not building a web application suited for Hyper Text Protocol Secure (HTTPS), rather than Hyper Text Protocol (HTTP) as used for our prototype. Using HTTPS ensures that communication with the server is encrypted and cannot be intercepted.

The second restriction made for this project involved not stress testing the web application to determine system stability, evaluate functional behavior and measure performance. Considering the reasons mentioned in the beginning of the subsection, but also upon recommendation from Mikael Laaksoharju, Associate senior lecturer at the Department of Information Technology, Division of Visual Information and Interaction at Uppsala University, he questioned the need for stress testing at all, considering the size of the prototype’s future target group.

Furthermore, despite building functionality which acquires a user’s personal data, no terms and conditions were written for our web application. During the course of the project, the European Union was in the process of enforcing new regulations known as GDPR regarding data privacy [EU18]. Due to time constraints, constructing the terms and conditions was deemed unnecessary for our prototype.

Despite implementing functionality to validate KRAV certified produce, verifying if the advertisements were KRAV labeled, could not be achieved. Due to a transition between new data systems as well as insecurity surrounding GDPR, KRAV was unable to provide access to their database.

### 4 Related work

We have decided to divide related work into two categories. The first consists of a web application for buying and selling products or services, and the other category consists of projects with the aim of reducing the amount of wool being wasted.
4.1 Web application for buying and selling products

Blocket.se[Blö18] is a well known Swedish web application where people and companies can sell services and products. We have more specifically decided to focus on the buying and selling of products aspect of the site. When a user wants to sell something they fill out a form and then pay Blocket a small fee, which varies depending on the amount of options selected. When the payment has been accepted, an advertisement of the users products are displayed on the web application, for all users to see.

The advertisement aspect of the web application is what we found interesting. However, since a person is able to sell virtually anything on Blocket, the form that a creator of an advertisement has to fill out, is vague. Apart from contact details and location, a user has to provide a title, price and description in the form of a short text and optionally, one or more pictures of the item(s) to be sold. Since our web application focuses solely on the purchasing and selling of wool, we intend on having a seller fill out a more detailed form when creating an advertisement. Highly detailed advertisements allow for a filter with more options. This in turn allows a buyer to easier filter out wool that is not of interest.

However, Blocket lacks integrated support for organic standards such as KRAV, i.e., there is no way of knowing if a person claiming to be selling organic products of the specified standard, is telling the truth or not. To determine this, an external database has to be searched. For example, to find out if a person claiming to be selling legitimate KRAV-certified products is being truthful, a buyer has to manually search the KRAV database in hope of finding the seller. Hence, to simplify the process, we integrated support for highlighting KRAV labeled wool.

4.2 Projects with the focus of reducing the wastage of wool

Bä, bä vita lamm har du någon ull? is a master thesis published by Sara Ericsson at Gävle Högskola. The aim of the thesis was to find a usage for wool of a quality deemed too low for scouring, or being woven into yarn. The conclusion of the thesis, is that wool can be mixed with soil to create a form of fertilizer [Eri17].

Since one of the goals with the project was to reduce the amount of wool being wasted, results such as that of the master thesis, could be put to good use. By providing such information on the web application, the chances that wool of varying quality being used productively could be increased.
Ullförmedlingen has a Facebook group dedicated to buying and selling Swedish wool. However, the administrator detected a number of problems with using Facebook. For example, the difference in quality regarding advertisements. Whilst some advertisements were acceptable, many lacked descriptions, decent pictures or useful information. With a Facebook group, an administrator is unable to make sure that an advertisement upholds a certain standard. Furthermore, it is difficult to filter out the advertisements which are not of interest. Just like Blocket, the Facebook group also lacks integrated support for organic standards such as KRAV [Sö18].

5 Method

The web application was implemented using a number of tools, resources and methods. This section will describe the tools and resources that were used, and why they were chosen. Firstly, we explain how we proceeded when identifying the user requirements. Secondly, we compare and analyze our choice of programming environment and web framework, continuing with our choice of map API, i.e., application programming interface. Finally, we explain how we protected a user’s password, our choice of database as well as the methods used for designing the client interface.

5.1 User requirements

The stakeholder Ullförmedlingen had previously carried out a survey, questioning both wool producers and wool refiners, on topics regarding what should be done about the current wool market. This survey resulted in user requirements for the buyers, as well as the sellers. The user requirements were considerable, and, on many fronts, overlapping, so we decided to use the information gathered to conduct a contextual inquiry. The results were used in discussion with the stakeholder to try and better evaluate how we could make the information more clear-cut and succinct.

5.1.1 Contextual inquiries

In order to gain a better understanding of what attributes of wool were most important to the users, we decided to conduct contextual inquiries. A contextual inquiry consists of visiting a user at their workplace, observing how they work, whilst asking questions in their natural environment, in an attempt, to get more realistic data [BH97].
Another goal of our contextual inquiries was to gain a better understanding of the current situation for the buyers and sellers of wool. Therefore, the interviewees chosen, were subjects with a minimum of five years experience in the Swedish wool industry.

5.1.2 Survey

To further improve our understanding and broaden our perspective of the users situation, we also conducted a survey. The main focus of the survey was to gather data on the users thoughts regarding the different properties of wool. If we could collect enough data, we hoped that certain patterns would arise, preferably giving hints on how to further design the marketplace. The survey was done digitally, and since we focused on properties of wool, the target audience consisted of people with experience in the wool market. Furthermore, with the wastage of Swedish wool being our primary focus, the people who participated in the survey were Swedish residents.

5.2 Programming environment

We chose to use NodeJs in this project, a programming environment designed to make scalable Internet applications [Nod18]. NodeJs is a JavaScript run-time environment, which means that it is possible to run scripts server-side to produce dynamic web applications, even before the page is sent to the client’s web browser. The fact that NodeJs only uses JavaScript increases the maintainability of the system, due to the fact that substantial portions of the front-end consists of the same data types, syntax and language conventions. Being released in 2008, NodeJs is relatively new, which comes with the consequence of not having the amount of libraries an older language might have.

An alternative to NodeJs is PHP [PHP18], a more well known scripting language released in 1995 mostly used for back-end programming. Being one of the early back-end programming languages, it has been widely used throughout the decades. In comparison to NodeJs, the surrounding community is bigger, making it easier to find support. As a result of years of bug fixing and language restructuring, there is a lower risk of libraries having deep-rooted bugs. A negative aspect of PHP is the intercommunication between languages such as HTML, CSS and JavaScript, being more complex due to PHP being its own language with distinct syntax and data types.
5.3 Web framework

Express was chosen as the web framework for this project. At the time of writing, it is the most commonly used web framework for NodeJs [npm18]. Express provides robust and efficient routing, i.e., the means by which URL and HTTP requests are routed to the code that handles them [Exp18]. The primary argument for using Express was that it was a NodeJs module. This allowed us to continue working in the same programming environment when working with our web-framework.

An alternative to Express is Ruby on Rails (RoR). Ruby on Rails is a web framework created with Ruby [Rub18]. It allows a programmer to create web applications, but in turn requires the programmer to use unified configuration rules and default patterns. Learning the rules and patterns, combined with the fact that none of the project members had any previous experience with Ruby, meant a lot of time would have to been spent on simply learning a new programming language; a conclusion was made that it would be inefficient, considering the limited time available.

5.4 Displaying advertisements on a map

To display advertisements on a map we needed an API. We chose Google Maps [Goo18c], as it was easy to interact with, provided detailed documentation, as well as convenient code samples. Combining all of this, with the fact that it required minimal effort to integrate with Google Geolocation API [Goo18a], which was used for converting addresses to coordinates, made Google Maps the best choice. However, a negative aspect is that the API is only free of cost up until 25,000 map loads per 24 hours; after exceeding this usage limit, each additional 1000 map loads cost $0.50USD [Goo18b].

An alternative to Google Maps was OpenLayers [Ope18], an open source JavaScript library. It is completely free, provides a wide set of functions and also supports the displaying of shapes and figures. However, considering the integration with Geolocation, Google Maps API was deemed to be the better choice.

5.5 Data storage

We needed a way to store the user and advertisement information. The database chosen for the project was the free and open-source MongoDB [Mon18]. It uses BSON based documents, i.e., a computer data interchange format, with schemas, which can be seen as the organization of data that determines how the database is to be constructed. BSON
is a common data format used for asynchronous browser-server communication.

MongoDB differs from SQL and other relational databases in the manner of how its data is stored. Relational databases base their data on relational models. The purpose of relational models is to provide methods that express the logic of computation for specifying data and queries. Users explicitly state what information the database should contain and what information to retrieve. The relational database then manages the system software such that it handles the data structures for storing the data, along with retrieval procedures for answering queries. In the case of a non-relational database such as MongoDB, no dependencies or relations restrict the handling of data.

5.5.1 Protecting sensitive information

In order to protect sensitive information, more specifically, a user’s password, an extra layer of security was deemed necessary. We decided to use Bcrypt [PM97], a password hashing function, compatible with a wide variety of programming languages, such as C, Java and Javascript. A password hashing function converts passwords into unreadable strings and are constructed to be impossible to convert back. A password is then solely used to generate a key, moreover, the only key, which matches with the hashed value, enabling login. Bcrypt ensures that, even in a case of unauthorized access to the database, the passwords would still be unobtainable without their respective keys. The hashing tool was used in the server.

5.6 Creating the client interface

When creating our web application, the client interface was designed using front-end programming languages. We used Hypertext Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript, in addition to Bootstrap [Boo18], an open-source front-end framework. HTML is the standard markup language, i.e., code, used for creating web applications; CSS is used to define the visual appearance [Wor18]. JavaScript has a variety of purposes, however, in this project, it was used to program the behavior of our web application. Bootstrap, although not strictly necessary, was used, as it utilizes pre-built components, simplifying the process of creating responsive design.
6 System design

Our web application follows a three-tier architecture model [Win18], which as the name implies, divides the application into three tiers. The first tier is the user services layer, also known as the presentation tier, which we have simply denoted as Client. The second tier, also called business layer service, is denoted as Server. The last tier is the data layer, also know as the data services layer, which we have denoted as Database.

![Figure 1: The three tier architecture model used in this project.](image)

6.1 Client

A user of our web application takes the form of a Client. As shown in Figure 1, a client can only communicate with the server. Communication is done through an interface, in this case, the web application. When a client wants to access a resource, for example view an advertisement, it sends a HTTP request to the server and waits for a response.

A client is able to:

- View a map displaying all of the current advertisements in the database. The advertisements are marked on the map using their respective addresses and ZIP codes, which are translated into coordinates by Google Geocoding.
• Register an account which is then stored in the database allowing a client to log in, along with the option of changing the account password

• Create an advertisement which is then stored in the database. A client can also search the database for advertisements.

### 6.2 Server

As shown in Figure 1, the server communicates with both client and database. The purpose of the server is to provide information requested by the user and work as an intermediary between clients and the database. Dealing with user passwords requires a certain aspect of security. To ensure the latter, we used the hashing function Bcrypt in the server.

The communication with the server follows the request-response method [MDN18]. The client sends a request for specific data and the server responds to the request. The method works synchronously, which implies that the requests are handled one after the other. Asynchronous events were also needed. An asynchronous event occurs independently of the main program flow, such that the normal flow of execution must be delayed until the request has been received and handled. The asynchronous events handled were the fetching of information from the database, as well as the requesting of external services from Google Maps.

### 6.3 Database

In this project we designed a database that contains information about users and advertisements. A user is created upon registration. The attributes a user consists of are as follows: first name, last name, username, email, password, address, ZIP-code and if the user is a private citizen, VAT registered company or a non-VAT registered company. An advertisement is created by a user and then saved in the database. The attributes an advertisement consists of varies, as there are many different types of wool. Besides attributes such as the title, price per kilo, pictures, description and location, attributes more specific used to describe the advertisement, gathered from the results of our survey mentioned in section 10.3, were: sheep breed, how lustrous the wool is, how fuzzy the wool is, the wool's fibre diameter, what season of the year the sheep were sheared, the length of the wool, if the wool contains debris, how dirty the wool is and if the wool is washed or not. Using these attributes, a filter was implemented, allowing users to find the specific kind of wool they are looking for.
7 Requirements and evaluation methods

In order to best achieve the purpose and aims of this project, i.e., create a web application that fits the needs of the wool community, a set of requirements and evaluation methods were formed. In this section we present what the requirements were, and how they were evaluated.

7.1 Requirements

During the early stages of the project, a set of core functionalities were formed from discussions both internally amongst the group members, as well as with the external stakeholder. Therefore, the implementation of these functionalities became the first requirement of the project. The functionalities were as follows:

- The ability for a user to create an account and log in
- The option for a registered user to create an advertisement
- A map function that allows a user to locate nearby advertisements
- A list showing all current advertisements in the database

The web application should be compatible with the five most used browsers, at the time of writing, these were [W3C18]: Google Chrome, Safari, Internet Explorer, Mozilla Firefox and Opera.

The contextual inquiry, mentioned in section 5.1, formed a basis for additional requirements. The first requirement was the need for the web application to be responsive, i.e., the web application should function on all smartphones, tablets and computers, independent of their screen-size. This was important as the contextual inquiry indicated that future users are more likely to use mobile devices when creating an advertisement, since they also use them to take pictures of the wool when selling. Another important reason for taking responsive design into consideration, is the fact that in 2017, mobile devices made up 52.64% of Internet traffic [Sta18]. We concluded that the omission of responsive design could lead to the exclusion of a large number of potential users.

The final requirement was to provide the user with the option of changing attributes on a posted advertisement. Interviews conducted during the inquiries suggested that it is not uncommon for users with more knowledge to point out flaws in other users advertisements. When a flaw was detected, the interviewees often contacted the creator of the advertisement, advising them to modify it.
7.2 Evaluation methods

The requirements were evaluated by conducting user tests. The tests were carried out on different browsers, e.g., one user may perform the test in Google Chrome while another uses Mozilla Firefox. This was done to evaluate whether our web application was cross browser compatible or not.

Two groups of users were chosen based on their previous knowledge concerning wool and its properties. The first group consisted of users with little to no knowledge, whilst the second group consisted of users with varying amounts of knowledge. These two groups were chosen to evaluate whether a users knowledge has an affects on how they perceive the web application. This was done by comparing the answers each user gave during the post-task examination, mentioned later in this section.

The structure of the user tests were simple. A user executed a given set of tasks, while we observed how they were carried out. If a task was completed successfully, i.e, if the user could complete the task without any assistance, the tested requirement was deemed a success. The tasks were the following:

- To find a certain category of wool in close proximity
- To create an account
- To create an advertisement
- To change a property of the advertisement they created in the previous task
- To use the search function to find wool with a certain set of attributes.

After each task, we examined the user’s experience by asking a series of questions. We wanted the questions to prompt them to describe their experience, rather than questions where the user simply answered yes or no. Hence, we tried to make the questions open-ended, for example: ”What aspects of creating an advertisement did you like or dislike, and why?”.

The questions were general and not related to one specific task. After every task, the users were asked the following questions:

- How intuitive did you think solving the task was?
- What would you suggest we add or remove to make solving the task more intuitive?
8 The web application - structure and usage

In what way, if any, did the site help you accomplish your task?

In some cases, follow-up questions were asked to make the users clarify what they meant.

8 The web application - structure and usage

The web application consists of three sections based on the requirements; the homepage, which contains the map and basic information; account-related functionalities, such as registration and login; the marketplace, where a user can create, find and search for advertisements. The sections are explained in further detail below.

8.1 Homepage

A visitor of the homepage is presented with some basic steps for getting started, along with a preview of the three most recent advertisements. As shown in Figure 2, the navigation bar is located at the top of the screen. The navigation bar is present on all pages and allows the user to navigate through the system.

Shown at the bottom of Figure 2, a visitor can catch a glimpse of the map. Just above the map, there is a button, that when selected, displays basic information about the markers on the map. Figure 3 shows the information provided by clicking the button. In the same figure, one can also see the window that appears when a marker is selected; the window displays information about the advertisement, along with an option to visit the web page associated to it. The rest of the homepage consists of information regarding the project along with contact information, as shown in Figure 4.
Figure 2: The latest advertisements and the navigation bar.

Figure 3: Nearby advertisements are displayed.
Figure 4: The about us section and contact information placed in the footer.
8.2 Account

In the right section of the navigation bar, as shown in Figure 2, there are options for a user to either log in or register an account. An account is needed to create as well as view individual advertisements. Registering an account consists of filling out a form, shown in Figure 5. After the form has been filled in correctly, the account is stored in the database.

![Figure 5: The form a user fills in when registering an account.](image)

After a user has successfully been registered in the database, they can access the login screen by trying to navigate to a part of the site that requires the user to be signed in, or alternatively by clicking login in the navigation field.
When logged in, a user may visit their account page, shown in Figure 7. Here, all information related to the account is displayed, as well as the option to change the account password. The page also contains a list of all current advertisements made by the account, along with the option of updating or deleting an advertisement.

![Login Screen](image)

Figure 6: The login screen.

![Account Page](image)

Figure 7: All account details and functionalities such as changing password and modifying advertisements created by the account.
8.3 Marketplace

In the marketplace, shown in Figure 8, a user can see a list containing all the current advertisements stored in the database, along with a description. When a user wishes to search for a specific advertisement, they can use the search function. A user specifies which attribute to search for and fills in the search bar.

![Marketplace Image]

Figure 8: A list showing all the current advertisements stored in the database. Above the list is the search function and the button to create a new advert.

By clicking the create-advertisement button, a user is redirected to the page where they can create an advertisement. There, a user fills out a form, shown in Figure 9, and uploads pictures of their wool. When they are done and have selected the submit button, the advertisement will be stored in the database and displayed in the marketplace.
9 Evaluation results

In this section all requirements related to functionality will be presented. In summary, all the required functionalities were successfully implemented, i.e., all users were able to singlehandedly carry out the tasks. Below each listed requirement, is a summary of what the user tests revealed about the functionality. This is followed by a summary of the users thoughts regarding cross browser compatibility and responsive design.
• The ability for a user to create an account and log in
The majority of the users thought the task was intuitive. Some users thought the font size of the text in the navigation bar was a bit too small; they stated that increasing the font size would have made the task easier. Users pointed out, that because the option of registering an account was located in the top right corner of the site, the task was easier to complete, as it was similar to other web applications.

• The option for a registered user to create an advertisement
This test was based on a theoretical scenario; users were given information about a piece of wool and were then asked to create an advertisement for it. Filling out the form was straightforward, finding the form proved slightly harder. The fact that the form was located in the marketplace section of the application misled some testers, who instead searched for it on the homepage. The user feedback was clear, we needed to highlight the section for selling wool, some users even suggested adding it to the navigation bar.

• A map function that allows a user to locate nearby advertisements
Users pointed out that the text in the button for explaining the different markers, shown in Figure 2, was too small. Furthermore, some users had doubts about the usefulness of the map, they explained that the same functionality could be achieved by simply expanding the filter with an option for a geographical region.

• A list showing all current advertisements in the database
This requirement was tested by asking a user to search for a specific advertisement using a filter. Users with little or no knowledge concerning wool and its properties, pointed out that information about the different filter parameters were badly needed, as they did not understand what the parameters meant.

• The option for a user to change attributes on a posted advertisement
The user test related to this requirement gave mixed results. Most users found it intuitive that all advertisements related to their account could be found on the account page. Others thought the exact opposite, since they believed everything related to an advertisement should be located in the marketplace section. However, once they had found their advertisements, changing attributes proved to be an easy task. Similar to the discussion on creating an advertisement, some users pointed out that adding an option for my advertisements in the navigation bar could be a good idea.

The user tests indicated that the web application was fully functional on all web browsers, except Internet explorer. More specifically, when using Internet explorer, the user tests
showed that the markers did not function correctly, i.e., they could not be seen on the map.

The user tests indicated that the web application was responsive, functioning on smartphones, tablets and computers of different screen sizes. However, when using the web application on smaller devices, users thought that the text size could be enlarged.

10 Results and discussion

This section provides a detailed presentation of the end results. We have divided the results into subsections, more specifically, an overview of the system, what we learned from the contextual inquiries and the survey, as well as a discussion regarding the results.

10.1 System overview

The final result was a fully functioning prototype of a digital service for buying and selling wool. It had all the core functionality specified in the requirements section. A user can register an account, create advertisements and browse advertisements created by other users. Furthermore, a user can also gather information regarding wool and locate nearby wool on a map. During implementation, many functions were expanded upon, resulting in improvements. For instance, hashing is used to protect user data before storage in the database.

However, not all requirements were fully achieved. The site was not fully compatible with Internet Explorer, more specifically, the markers on the map did not function correctly, i.e., they could not be seen on the map. Furthermore, due to reasons such as GDPR, mentioned more in depth in section 3.1, integrated support for KRAV could only partly be implemented. The web application itself, functionality-wise, has the ability to highlight organic produce. Since we were denied access to KRAV’s database, there is no way to verify if KRAV-labeled advertisements are legitimate.
10.2 Contextual inquiry

When conducting the interviews and interacting with people involved in the Swedish wool community, we noticed a lot of recurring themes. Usage of the Facebook group "Ullförmedlingen" was something they all had in common and claimed had been helpful. Nonetheless, they all felt that it had flaws. For example, the difference in quality regarding advertisements. Whilst some advertisements were acceptable, most lacked descriptions, decent pictures or any useful information at all. Another problem highlighted during the interviews was the current situation surrounding the transportation of wool. Despite being of light weight, wool takes up a lot of space, often leading to shipping or transportation costing as much as the product itself.

When discussing the various and most important properties of wool, we also noticed recurring answers. The answers suggested that certain properties could be determined by knowing others. For example, by knowing if a sheep is purebred, one can draw certain conclusions about the length, fuzziness, and type of fiber. If the wool is fuzzy, see Figure 11, then the wool is also likely to be fine-fibered. These results were used to draw conclusions when designing the web application. The most important properties highlighted by the interviewees were used to design the create-an-advertisement form.

One interviewee highlighted that it takes a lot of time to understand the different properties of wool, what they mean and how they work in conjunction to one another. In this case, the interviewee believed the need to spread information regarding wool was a solution.

When discussing usage of a potential web application, the interviewees had input regarding the use of mobile devices. They mentioned that web application should work on mobile phones as they were used to take pictures of the wool to be sold.

10.3 Survey

The target audience of the survey consisted of people who had previous experience in the wool market. Approximately 50% of the people who answered the survey, stated that they had a minimum of five years experience in the wool market. The main focus of the survey was to identify what properties of wool that the users thought were the most important. The results, as seen in Appendix B, indicated that all properties listed were important. This was something we had to take into consideration when deciding on which properties should be used to define an advertisement.
10.4 Discussion

The conclusion drawn from the evaluation results, was that the core functionalities specified in the requirements worked correctly. However the user tests indicated that there were minor improvements to be made in order to make the site more user friendly, described more in-depth in section 9.1. For example, adding an option in the navigation bar for creating an advertisement.

As mentioned in section 5.1, the user requirements that had been given to us initially by our stakeholder, were considerable and sometimes overlapping. Therefore, we conducted contextual inquiries and a survey to try and make the information more clear-cut. One aspect of this was an extensive list of wool properties; we wanted to narrow down the number of fields a user had to fill in when selling wool, while at the same time making it easier for beginners to find the wool that suited their needs. We wanted to know if it was possible to determine properties, given another property. For example, if it was possible to determine what properties the wool had, if given the sheep breed. Learning about wool proved to be not as straightforward as we anticipated. The contextual inquiry showed that we had misjudged the amount of work required to structure the attributes, given the complexity of the problem, and time constraints we had for this project.

An alternative route explored in order to define an advertisement, was trying to pinpoint what properties the users considered to be the most important. The results of our investigation showed that practically every property was of interest. This made it very difficult to narrow down the number of properties needed, as well as determine which properties were not of interest.

Our web application handles all of the problems with using the Facebook group presented in section 4.2. As each creator of an advertisement fills in the same form, the difference in quality regarding advertisements is minimized. Filtering out advertisements in the Facebook group was considered a difficult task, but is made easier with our filter, which is designed specifically for the most common attributes of wool. As our web application also has a page for information regarding wool, it can prevent problems that arise due to the lack of knowledge surrounding the topic, as well as contribute to better advertisements.
11 Conclusions

The end result of the project was a fully functional prototype, more specifically, a web application, dedicated to buying and selling wool. The web application tackles the problem of localization, by highlighting advertisements on a map. Subjectivity when selling wool is counteracted, as all users have to fill in the same form when creating an advertisement. Integrated support for KRAV was implemented in the web application, however, it is not connected to an external database, for reasons specified in section 3.1. At the time of writing, no web applications fully dedicated to the buying and selling of wool exist.

Through the contextual inquiries, it was clear that there existed a steep learning curve when it came to properties of wool. There are a lot of attributes that a buyer has to take into consideration when buying wool, and the amount varies depending on the intended area of use. A person new to the field, may have a hard time knowing which attributes are important for them. The idea was to counteract this by creating a categorization system, i.e., dividing the wool into categories based on its properties and most suitable area of usage. This way, a beginner could more easily find the wool they needed, since they would not need to know exactly what all the different attributes meant. The objective was to find out what attributes a buyer believed to be important and how these attributes could be determined. This information was to be gathered through a survey. However, the information we managed to gather indicated that all attributes were of importance. This meant that there were a lot of different combinations of attributes. The many different combinations, provide the basis for personal opinions when selling wool. A categorization system would have helped counteract the subjectivity, a key factor in reducing the wastage of wool, by guiding the users when assessing their wool. From the contextual inquiries, we gathered that a minor change in attributes could alter the area of usage entirely, and that it would require more research, and time, to fully and accurately, determine the categorization of the wool.

12 Future work

From the user tests, it was clear that the web application conformed to the requirements. However, there were a few improvements that could be made regarding design-related aspects. They were:

- To enlarge the font size on mobile devices
- To move the create-advert button to the navigation bar
• To simplify access to the *my-adverts* page, by moving it to the navigation bar.

During one of the contextual inquiries, an interviewee highlighted an important aspect of using a Facebook group to buy and sell wool. The interviewee pointed out that a positive aspect of using Facebook was the community, i.e., the ability to ask other members questions regarding wool related topics. This is something that should be taken into consideration during future development. By giving our users the ability to help one another, by means of a forum or a chat service, the same positive social aspect of the Facebook group, can be achieved.
References


References


A  Contextual inquiry

When conducting the contextual inquiries, all users were asked a set of standard questions to gather further insight on topics regarding our web application. These questions led to valuable discussions, giving us more information on the topics we were studying. The standard set of questions were as follows:

- How many years of experience do you have in the wool industry?
- When selling or buying wool, what properties do you find the most important?
- What is your opinion on the current wool market?
- How would you solve the problem regarding the wastage of wool?

A.1  Summary of the interviews

We have used pseudonyms when describing the interviewees.

"Kim" is a farmer, situated in Uppsala, Sweden, with 10 years of experience in the wool industry. Kim owns approximately 90 sheep, consisting of the breeds Texel and Dorset. Kim focuses mostly on selling meat, seeing wool as a byproduct. The interview was conducted at Kim’s farm where we got to learn about the effects of the current wool situation from a sellers perspective. With the wastage of wool in the current market leading to a lessened value, Kim’s view was that spending time on preparing the wool to be sold, was not worth it. Besides Kim’s take on the current wool market, we were also shown different properties first hand, giving us further insight on things to take in to consideration when designing the marketplace.
"Shamon" is a farmer, situated just outside Uppsala, Sweden, with five years of experience in the wool industry. Shamon has three breeds of sheep on her farm; Roslagsfår, Gotlandsfår and Jämtlandsfår. Shamon focuses mostly on taking care of, and selling the wool. Therefore, when conducting the interview, we concentrated on the various properties of wool and the areas of usage. Furthermore, we discussed how certain breeds and/or properties of wool could be used to determine other properties.
"Tove" is a wool refiner with 40 years of experience in the wool industry. Tove buys all kinds of wool, from different sheep breeds, using it to spin the wool into yarn, which is then used to make a variety of products. Having dealt with wool of different qualities over a longer period of time, Tove had valuable knowledge regarding its properties. Tove had interesting thoughts on what was important from a buyer's perspective. With many years of experience in the wool industry, we discussed the situation regarding current wool market and problematic wastage. Tove also pointed out that there is a steep learning curve when it comes to wool; it takes beginners a lot of time before they understand what all the different properties mean. The importance of having high quality pictures of the wool to be sold, was a reoccurring subject. Given such a picture, Tove claimed that, a lot could be said about the wool and its properties. The interview with Tove gave further insight on aspects to take into consideration when designing the web application.
B Survey

With the wastage of Swedish wool being our primary focus, the people who participated in the survey were Swedish residents. Hence, the survey was conducted in Swedish.

Figure 12

Vad är du?

Figure 13
**Hur ofta köper du ull?**

68 svar

- 58.8% Varje vecka
- 16.2% Varannan vecka
- 22.1% Varje månad
- 16.7% Någon gång per år
- 27.3% Aldrig

**Figure 14**

**Hur stor mängd ull köper du vanligtvis?**

66 svar

- 51.5% 1 - 5kg
- 16.7% 5 - 20kg
- 27.3% 20 - 100kg
- 100kg eller mer

**Figure 15**
**B Survey**

1 - Inte viktigt, 5 - Väljligt viktigt

Figure 16

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1 - Inte viktigt, 5 - Väljligt viktigt

Figure 17
Hur viktigt är det att veta finfibrigheten på ullen?

1 - Inte viktigt, 5 - Väldigt viktigt

Figure 18

Hur viktigt är det att veta om det är helårsull eller halvårsull?

1 - Inte viktigt, 5 - Väldigt viktigt

Figure 19
Hur viktigt är det att veta längden?

- 1 (2,9 %)
- 2 (4,4 %)
- 3 (4,4 %)
- 4 (38,2 %)
- 5 (58,8 %)

1 - Inte viktigt, 5 - Väldigt viktigt

Figure 20

Hur viktigt är det att veta fårets ras?

- 1 (4,4 %)
- 2 (1,5 %)
- 3 (11,8 %)
- 4 (22,1 %)
- 5 (60,3 %)

1 - Inte viktigt, 5 - Väldigt viktigt

Figure 21
Hur viktigt är det att veta hur pass ren ullen är? Dvs om den exempelvis är fri från smuts eller smutsig.

68 svar

1 - Inte viktigt, 5 - Väldigt viktigt

Figure 22

Hur viktigt är det att veta hur skräpig ullen är? Dvs om det exempelvis finns växtrester eller tistlar kvar i ullen

68 svar

1 - Inte viktigt, 5 - Väldigt viktigt

Figure 23
B Survey

Figur 24

Hur viktigt är det att veta om ullen är tvättad?

1 - Inte viktigt, 5 - Väldigt viktigt

Figur 25

Spelar det någon roll för dig om ullen kommer från en tacka eller bagge?

Figur 25
Spelar det någon roll om ullen kommer från ett lamm eller får?

68 svar

Figure 26

Vet du vad microntalet säger om ull?

68 svar

Figure 27