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Abstract:

This project was faced with an issue of Danish spearfishers having difficulties sharing information with the community of Danish spearfishers, about relevant information such as fish caught.

In parallel, a citizen science project known as Fiskeatlas, were collecting similar to the information that the Danish spearfishers were likely and interested to share with the Danish spearfishing community.

In this paper a documentation of initiating and establishing collaboration between the Danish spearfishers and the scientists of Fiskeatlas, is described.

A scientific objective was gained and requirements for an application, collecting data contributed by the Danish spearfishers and delivered to the scientists of Fiskeatlas were established.

The project described in this paper, took the responsibility of developing an application, using recognized software development method and user experience experimentation for delivering a prototype in the end of this project.

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1 Introduction

The following section describes a user story about the problems faced by Danish spearfishers when hunting in Danish waters. The following user story will contribute with a motivation and problem approach for the development of a fully defined problem formulation in this paper.

A Friday evening in the middle of Copenhagen during September 2015, two spearfishers prepared their equipment for a hunting trip with the hope of bringing home sea trout and flounders caught at one of the Danish shores of Northern Zealand.
At 23.00 CET, the two spearfishers headed towards the coast. The ride was estimated to last about an hour before reaching the destination. The weather from the past three days had been changing and the two spearfishers were taking a chance and risk by traveling this far. The risk the spearfishers were faced in this situation was that the water at the coast could have a bad clarity for the two spearfishers to dive and see anything within. A situation like that typically calls an end to a dive. The chance the spearfishers took was that the clarity of the water was ideal to observe fish within, but there was no method of knowing how the water condition was for sure. This tendency of Danish spearfishers traveling these distances for spearfishing is quite common in Denmark.

During the preparations that the two spearfishers did before they drove, they checked the weather forecast of the day and the weather forecast for the previous three days. Checking the weather forecast for the previous days and the weather forecast of the day is commonly used to predict weather and water clarity with. Although, it is never certain that predictions are correct since no recognized method is used for predicting such a factor.
A prediction commonly made by spearfishers of water clarity is based on experience and not a measured parameter. Most spearfishers are able to estimate the risk of water being unclear with a slight accuracy. The water at the shores is influenced by many factors, which is hard to measure, just as weather forecasts in general.
At this point, there are no software applications that provide a measure of the waters clarity, similar to how general forecasts are made. In Denmark, general weather forecasts can be found on Danish Meteorological Institute (DMI) homepage (Danish Meteorological Institute, 1872) or using DMI's mobile application.

Before the two spearfishers drove towards the destination, they also checked social media for information about the weather conditions and the waters clarity close the location of where they were heading.
The reason for why the spearfishers were checking the social medias for information, was because of a large community of Danish spearfishers are sharing information such as; observed water clarity, fish caught and lost equipment at shores.

This social and informative Danish spearfishing community is especially represented in Facebook groups. An example of information shared by a Danish spearfisher within a Facebook group is illustrated in figure 1.

Figure 1 - Screenshot of a Danish spearfisher sharing an observation with other spearfishers on Facebook

The two spearfishers read on Facebook that the waters on the northern coast were most likely unclear. This information was difficult for the two spearfishers to find on Facebook since Facebook does not deliver a proper way of searching for such information. Mange groups about spearfishing are created on Facebook, but there is no rule or guide for where these observations are reported. Additionally, the display of the location of the information is not always precise since no recognized and standard methods are found within these Facebook groups about spearfishing.

The two spearfishers managed to find a spot with lesser cloudy water and brought back three sea trout's and one flounder.

Spearfishers are on each trip taking a chance and a risk that the dive will be called off because of low water clarity. Many spearfishers are sharing information about water clarity using social media, but there is no standardized method or platform existing to store and display these contributed observations in an intuitive way. This issue raised the following question - how could these contributed observations by the Danish spearfishers stored and displayed using a standardized and structured way?

An additional common tendency of the Danish spearfishers on social media is displaying latest catch made. It is a typical tendency which provides much information about fish diversity of the Danish waters. An example of a Danish spearfisher sharing information about the latest catch is illustrated within figure 2.

Figure 2 - Danish spearfishers sharing information about his latest catch on Facebook

Spearfishers benefit and become motivated from reading this information's of fish caught, made by other Danish spearfishers.

The question which then occur, is what is the spearfishers' motivation of this tendency to share observations and could the method of sharing and displayed these observations be improved?
With the interest of answering these two questions an investigation was performed with the focus on what the spearfishers' interest and motivation is for sharing observations with each other. The approach of this investigation had a broad focus by investigating the possibilities of sharing information in communities on the internet and not just among spearfishers.

1.1 Sharing Information

Sharing information with the rest of the world has become much easier since the beginning of the 90's. The reason is because of the accessibility, expansion and development of the internet (Ruthfield, 1995).
Users of the internet are sharing information such as cooking recipes, product reviews, personal opinions and information using the internet. The possibility of etc. managing a web domain and sharing information using a blog is possible for everybody who owns a computer.

The tendency of sharing information started centuries ago using newspapers. Although, newspapers was and is a media typically controlled by huge companies. Not many individuals had the possibility to share information.

Since the internet became available, in the middle of the 90th century, individuals with a computer and a digital skillset, was able to share all kinds of information using the internet and programming tools such as HTML and CSS.

The 21st century is the latest period in time where it has become much easier to access knowledge using the internet through smartphones, tablets, and desktops. An assumption of this paper is that the users' expectations and demand for easy accessible information has increased along with the development of the Internet. Additionally, the design standards of application and web services with great and intuitive user experience have an increasing user demand.

Now that this paper established that sharing information using the internet has in general become much easier in the 21st century, it is interesting to point the focus of this investigation at a category of typically uses by communities on the internet for sharing information. Social media is a category of the internet which is assumed in this paper to be one of the most used tools for communities to share information through.

Moving the focus of this investigation closer to a specific community roaming the internet and especially on social media is the spearfishing community found. This community is highly motivated and enthusiastic when sharing information on social media. Although a problem assumed in this paper is that the tools such as social media used for sharing information is not ideal for the spearfishers' specific need.
Disregarded the social media briefly, there are other tools available on the internet which allows spearfishers to share observations etc. spearfishers latest catch. It is possible to access the information through an application for displaying these observations. The solution implicitly being referred to is an interactive map application where it is possible to contribute four different types of observation categories using an interactive map. The name of the website hosting this interactive web application is known as UVjaegeren.dk. The specific name of the application displaying the observations made by spearfishers is known as Spot Kort (Torben Heimbürger and Søren Andersen, 2015). A screenshot of the application from the website is illustrated in figure 3.

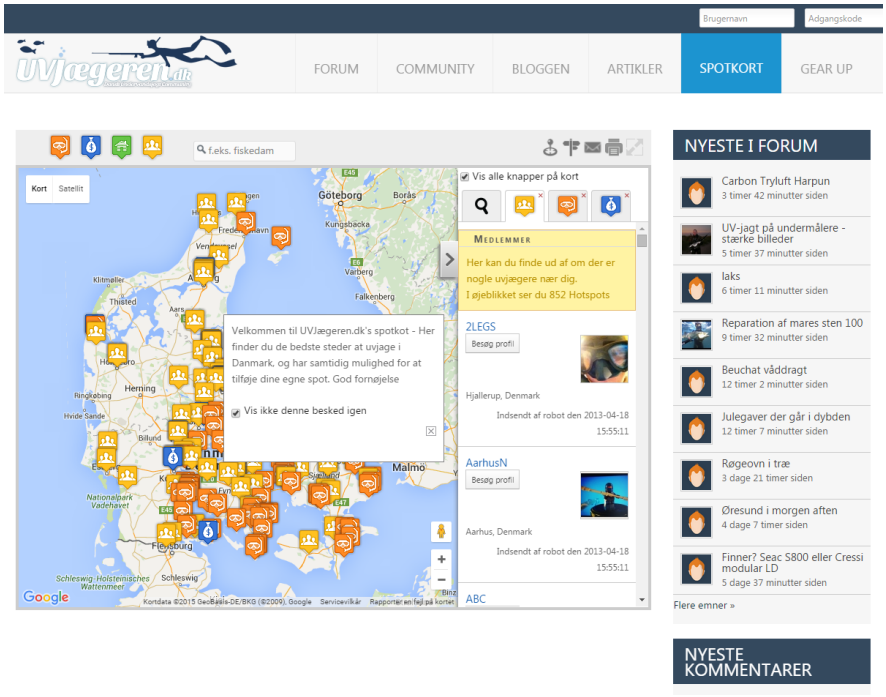

Figure 3 – Spot Kort hosted on the website named UVjaegeren.dk (Torben Heimbürger and Søren Andersen, 2015)

The functionalities of the application located on the website were primarily consisting of four different types of observations that can be contributed with and displayed on the interactive map. The four types of observations are following:

- Hunting locations
- Spearfishing gear shops
- Shelters and sleeping facilities near shores
- Location of the websites spearfishing members

It is an interesting choice of observation categories available within the application. The usability of all four categories are most likely not equally useful. The idea of using an interactive map as a solution for contributing and displaying observation made by Danish spearfishers is an interesting solution for this project.
Based on this brief and superficial investigation with a focus on user experience and functionality, it is certain to claim that the application named Spot Kort is suffering from bad user experience and technical bugs.
Spot Kort is not responding to some of the requests being requested when using the application. Additionally, the website and service are not fully optimized for mobile devices even though the website behaving responsively on mobile devices. If only this project were caring about the idea and innovation of the application on the website, the application would potentially have been this projects solution for enabling the spearfishers to more easily share observations among each other. Unfortunately, this application does fail in user experience and application functionality. The idea and innovative solution will however be benefited from further into this project.

The spearfishers' interest for making use of such an application to contribute observations with is only assumed and it will be beneficial to figure out what preferences Danish spearfishers have for contributing

and accessing observations. In order to answer that implicit asked question an investigation has been conducted and is within next section described in this paper.

1.2 Information & Knowledge Sharing

As mentioned, Danish spearfishers are a good example of a community of people who are sharing observations among each other. Spearfishers in Denmark are sharing information about various kinds of information relevant to other spearfishers. Based on that observation an investigation about information and knowledge sharing among spearfishers in Denmark was conducted the 12th of September 2015. The goal of the investigation conducted was to better understand what the unwritten rules and tendencies exist within the Danish spearfishing community. Basically, the questions of the investigation were asked to understand what information the spearfishers are sharing, what information they are not sharing and what restraints and challenges Danish spearfishers are facing when sharing information among each other.

1.2.1 Investigating Danish Spearfishers Interest

The 12th of September 2015, a link to a questionnaire developed and hosted in Google Forms (Google inc., 2015), was shared using three Facebook groups. The three Facebook groups had at that time point in time, the largest count of members compared to other Facebook groups about Danish spearfishing. All three Facebook groups are about spearfishing in different country parts of Denmark. The questionnaire shared, can be found in Appendix N.

Facebook groups included in this investigation are the following; UV-jagt Sjælland, UV-jagt Østjylland and UV-jagt Fyn. All three Facebook groups had at that point in time, the following count of members.

- 2.712 members (UV-jagt Sjælland)
- 2.760 members (UV-jagt Østjylland)
- 1.756 members (UV-jagt Fyn)

The questionnaire shared was composed by six open-ended questions and six closed-ended. In total there were 12 questions within the questionnaire (Appendix N – Information & Knowledge survey). The first three questions of the questionnaire had the objective to identify the participants' information of gender, age and the country part of where they were currently living.
The four following questions had the objective to investigate the reasons for the participants' tendency to share information and knowledge, what information and knowledge the participants liked to share and what they do not share with the spearfishing community.
The following three questions had the objective to answer what limitations the participants are experiencing when sharing information and knowledge.
The last two questions shared the objective of measuring how much preparation the participants are performing before going on a spearfishing trip. The data was collected using a semantic differential scale (Tullis and Albert, 2008).

The investigation ended the 13th of September 2015. 97 participants contributed their answers. The findings of this investigation will be the foundation to propose a problem statement based on the Danish spearfishers' answers and in collaboration with the ongoing investigation of theory and tendencies found within this introduction.

1.2.2 Findings

This investigation collected answers from 97 Danish spearfishers (n). The participants of the survey had a mean age of 32.5 years and an age interval between 16 and 62 years. The primary group of participants was males, which represents 98 % of the participants. The last 2 % or represented females.

The major group of participants was localized on either Fyn, in the city of Copenhagen and area or in eastern Jutland which was expected, since all three Facebook groups represented these regional areas.

95.9 % of the participants shares information with the spearfishing community. Information shared is according to the findings about water clarity. The motivation of sharing information and knowledge is typically motivated and engaged by being helpful spearfisher.

The main reason not choosing to share information and knowledge is the risk of other spearfishers abusing the knowledge. According to the data, the participants do not share information about their hunting areas and a smaller group of the participants do not share what they caught.

In one of the questions within the questionnaire the participants was asked what preparations they are performing before going on a spearfishing trip. A wide variety of preparation was mentioned, but mainly were the weather forecast studied. Measured on a scale, the participants answered that they are preparing for a dive, but more preparations could according to their answers be performed.

The participants were asked about the limitations they experience when sharing information and knowledge about spearfishing. The results indicated that the participants do not feel they are experiencing any limitations when sharing information and knowledge on a general level.

The participants was asked the same question, but more specific about sharing geographical information and knowledge, which resulted in a more wide opinion about the topic.

These findings provide an indication that the majority of the Danish spearfishers of this questionnaire are motivated and have an interest in sharing information and knowledge among other spearfishers. The findings also indicate that it is easy to share information and knowledge about spearfishing, but it is possible to improve the possibilities.

1.2.3 Making it easier to share information

Based on the findings from the questionnaire, it is possible to notice that spearfishers are sharing information and knowledge among each other and is motivated and engaged based on helpfulness. The way of sharing information through social media, such as Facebook, is instant and spearfishers can reach out to other spearfishers immediately. Although, it is assumed that sharing elaborate knowledge about etc. a specific location or fish caught is limited. Additionally assumed within this paper, storing and accessing data about spearfishing is also a challenging exercise since social media, such as Facebook, stores information in a chronological and not ideal way according to the way spearfishers' tendencies. Retrieving data is not easy if the information is old. Social media such as Facebook is an ideal platform for instant and immediate information and knowledge sharing, but when it comes to detailed sharing of observations and accessing older observations, it becomes a challenge for the spearfishers.

The following question is then occurring - how would an ideal solution for Danish spearfishers take shape in order to have a better user experience and also enable the spearfishing community to access stored observations without major challenges?
As the findings of the questionnaire highlighted, the Facebook groups are often updated with recent catches of fish, contributed by the spearfishers within the Facebook groups. It appears that observations

shared about catches are a frequent tendency which is also interesting to focus on within this project. Could the potential spearfishers' tendency to register fish observed or caught within Danish water be used for scientific purpose?

1.3 Contributing to Science

Considering the Danish spearfishers' motivation and engagement for sharing information and knowledge as well as the community's own demand for knowledge, this supply and demand could be channeled into solving a higher scientific issue or question. Additionally, it could also make it interesting and easier for spearfishers to share information and knowledge among each other.

Spearfishers in Denmark are sharing a lot of information and knowledge through the internet, which basically could be useful data processed using proper scientific methods. As the findings of the questionnaire indicate, the community of Danish spearfishers is sharing knowledge and is highly motivated to share knowledge because they want to help each other. If this motivation and engagement could be channeled in the direction of contributing this data using a framework for proper data handling, a potential great amount of data could be collected and could help etc. monitoring fish living in Danish waters.

Additionally, it is typical to find disputes between etc. spearfishers and regular fishermen. Common fishermen can sometimes dispute with spearfishers about what method of catching a fish is the proper method. A project that would benefit from spearfishers volunteer participation and contribute observation of fish observed as data to science could potentially make spearfishing appear ethically correct in fishermen's opinion and enhance the good reputation about spearfishing.

A question in this project then occurs based on the previous statement - what scientific purpose could this potential way of collecting data be serving and what framework should there be used which also could benefit the spearfishers own interest when collecting data?

1.4 Similar projects

To establish a project that enables spearfishers to contribute with etc. observations about fish it is interesting and beneficial to investigate if other projects also are making use of the public to collect data. With this interest there has been investigated other similar projects, which can be benefitted from in terms of structure such as governance, framework or data collection methods.

Three similar projects have been investigated which share same characteristics as this papers project. The projects investigated are known as NaturTjek (Danmarks Naturfredningsforening, 2015), BioBlitz (Statens Naturhistoriske Museum, 2015) and eBird (Audubon and Cornell Lab of Ornithology, 2002).

The two first mentioned projects named NaturTjek (Danmarks Naturfredningsforening, 2015) and BioBlitz (Statens Naturhistoriske Museum, 2015) are both projects established in Denmark. The third mentioned project named eBird (Audubon and Cornell Lab of Ornithology, 2002) is an international project active all over the world.

With these three projects reveal it is interesting to investigate what methods, frameworks or elements are used which could benefit this papers investigation.

1.4.1 Biodiversitet Nu

The Danish project named Biodiversitet Nu or translated into English is meaning - Biodiversity Now. The project is collaboration between the Danish Society of Nature and researchers from Copenhagen University and Aarhus University (Danmarks Naturfredningsforening, 2015).

Biodiversitet Nu is currently running and are planned to run from the year 2014 to 2020 (Danmarks Naturfredningsforening, 2015). The goal of Biodiversitet Nu is to provide new knowledge about the current status of Danish nature, by investigating and observing whether it goes forward or backward for selected animals, plants, fungi and habitats found within the Danish habitats (Danmarks Naturfredningsforening, 2015).
Biodiversitet Nu is involving the general public in the collection of data. The scientists of the project have selected some species and habitats based on scientific research which according to their research, could indicate how nature is doing regarding natural progression (Danmarks Naturfredningsforening, 2015). During the project's progress, volunteer participants are asked to make as many data contributions as possible of selected species and habitats. Every public individual is able to participate in the collection of data (Danmarks Naturfredningsforening, 2015).

Based on this description and the statement written on Biodiversitet Nu's website, it is certain that Biodiversitet Nu is a citizen science project (Danmarks Naturfredningsforening, 2015).

Biodiversitet Nu believes to provide a perspective of the biological diversity of the Danish nature. It is their objective to collect 150.000 data contributions every year from 2015 until 2020 with at least 1.500 yearly registrations in each municipality (Danmarks Naturfredningsforening, 2015).

In the year 2015 there will be established a basic knowledge based on the current contributed data and after two years of registrations the scientists will start concluding how the biodiversity in Denmark is progressing. These results will be used to inform local politicians, Danish officials and landowners to improve conditions for local biodiversity (Danmarks Naturfredningsforening, 2015).

The observation can be contributed with using a mobile application named NaturTjek (Danmarks Naturfredningsforening, 2015). This mobile application is available for both IPhone and Android mobile devices (Danmarks Naturfredningsforening, 2015). Volunteer participants are able to register what they observe while staying in the wild or returned to their home (Danmarks Naturfredningsforening, 2015).

This project is and will be highly inspired from and considered as part of state of the art. Since one of the objectives within this project is to involve the general public, the method could be learned from when involving the Danish spearfishers in this papers project.

1.4.2 BioBlitz

Another Danish project named BioBlitz is a project with a concept developed by Sam Droege from USA in 1996 (Statens Naturhistoriske Museum, 2015). The concept is flexible and basically involves volunteer participants in taking a snapshot of the biodiversity based on following conditions (Statens Naturhistoriske Museum, 2015).

- Joined observational hunt for animal species.
- Defined geographical area.
- Defined interval of time.

The concept of BioBlitz relies on the public, which is similar to the previous project investigated named Biodiversity Nu. Individuals which is well aware about the nature can invite other individual with lesser knowledge about the natural diversity, out together to find as many different species as (Statens Naturhistoriske Museum, 2015).

Project BioBlitz has multiple objectives. The two main objectives are primarily based on communicating data about nature's biodiversity and the registration of observed species found in nature. A more elaborate description is following listed (Statens Naturhistoriske Museum, 2015).

Communication - The objective to communicate the observed biodiversity or diversity, of a special nature habitat (Statens Naturhistoriske Museum, 2015).

Registration of species - The objective is to monitor nature (Statens Naturhistoriske Museum, 2015).

The secondary objectives are varied and more elaborate description is following listed (Statens Naturhistoriske Museum, 2015).

Learning - Teaching school children about nature and how to share interest and knowledge about nature, animal species or a natural area (Statens Naturhistoriske Museum, 2015).

Encouraging - The objective to create an interest of natural sciences using public meetings, researchers or other nature experts who are enthusiastic about nature (Statens Naturhistoriske Museum, 2015).

Citizen science - The objective is to utilize public contribution by collecting data for a scientific purpose (Statens Naturhistoriske Museum, 2015).

Social event – The objective is to gather scientists in events where they can meet other scientists who share the same interest in nature and diversity (Statens Naturhistoriske Museum, 2015).

Any individual is welcome to participate in a BioBlitz event (Statens Naturhistoriske Museum, 2015). Based on this information found on BioBlitz website, BioBlitz is also a citizen science project just as Biodiversitet Nu. In addition, BioBlitz is also a project managed by the same university (Statens Naturhistoriske Museum, 2015).

The concept named citizen science has so far appeared in two different projects involving the public helping to collect data. It is following interesting to if any international project also is utilizing the concept of citizen science and why?

1.4.3 eBird

The last project which is similar to this papers project focus is named eBird. eBird is a real-time checklist application that is available online, but not through a mobile application. eBird is a project about registering and accessing observation of birds (Audubon and Cornell Lab of Ornithology, 2002).

The project was launched back in 2002 by the Cornell Lab of Ornithology and National Audubon Society. eBird enables scientists to access a rich data source for basic information about occurrences and diversity of birds (Audubon and Cornell Lab of Ornithology, 2002).

The purpose of the project is to increase the applicability and accessibility of the high amount of bird observations made every year by amateur and professional bird observers. eBird is one of the fastest growing biodiversity data collection project existing (Audubon and Cornell Lab of Ornithology, 2002). In May 2015, volunteer participants registered more than 9.5 million birds all over the globe. After volunteer participants register an observation, the data are shared through eBirds global and digital community of educators, landowners, ornithologists and conservation biologists (Audubon and Cornell Lab of Ornithology, 2002). All observations registered will in the future be used to better understand the distribution of birds all over the world (Audubon and Cornell Lab of Ornithology, 2002).

The method eBirds is using is enabling volunteer participants to register bird observations using a checklist located on a eBirds website where it is possible to view the registration of several observation using database queries. The project is engaging volunteer participants by providing them a web based tool for recording their personal observations. This tool enables the volunteer participants to visualize their observations using etc. graphs. The web based tool is available in English, Spanish and French. Local scientists and bird experts are also prioritizing review of unusual observation contributions which is noticed by the system behind the application. This review of unusual observations is to maintain data quality and reliability of the data collected (Audubon and Cornell Lab of Ornithology, 2002).

Project eBird is also collaborating with local area partners who contribute with bird observations collected using the local area partners own data collection application (Audubon and Cornell Lab of Ornithology, 2002). With that arrangement, eBird is also targeting specific participants with a potential high level of expertise. These local partners may have different methodologies or more specific objectives compared to eBird (Audubon and Cornell Lab of Ornithology, 2002).

Compared to the previous mention Danish citizen science projects, eBirds appears to be a more extensive and comprehensive citizen science project. The possibility for local area partners to contribute with batches of observations is an interesting factor to consider in in this investigation since it could be relevant for this project.

1.4.4 Findings

The three previously investigated projects do all utilize citizen science as a concept. The possibility of benefiting from the public for collecting observations is ideal for this project's objective. The possible to apply the same concept in this project is ideal since the interest of sharing information among spearfishers is popular.
Citizen science is a potential concept which could be utilized with the community of spearfishing in Denmark. There is tremendous potential to include citizen science as a scientific method to gather observations about fish and other marine observations with. The questions then occurring is what is the specific requirements for a project being able to become a citizen science project?

1.5 Citizen Science – A Proper Concept?

Citizen science appears to be a recognized concept when benefitting volunteer participation for collecting observation as data. The interesting question then occurs - what is citizen science and could this concept be utilized with Danish spearfishers as volunteer participation?

Citizen science is a concept of research collaboration involving members of the public in scientific research projects to address real-world problems (Cohn, 2008). Citizen science differentiates from other ways of public volunteer participation in scientific studies etc. where volunteers contribute as less active parts such as participating as a test subject within a scientific study (Cohn, 2008).

Citizen science as a concept can manage work on a massive scale and generate data with a high quality which can result in trustworthy and valid scientific results along with unexpected revelations and insights (Trumbull et al., 2000).

Could the spearfishing community in Denmark become a part of a citizen science project or become a part of an already existing citizen science project?
The population of Danish spearfishers is highly qualified for being able to support a citizen science project since frequent observation and information are proved to be shared among the Danish spearfishers. The problem is though that establishing a citizen science project from the ground within the timeframe of this project can become a challenge. The alternative solution within this project could then be solved by enabling the Danish spearfishing community to become a part of an already existing and relevant citizen science project. However, a relevant citizen science project with an objective similar to the spearfishers interested is then needed to be found.

1.6 Merging Spearfishing and Citizen Science

The spearfishing community is missing a standardized method for collecting and sharing the observations made. Additionally, there are missing a scientific demand for the marine observations that the spearfishers can deliver. With the approach of revealing a project with the demand of collecting marine observations there has been searched for an existing citizen science project that would benefit from receiving observations as data provided by the Danish spearfishers. An already existing and current project localized in Denmark would be appropriate to merge the contribution of the Danish spearfisher community with.

1.6.1 Project Fiskeatlas

In 2006 a national project of mapping fish diversity in Danish waters was initiated. This project was and still is managed by the Danish Natural History Museum and University of Copenhagen. The project goes by the name of Fiskeatlas (Zoologisk Museum, 2006).

From the year of 2006 to 2009, Fiskeatlas was focusing on collecting data about freshwater fish. In 2009 this focus was broaden from freshwater fish to also mapping saltwater fish, which became the project's first priority in 2009 (Zoologisk Museum, 2006).
The motivation driving this project is based on the inadequate information available of the Danish saltwater fish diversity in Danish sea (Zoologisk Museum, 2006).
This is especially relevant for the majority of the saltwater fish species that are not subjects for commercial fishing. The information in the numerous reference books about fish is often reliant on outdated information. There is currently a demand for this information being updated and qualified (Zoologisk Museum, 2006).
The goal of Fiskeatlas as a citizen science project is to collect data about fish diversity which will be used for writing a book containing scientific knowledge about Danish salt- and freshwater fish (Zoologisk Museum, 2006). The Danish waters include a large number of habitats, from the deep-similar parts of Skagerrak to the almost fresh interior Baltic Sea. The Danish saltwater fish adapted to this large variation and therefore consists of many species (Zoologisk Museum, 2006).
Many of the Danish freshwater fish thrives in brackish water, it is not rare to encounter freshwater fish in the sea. During the history of time there have been registered 252 fish species in Denmark (H. et al., 2004). To the list of fish observed in saltwater there is a demand for adding information about the following species that have been appearing in Danish waters since 2004 which is following listed (H. et al., 2004).

- Round goby (Neogobius melanostomus)
- Sterlet (Acipenser ruthenus)
- Siberian sturgeon (Acipenser baerii)
- Diamond Sturgeon (Acipenser gueldenstaedtii)
- Vest Atlantic sturgeon (Acipenser oxyrhynchus)
- Sunfish (Lepomis gibbosus).

About half of the Danish saltwater fish are considered as guests who do not breed in Danish waters. Many of the new appearing species have come to Danish waters with help of human transportation (H. et al., 2004).
The Danish fish fauna contains barely 1% of the world's known fish but new fish has been appearing. Since 1981, there has been added 37 species to the list. The species that came to Danish waters by natural causes often comes from the Atlantic Ocean (H. et al., 2004).

Updating the scientific knowledge- and provide a more accurate understanding about the fish diversity in Danish waters, is two of the primary scientific objectives Fiskeatlas trying to complete (Zoologisk Museum, 2006). The project documented within this paper is motivated to contribute with observations to Fiskeatlas current database with the help from the Danish spearfishers volunteer participation.

Witten on Fiskeatlas website, the public is encouraged to contribute with larger amounts of data. Such a contribution can be arranged by contacting the Secretariat of Danish Natural History Museum (Zoologisk Museum, 2006). The researcher of this project contacted the Secretary of Danish Natural History Museum in order to discuss such an arrangement.

This citizen science project managed by the Danish Natural History Museum and University of Copenhagen is a much appreciated project by the government and also by the researcher of this project.
Motivated by this opinion this project offered the Danish Natural History Museum and University of Copenhagen to contribute to the project named Fiskeatlas, by developing a specific application for collecting observation made by Danish spearfishers. This arrangement is expected to consist of similarities with eBirds governance and arrangement by involving local partners, which is collecting data from specific populations of experts and volunteers participants.

The 19th of October a meeting with the project manager of Fiskeatlas was held, where an elaborate explanation of their project was provided for this projects understanding.
The method and procedure Fiskeatlas has been using for collecting data have based on a very manual method. The public have been able to contribute with observations about saltwater fish in Danish waters. The ways of collecting and contributing with observations have been possible in several ways. Observations of a fish in Danish waters can be reported directly by phone to Fiskeatlas scientists. The information of the fish caught has also been possible to send through e-mail.

The information Fiskeatlas have been requiring from previous contributions are listed as following:

- Specie of fish
- Location of fish observed
- Date of fish observed
- Method of how fish was observed
- Documentation of proof (Most reliable are images)
- Personal contact informaion

Fiskeatlas requirements for collecting data and receiving them were established during the meeting with the researcher of this project and Fiskeatlas scientists.
The requirements established by the project manager of Fiskeatlas for the application being developed in order to collect data with the help from the Danish spearfishers, was open for this project's researchers to design and develop. However the scientist of Fiskeatlas suggested that user experience should be prioritized in order to motivate the spearfishers using that advantage.
Additionally, the manager of Fiskeatlas had some additional requirements for the data being contributed with. A certain group of parameters is necessary to be entered by the volunteer participant when contributing an observation of marine species.

The parameters are listed as follows.

- Name of fish specie
- Number of fish
- Date of observation
- Name of participant
- E-mail of participant
- Precise location description (above water level)
- Habitat description (below water level)
- Latitude
- Longitude
- Documentation of fish caught
- Time stamp of report

The agreement of the meeting was to establish collaboration between Fiskeatlas and the researcher of this project. The collaboration of these two parties established the common goal of developing and implementing an application for Danish spearfishers to enable contribution of observations of fish observed in Danish waters, provided to Fiskeatlas database.

1.7 Problem Statement

With the potential interest of the two parties merging in a structured way of collecting observations about fish in Danish waters it is possible to join requirements of both parties participating within this project. The two parties which is necessary to meet the requirements and interest for is the spearfishers and project Fiskeatlas as illustrated in figure 4.

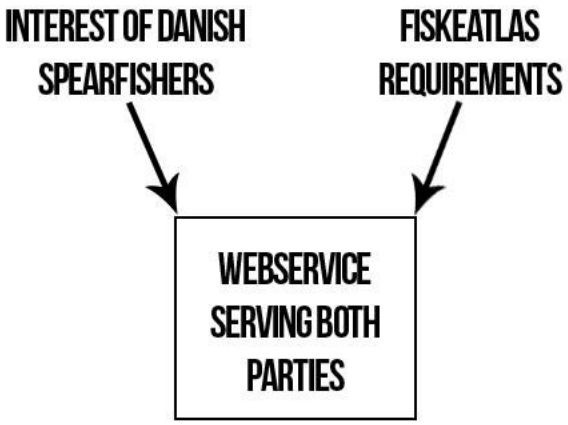

Figure 4 - Merging spearfishers and Fiskeatlas interest to complete a scientific objective

In order to development a successful application which is able to collect observations made by spearfishers and contribute the data to Fiskeatlas database, both parties requirements and interest is required to be met.

Based on the interest of both parties stated above it is following possible to establish a problem statement which will be the fundamental approach of this project's problem to solve. The problem statement formulated below will not be the same as the objective Fiskeatlas are trying to complete. This project will focus on benefitting from the spearfishers' interest in sharing information and making it easier for Fiskeatlas to collect the spearfishers' observations.

With that established approach the problem statement is formulated as follows.

"The scientists of Fiskeatlas are missing an optimized system which is able to collect observation about fish provided by Danish spearfishers. This system is required to meet the standards of a citizen science concept application and provide great user experience for the Danish spearfishers "

2 Analysis

With the established problem statement it is possible to approach a more thorough investigation and analysis, with a concrete focus on certain elements of citizen science, relevant for this project.

To benefit from the concept of citizen science, it is important to identify the concept in depth. The identification of the concept will bring focus on the benefits and challenges, which can help establishing a substantial tool for the Danish spearfishers as volunteer participants and the scientists of Fiskeatlas, by integrating the best elements of citizen science and dealing with the challenges in a proper way. The challenges recognized within previous documented citizen science projects, will be investigated, discussed and planned to be properly dealt with.
Another objective of this investigation and analysis is to learn from most recent uses and implementations of the citizen science concept. This investigation can potentially reveal how to avoid user experience issues related to existing reporting applications, which assumed will not be revealed by studying the citizen science concept in theory.
Additionally, there will be investigated the variation of concepts of citizen science when making use of technological tools, in order to achieve an innovative solution to solve the problem addressed within this project.
The final part of this investigation and analysis is to establish requirements for both Danish spearfishers and scientists within this citizen science collaboration.
In order to accomplish an ideal solution for both the scientists of Fiskeatlas and the Danish spearfishers, all their needs will be highlighted and documented using a certain method known as Rapid Application Development.

This investigation and analysis will begin by identifying the citizen science concept in depth.

2.1 Identifying Citizen Science

The objective of this project is to establish collaboration between the volunteer participants of this project and the scientists. In order to establish this collaboration, it is this projects responsibility to design and develop a service for the spearfishers to contribute with observations for the scientists of Fiskeatlas. To successfully do that while maintaining a citizen science concept it is necessary to understand the framework of the concept and become familiar with the benefits and challenges of the concept. The reason to understand this concept is to avoid designing and developing an etc. non-intuitive application, which does not meet both parties' requirements. Additionally, the major challenges of the concept will be elaborated and discussed for this project to establish concrete solutions.

2.1.1 What Is Citizen Science

First of all, citizen science is not the only term used to address the same concept. Citizen science is also recognized as; crowd science, crowd sourced science, civic science, volunteer monitoring, community science and networked science. This paper will keep using the term citizen science.

Citizen science has been used in practice for at least the past 100 years. The first registration and documentation of the concept being used, was by the Audubon Society's Annual Christmas Bird Count Survey, which started in the beginning of the 1900s (Cohn, 2008; Silvertown, 2009).
New volunteers are in these days still joining the participation of the same survey and about 60.000 to 80.000 volunteer participants joined the project, since the beginning of the 1900s (Cohn, 2008; Silvertown, 2009).

Since the first documented use of citizen science as a concept, the number of studies using this concept has increased (Cohn, 2008). The number of volunteer participants enlisted in citizen science studies has also increased and the scope of data collected over time has increased as well (Cohn, 2008). Based on this knowledge stated in the paper by Cohn, citizen science has become a popular concept during the past.

The concept can in one sentence be defined as a method for benefiting from the public in order to collect data locally, regionally and worldwide (Cooper et al., 2007; Devictor et al., 2010; Trumbull et al., 2000).
The collected data is typically analyzed to provide statistical insights in population trends, diversity range changes and shifts in nature's biology. The statistical results are normally published in scientific literature and used to inform authorities such as governments or United Nations (Bonney et al., 2009).

The concept is a form of study, which invites volunteer participants to join collaboration with scientists to solve a real scientific issue (Cohn, 2008; Dickinson et al., 2012; Wiggins and Crowston, 2011). In citizen science, volunteer participants are playing an essential part within the research as the contributor of data (Dickinson et al., 2010).
The volunteer participants, can be defined as a citizen scientist that contribute with data (Alabri and Hunter, 2010; Silvertown, 2009). However, citizen scientists and the scientists of the projects does not share the same scientific recognition within the scientific community (Alabri and Hunter, 2010; Silvertown, 2009). The scientific community recognize the volunteer participants different compared to the projects scientists.
The volunteer participants can also be referred to as field assistants. The field assistants, citizen scientists or volunteer participants, assist in monitoring, collecting and registering data about e.g. wild animals, plants or other environmental subjects (Cohn, 2008).
Typically do the volunteer participants not analyze the data contributed nor write scientific papers about the matter (Cohn, 2008). However, the volunteer participants are without a doubt an essential part of the data gathering process, which the concept is highly reliant on (Cohn, 2008).

Most volunteer participants joins a citizen science project, because they love the outdoors and are concerned about environmental changes and want to make an influential impact on the issue addressed. It is not typical that volunteer participants are paid for their participation (Cohn, 2008). The reason for participating within a citizen science project is typically because the volunteer participants are motivated by personal interest.

Citizen science can also be described as an improvement to more traditional scientific study concepts (Lee et al., 2006; Eden, 1996; Heiman, 1997; Au et al., 2000; Pattengill-Semmens and Semmens, 2003). There are major benefits from using citizen science as one approach for gathering data (Lee et al., 2006). The benefits will be further elaborated on later within this paper.

Citizen science is a concept which differentiates from other traditional science concepts, which includes public participation, where volunteer participants take less active roles. The role of the participant in a traditional study could be providing research facilities or computing power for scientific studies (Dickinson et al., 2010).

In addition, a definition of citizen science established within the paper by Rotman et al. addresses the theory about dividing citizen science projects into three different categories. The categories from the paper are established as follows.

Contributory projects - where the volunteer participants contributes with data to the citizen science project, designed by scientists (Rotman et al., 2012).

Collaborative projects - is designed by scientists were volunteer participants can contribute with data and also aid in the project design (Rotman et al., 2012).

Co-created projects - in which both scientist and volunteers are involved in all elements of the project (Rotman et al., 2012).

The project of this paper will most likely be categorized as a collaborative citizen science project, where the project is designed by the scientists, but the spearfishers will become part of the service design.

When summarizing all the facts that have been addressed, it can be stated that citizen science has a historical recognition and a potential powerful functionality of collecting data using public participation.

In addition to the theory supporting the definition of citizen science, it is also interesting to investigate and analyze the trends of the concept, in order to provide another perspective at the concept and not only from a theoretical perspective.

2.1.2 Citizen Science Trends

The trends over time in citizen science also highlight the benefits and challenges experienced by specific projects.
Citizen science has often been used as a form of informal science education or an outreach to promote public understanding of science, etc. initiated by governments. Experience with this model of science shows that, with structured research architecture and under the proper circumstances, citizen science can work on a massive and global scale, capable of generating high quality data that lead to reliable, valid scientific outcomes as well as unexpected insights and innovations (Dickinson et al., 2010).

An existing example of a citizen science project established in Denmark is the project named Opdag Havet which is initiated by World Wildlife Fund (WWF). This project is focusing on the marine ecological life which includes marine plants as well as marine fish found in the Danish waters (World Wildlife Fund (WWF), 2015).

A rising number and variation of citizen science projects are benefiting from the affordances and the efficiency of the citizen science concepts (Silvertown, 2009; Wiggins and Crowston, 2011).

A main pillar of ecological studies focusing on the conservation of biodiversity is benefitting from volunteer participation. Citizen science has become a popular method of research during the past decade, with the ability to monitor large-scale environmental changes using the benefits of the internet and the public (Dickinson et al., 2010). In addition, new designs and implementations on cell phones, web based- and responsive technologies are in a rapid progress, which makes it potentially easier to immediately validate observations registered (Burke, Jeffrey A et al., 2006).
Outdoor hobbyists are the typical volunteer participants for ecological studies, which are able to access learning material, collect data and register through a web based interface into a database, where results can be accessed and displayed using graphs and maps (Dickinson et al., 2010).
Data collected, using citizen science methods, is essential for the experimentation of a scientific hypothesis and assessing, which involves large geographic areas.

Scientific studies with data collected using limited participation and resources are often incomplete or outdated (Alabri and Hunter, 2010). Citizen science is a powerful and efficient research method when a more comprehensive data collection is needed. Additionally, citizen science project often provide increased public awareness of environmental issues (Alabri and Hunter, 2010).
Scientists resort to citizen science when monitoring ecosystems and protecting species under the threat of extinction (Alabri and Hunter, 2010). There has been an increase in the volunteer participation in citizen science projects. The success of research project using citizen science methods depends on the engagement of volunteer participation in the collection of data (Alabri and Hunter, 2010).

Becoming familiar with the trends of citizen science projects conducted over time, reveals benefits which has been made use of in previous citizen science projects. The benefits will follow be elaborated on in order to highlight the advantages of using this specific concept.

In contrary to the benefits there are also been highlighted challenges of the citizen science concept, which will also be further elaborated on after the benefits has been covered.

2.1.3 Benefits of Citizen Science

Citizen science brings many benefits to a project when implemented. There are following described and discussed some of the most beneficial advantages of citizen science.

As mentioned earlier, citizen science can complement and enhance more traditional scientific studies by enabling a great amount of volunteer participants to contribute with a high altitude of data (Lee et al., 2006; Conrad and Hilchey, 2011).

The citizen science concept engages a scattered population of volunteer participants. The benefit of enabling the use of a scattered population in citizen science projects is that the data reflects a larger geographical area (Cooper et al., 2007). Citizen science projects have earlier in history proven that animal species have been responding to the recent climate changes. Strong evidence of data was collected by a scattered participation of volunteers, which proved the benefit (Dickinson et al., 2010; Conrad and Hilchey, 2011).
Additionally, the use of the public and more specifically volunteer participants increases the efficiency of the budget. Citizen science do not necessarily lower the cost of a scientific study, but it can potentially increase the amount of data collected using the same budget as a traditional study concept (Alabri and Hunter, 2010; Conrad and Hilchey, 2011).
Another benefit existing within the citizen science concept is that the concept do typically lead to raised public attention about environmental and scientific issues (Alabri and Hunter, 2010; Conrad and Hilchey, 2011).
Since a large number of participants are involved, the concept brings a larger public audience which is likely to broadcast the findings of the project. The greater the public interest of the project is, the more likely the project becomes influential on etc. government policies (Couvet et al., 2008; Conrad and Hilchey, 2011).

Most relevant for this specific project, is that citizen science is particularly suitable for studying the effects of animal diversity of environmental loss which provide sufficient coverage of geographical studies. Using the data collected about species, such as quantity of species and migration tendencies, scientists are able to test hypotheses for which species will be affected by certain changes in geographical regions (Dickinson et al., 2010; Conrad and Hilchey, 2011).

2.1.4 Challenges of Citizen Science

In contrary to the benefits, citizen science also brings challenges to a project when the concept is made use of. Some of the challenges can be solved by scientific proven methods. Other challenges the project has to adapt to. There are following described and discussed the major challenges of citizen science.

The first challenge addressed of citizen science is the large amount of data collected which can become difficult to manage if no proper data management has been developed prior to the data collection phase. This challenge can also be experienced within other conducted citizen science studies and this challenge basically requires proper planning and management (Conrad and Hilchey, 2011).

Another challenge within citizen science is found within the scientific collaboration between the volunteer participants and the scientists of the project. The collaboration is shaped by a variety of factors, which involves social standards of science and disciplinary knowledge. The scientific work of citizen science is based upon a shared vocabulary understanding of methods and meanings, which is dependent on mutual

recognition of reputation, knowledge and competency. Reputation is critical for establishing collaboration between volunteer participants and scientists. Establishing a collaboration between volunteer participants and scientists of groups with different reputation in the scientific community can be difficult because the group with less reputation can end up perceive themselves less recognized within the scientific community (Rotman et al., 2012).

Additional and a more general challenge are being able to convince the volunteer participants that they are an influential part of the project. This issue is also related to the motivational challenge of the volunteer participants. This challenge is specifically challenging in citizen science projects where volunteer participants and scientists of the projects have different values, goals and criteria for reaching data quality and success of the specific project (Rotman et al., 2012).

Also is a challenge of the concept appearing when volunteer participants of a citizen science project are allowed to participate in the project, but are excluded from the later phases of the research, which prevents complete participation (Rotman et al., 2012).

One of the major challenges existing within the citizen science concept is the challenge of motivating the volunteer participants while also ensuring the quality of data reached, according to scientific standards (Rotman et al., 2012; Conrad and Hilchey, 2011).
The results from the paper by Rotman et al., reveals that there exists critical implication when designing tools which motivates volunteers to participate in a citizen science project and to establishing collaboration between volunteers and scientists in ecological citizen science projects. It is a critical importance that motivational elements are considered and implemented within the tools designed and created. Volunteer participants will be more engaged to participate in the collaboration of the citizen science project, when given the proper motivational elements at the right point in time (Rotman et al., 2012).

Another major challenge of citizen science is unreliable data or also referred to as data reliability, which is one of the major concerns existing. The concept allows regular citizens to join citizen science project without any requirements regarding scientific experience (Cohn, 2008; Crall et al., 2011).

When new volunteer participants within a citizen science project are recruited there is not a scientific recognized standard process of screening for bad intentions. The concept is naive in that sense. That being said, citizen science contains an inherent challenge. The potential anonymity, limited knowledge, expertise and training of the volunteer participants can result in poor data reliability and malicious data being registered (Alabri and Hunter, 2010). Lack of a scientific method and poorly designed methods for collecting data can lead to incomplete and inaccurate data (Alabri and Hunter, 2010).
The issue of unreliable data is one of the challenges, which will be further addressed, discussed and processed a solution for later within this investigation and analysis.

The last major challenge of citizen science addressed is recognized as low data quality, which appears similar to the challenge of unreliable data, but the challenge about data quality is different (Alabri and Hunter, 2010).
Collecting data for a scientific reason, there are often several parameters which need to be included within a contribution of data. As an example, when reporting an observation of an animal, it is most likely not sufficient to state that a specific animal has been observed. Some scientific parameters has to be included

which could be a geographical location of where the animal has been observed. Data quality can be increased in levels, which means that more documentation of the observation being provided, the more certain the observation can be trusted.
Requiring a lot of documentation from the volunteer participants can in contrary demotivate the volunteers within the participating of the project, because the process of contributing with observations is too comprehensive. The issue of data quality will also be elaborated on within this paper and a proposed solution will be presented.

2.2 Motivation

One of the major challenges mentioned when identifying citizen science, is motivating both the volunteer participants and the scientists of the project. Motivating the volunteer participants to continue contributing data is a difficult task. Money is no solution in this concept. The motivation has to arise from other factors. These factors have been defined by other papers studying the challenge of motivation within citizen science.

Only a small amount of citizen science projects have been able to establish a total collaboration between volunteers and scientist which is sustainable. Volunteers have successfully been providing data for a period, but the motivation over time has been lost (Rotman et al., 2012).

To establish and maintain a more sustainable collaboration between the scientists and the volunteers, the achievement the concept needs to reach the needs and requirements of the volunteer participants and the scientists (Rotman et al., 2012). In order to do that, it is necessary to understand what motivates each of the two parties.

An investigation by Nov et al. of volunteer participants motives, suggest that citizen science projects needs to focus on the volunteer participants engagement within the project and the goals of the project (Nov et al., 2011). The method suggested, is about communicating the project's goals and achievements through a media platform, where the volunteers would notice it (Nov et al., 2011). The media platform can most likely be similar to - or a social media. An intrinsic or personal motive of the volunteer participants is emphasized by Nov et al., implies a demand to design and develop a gamification based solution (Nov et al., 2011).

In addition, a paper by Rotman et al. establish four categories of motives for social volunteer participation in order to understand a common goal for the volunteer participants in order to stay engaged within the specific project. The four motives following defined as:

Egoism - The first motive named egoism, is relevant when the final objective is to increase the individual's own welfare (Rotman et al., 2012).

Altruism - The second category named altruism has the objective to increase the welfare of another individual, or group of individuals (Rotman et al., 2012).

Collectivism - Collectivism has the objective to increase the welfare of a group which the individual belongs to (Rotman et al., 2012).

Principlism - The last category named principlism has the objective to keep the volunteer participants interested in one or more principles which is personally important for the participants (Rotman et al., 2012).

The first category mentioned named egoism appear as the most appropriate motivation to consider when designing for the Danish spearfishers within this project. Principlism could although also fit into the behavior of the Danish spearfishers.
The investigation of the motivational factors made by Rotman et al. concluded that both volunteer participants and scientists are primarily motivated based on egoism to continue the collaboration and continuing the participation of a project (Rotman et al., 2012).
The results of this investigation can be benefited from, within this project. Developing an application which provide data for the project Fiskeatlas, but also displays the data to the public could maintain the volunteer participants' egoism to stay engaged and motivated within the project.

Also revealed, was that the scientist want to advance science and improve their own career. In comparison, volunteer participants want to participate in scientific studies motivated by personal interest, curiosity and commitment, which is also revealed by Rotman et al.
The volunteer participants motivation is temporal, dynamic and will change although the scientific goal remains the same during the process of the project (Rotman et al., 2012).
The paper by Rotman et al. states that two specific points in time require special attention to maintain the volunteer participants' engagement.

Initial encounter - The first point in time, is the initial encounter between a volunteer participant and the specific scientific project (Rotman et al., 2012).

End of project - The second point being the time where the project ends and the volunteer participants need to consider whether to continue contributing to other projects or stop participating in any projects (Rotman et al., 2012).

Both points in time, is where the motivational influences are most significant (Rotman et al., 2012).
Knowing the right motivations of the volunteer participants and being able to maintain them can result in increased collaboration between volunteer participants and the scientists (Rotman et al., 2012).

Based on the previous findings from the paper by Rotman et al., there has been established certain topics for motivational factors which is necessary to consider when designing for citizen science projects.
Following topics should be considered according to Rotman et al.'s results.

Timing - ensuring the proper motivational factors are considered and used at the right point in time during the project's process. Ideally a functionality of the application should be able to identify situations where the volunteers declines or can decline participation, and then enable proper motivational factors for them to stay engaged and motivated (Rotman et al., 2012).

Highlighting data use - the application designed and developed, is expected to inform the volunteer participants where the data is used, how the data is used and to what extent the data is being used for. This is for providing the volunteer participants with feedback about the contributed data (Rotman et al., 2012).

Locality - the application is expected to inform the volunteer participants what purpose and impact the data will have for the local environment which they are interested or concerned about. This factor is recognized as a catalyst for the volunteer participants' continuous involvement (Rotman et al., 2012).

Synergy - establishing common standards for a collaborative citizen science project that will utilize local area for mass efforts of the volunteer participants (Rotman et al., 2012).

Matching scientists, volunteer participants and tasks - resolving geographical obstacles by establishing a common platform for citizen science projects where scientists can create achievements for volunteer participants, based on their need for data.

Breaking task into smaller scale "building blocks" - compatible with the geographically local based projects, minor building blocks allow volunteer participants to find task which could fit to their interest and increase their engagement for a longer period of time (Rotman et al., 2012).

The mentioned solutions will potentially help keeping the volunteer participants motivated for contributing with data for the citizen science project. What is also necessary to remember is maintaining the scientists' motivation for continuing the work, by providing them with tools within the system for engaging their participation.

2.3 Data Reliability

Addressed as one of the other main challenges, unreliable data is one of the major weaknesses which citizen science brings to a project. It is necessary to understand with the scope of this data unreliability can reach in order to prevent it from occurring and influencing the data collected. It is also important to investigate how it could be possible to avoid data being unreliable by implementing security measures. It is therefore necessary to make use existing and recognized security measures such as data inspections and solid data reporting frameworks. Several methods will following be addressed and discussed. Data unreliability is seen as one of the main risk found within citizen science. It is therefore beneficial getting as familiar with the problem using elaborate investigation of the potential magnitude of this potential problem.

2.3.1 The Importance of Data Reliability

Used as an example to explain the issue of data reliability - Fiskeatlas are inviting volunteer participants to participate within the collection of data about saltwater- and freshwater fish. The data contributed with is mainly contributed by fishermen, free divers and scuba divers who are sharing a common interest and concern about the ecological fish diversity of Danish waters. These groups of volunteer participants are presumably motivated to contribute with reliable data, because they are also interested in the water habitats and fish diversity being preserved.
A potential worst case scenario could be volunteer participants with bad intentions who would provide wrong information about fish observed. Providing unreliable data could be personal or professional motivated, because of etc. project competition or political involvement. This worst case scenario will most likely not take place, but realistically this is a relevant challenge and a threat to a citizen science project.

Focusing on a more plausible bad case scenario is when volunteer participants are contributing with incorrect data because of missing knowledge about etc. wrong species of fish observed (Crall et al., 2011). As an example, it can be difficult for an amateur fisherman knowing if he caught a salmon or sea trout. Both species look a lot alike and sometimes it can be a few pair of fish scales which makes the difference between two species.

The last potential bad case scenario being addressed can either be typos or more commonly human errors when volunteer participants are contributing observations (Alabri and Hunter, 2010).

It is most likely not possible to prevent all unreliable data challenges without sacrificing some of the benefits citizen science possess when collecting data. It is although important to implement security measures for avoiding most of the potential unreliable data contributions made by the volunteer participants.

2.3.2 Securing Data Reliability

The risk of data unreliability has been acknowledged in previous sections and it is important to investigate and discuss what is possible to do within a citizen science project to avoid unreliable data from being contributed. This risk can be reduced by implementing or perform certain security measures during a citizen science project.

The study by Crall et al. suggests various considerations to be made and methods to be used during a citizen science project development (Crall et al., 2011).

Training and information vouchers - One of the methods which is suggested by Crall et al. to secure the data reliability, is extended volunteer participant training and information vouchers found within the contribution process. As Crall et al. states, the rate of misidentification dependent on the identification difficulty of a given specie (Crall et al., 2011). Fish can be hard to distinguish the difference between when two species are looking alike. This method is highly relevant for this project to consider.

Geolocation - Another method suggested by Crall et al. is utilizing the use of geolocation. Most personal and technological devices are able to track the geographical location (Crall et al., 2011). Stated in the paper by Crall et al. - their volunteer participants did not have any experience with GPS use, but the volunteer participants turned out to use the GPS tool with success (Crall et al., 2011). Using the GPS location as suggestion for the volunteer participants must be considered when the requirements for the application are being established.

Consider participant certification - The paper by Crall et al. also suggest future citizen science project to consider a certification process for volunteer participants (Crall et al., 2011). Enabling a certification for the participants could benefit a more reliable data contribution and also prolong the long term commitment of the volunteer participants.

Consider participant grouping - Another suggestion made by Crall et al. is grouping individuals based on experience (Crall et al., 2011). This consideration could be valid and useful when spearfishers are involved. Some spearfishers has years of experience than others do not. Grouping spearfishers could make predefined reliability factors available before the scientists of Fiskeatlas are assessing the contributed observations.

2.4 Data Quality

Previously addressed and described is the challenge of data reliability and also relevant for the contributed observation is the data quality being discussed in this section. In citizen science projects there commonly a standard of the data's quality, which is typically established by the scientists managing the project. The purpose of this data is used to solve a scientific objective by etc. revealing ecological diversity. This is only possible with data providing a certain high amount of data quality.

As mentioned within the previous topic about unreliable data, it was discussed that poor training, knowledge and expertise of volunteer participants can lead to unreliable data, but it can also affect poor quality of data being submitted (Alabri and Hunter, 2010).

In the paper by Alabri and Hunter there is a certain model provided as a tool for improving and measure the level of data quality using subjective and objective evaluation of data submitted. This framework will also enable trust among volunteer participants of an online citizen science community to be measured, deduced and summarized to create trust metrics for data contributed based on its origin (Alabri and Hunter, 2010).

The framework referred to is known as MIT's Total Data Quality Management (TDQM) which originated from industries need for high quality data sets. The general objective of this TDQM framework is to establish a theoretical basis and to improve data quality over time (Richard Y. Wang et al., 2002).

Three major elements establish the fundamentals of this TDQM framework which is:

- Definition of data
- Analysis of data
- Improvement of data

The first element focuses on the definition and measurement of data quality. The second element focuses on defining and calculating the impact of poor data quality and the benefits of high quality by analyzing this risk and chance. The third element focuses on improving the design of the data collection method and implementing new solutions to improve data quality (Richard Y. Wang et al., 2002).

An illustration of the model can be seen in figure 5.

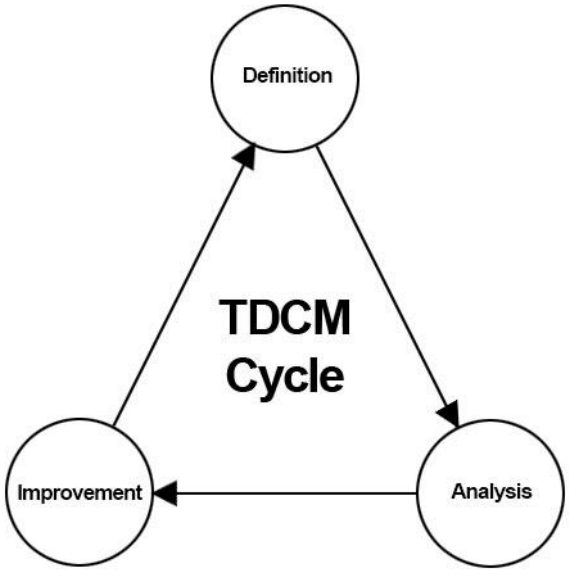

Figure 5 - TDQM Cycle (Richard Y. Wang et al., 2002)

The understanding of "data quality" can appear obvious, but data quality is not well defined within the current citizen science concept. MIT revealed that data quality has a variety of dimensions for scientists who include accuracy, trustworthiness, relevancy and timeliness. This implicitly means that a clear and

consistent definition of data quality metrics is currently needed to be established for each individual project (Richard Y. Wang et al., 2002).

Mentioned within the introduction of this paper, the citizen science project; Fiskeatlas initiated in the beginning of 2006 the collection of observation about fish diversity and over many years the project have collected thousands of observation from volunteer participants. At this point in time Fiskeatlas has established a standard of parameters required when registering an observation, which contains a high amount of data set quality. Following is a list provided by Fiskeatlas project manager, which ensures the quality of an observation. See following list which contains the mentioned parameters.

- Name of fish specie
- Number of fish
- Date of observation
- Name of participant
- E-mail of participant
- Precise location description (above water level)
- Habitat description (below water level)
- Latitude
- Longitude
- Documentation of fish caught
- Time stamp of report

The listed parameters is the minimum required parameters which is needed to be provided by participants for Fiskeatlas citizen science project and is required to be implemented within the application which will be designed and developed in this project.

2.5 Recognized Citizen Science Frameworks

Besides the areas of challenge and benefits of the citizen science concept, there are also conducted an investigation of recognized frameworks which could benefit and influence this project's design, development and management. Several recognized governance structures is following uncovered, investigated and discussed in order to provide a proper governance structure for this citizen science project.

2.5.1 Governance Structures

There will following be provided a description of several governance structures established by Conrad and Hilchey, which enables certain advantages and disadvantages when applying one of the governance structure models. One of these governance structures will be identified with this papers project and used for this project's future management.

Consultative/functional – This governance model is led by the government and run by the community. Basically, the government recognizes the scientific issue and establishes community based monitoring groups to observe the issue. The main advantage about this governance structure is the possibility for long-term data sets because of high budgets and great public awareness. The disadvantage is that this governance structure is dependent on government funding which can change depending on decisions being

made externally and independent from the projects management. Another disadvantage of this governance structure is the small amount of diverse stakeholders connected to the project (Conrad and Hilchey, 2011).

Collaborative - This governance model involves a diverse variation of stakeholders leading various perspectives of the project. The stakeholders can also be private individuals. This model is not politically motivated. The advantage of this collaborative governance model, often possess more decision making power from the stakeholders which widens the work boundaries of the citizen science project. On the other hand, the disadvantage is that the project results are typically not published and presented to the public (Conrad and Hilchey, 2011).

Transformative - The Transformative governance model is a community managed and funded model. The community recognizes the scientific issue and is trying to get the government's attention. The advantage with this governance structure is that it can be successful with the community and stakeholders support. The disadvantage is that the stakeholders and community involved may not be diverse which can result in bad credibility and capacity issues. This type of model can also conflict with certain government laws (Conrad and Hilchey, 2011).

2.5.2 Findings

The type of governance structure implemented within this project is based on Fiskeatlas initiative which pre defines the project as a Consultative/functional governance structured project. Although, the initiative by this papers project converts the project into more Transformative governance structures project by involving the community on trying to get the government's attention.

2.6 Related Work

In previous sections of this investigation and analysis chapter, there have been addressed several theories of elements essential for establishing a proper citizen science project.

Another perspective that is interesting for this project is highlighting what other current citizen science projects or similar projects have implemented and experienced during the past years. With the interest of learning from current projects, there has been investigated and analyzed four other projects similar to the project documented within this paper.

The four projects, which following will be addressed, are utilizing some of the theory discussed in this paper. Two of the projects, one named NaturTjek and another named Opdag Havet is actual Danish citizen science projects, where the third being an international citizen science project named eBird which is also previous addresses within the introduction of this paper. The Fourth project being addressed is not recognized as a citizen science project, but is still relevant for this project to learn from, since it involves the Danish spearfishers. The benefits and challenges of these four projects will be experienced from during this investigation and analysis.

2.6.1 NaturTjek

A citizen science project currently running from 2014 to 2020 is the project named Biodiversitet Nu or Biodiversity Now when translated into English (Danmarks Naturfredningsforening, 2015). The project has been addressed earlier within the introduction of this paper. It is at this point interesting to investigate and analyze how well this project is handling the theory uncovered in this analysis.

Briefly mentioned about Biodiversitet Nu is that it has been granted 13 million Danish kroner in order to establish a citizen science project with collaboration between the Danish Society of Nature and researchers at the University of Copenhagen and Aarhus University (Danmarks Naturfredningsforening, 2015).

The method Biodiversitet Nu is using for engaging and motivating the public is through social media. Illustrated in figure 6, Denmark's Society of Nature Conservation established a Facebook page. This Facebook page contains recent updates from the Biodiversitet Nu project. Indicated in area 1 of figure 6, there is a link to the mobile application which makes it possible for the visitors to go directly from the Facebook page to the application.

Figure 6 - Screenshot of NaturTjek's Facebook page

Also illustrated in figure 6 area 2, the project is reached 54.190 Facebook likes. This makes it possible for the project to immediately reach and inform a major group of volunteer participants using Facebook. In field number 3 of figure 6, there are frequently updated recent events or status of the project. This is also an efficient feature to for updating interested participants of the project. Goals and milestones could be communicated using this functionality.

Biodiversitet Nu is clearly making use of the theory of motivational factors for engaging the public to keep contributing observations for the project by utilizing this Facebook page.

Another method Biodiversitet Nu is working according to the theory of motivating the public is using an overview of data registered in each municipality as illustrated in figure 7.
In this papers opinion, this is a type of gamification which has been utilized in order to challenge the regional parties in Denmark against each other. An illustration of the website with the municipality challenge is seen in figure 7.

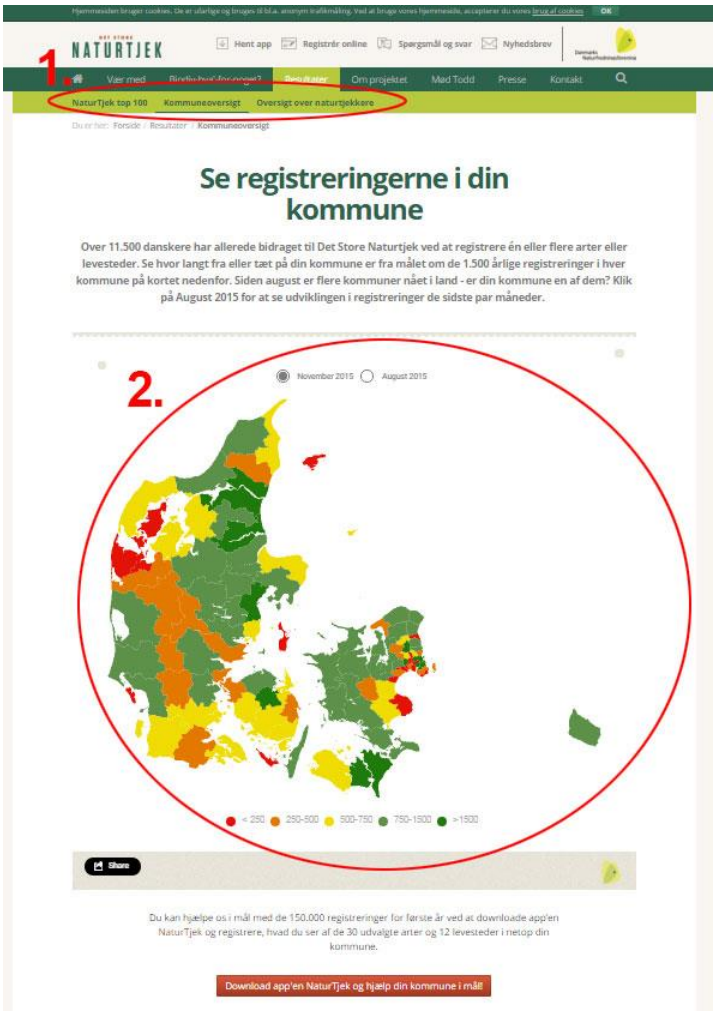

Figure 7 - Screenshot of NaturTjek's municipality challenge on their website (NaturTjek, 2015)

In area 1 if figure 7 there is located a group of links to pages with content that enable the visitors to find certain motivational features implemented on Biodiversitet Nu's website. This is in theory increasingly efficient for the volunteer participants' engagement and motivational interest to continue participating. Within area 2 of figure 7, the actual municipality overview is located. This will according to theory also increase the volunteer participants' motivation to stay participating within the citizen science project.

Biodiversitet Nu have also established requirements for the amount of observation collected in order to provide a trustworthy description of the ecological diversity found in Danish nature.

Biodiversitet Nu requires at least 150.000 observations registered from 2015 to 2020 with at least 1.500 yearly registered observations from each of the 98 municipalities existing in Denmark (Danmarks Naturfredningsforening, 2015).

Although, reviewing the total amount of registrations shown within the mobile application illustrated in figure 8, the objective is most likely not possible to reach in 2015. The current amount of observations this year will possible not be reached. The amount of total observations divided by the total amount of municipalities shows that in average only 850 observations have been contributed with and only one and a half month left of the year (Danmarks Naturfredningsforening, 2015). However, the amount of observations contributed to Biodiversity Nu is still useful data in that amount. The project is relatively new and more public attention will most likely appear over time.

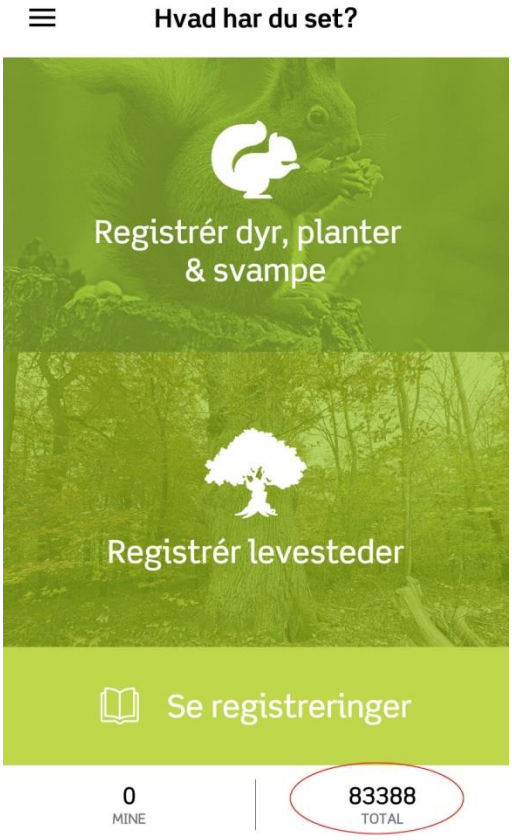

Figure 8 - Screenshot of Biodiversitet Nu's mobile application named NaturTjek (NaturTjek, 2015)

The reason for Biodiverstitet Nu' not reaching their objective of 1500 for each municipality this year, could be the public's lack of personal interest and the volunteer participants' egoism are not maintained properly. Also, the application is not available using a browser. This means that it is not possible to register observations through a desktop.

2.6.2 Opdag Havet

Another citizen science project investigated in this paper is currently running in Denmark and very related to this project is named Opdag Havet or Experience the Sea when translated to English. This project has been initiated and established by World Wildlife Fund (World Wildlife Fund (WWF), 2015).

In collaboration with scientists from the center of macro ecology, evolution and climate at the University of Copenhagen, the World Wildlife Fund is analyzing registered data. This data will reveal the state of biodiversity and environmental condition in various habitats as well as mapping specific species found at sea (World Wildlife Fund (WWF), 2015). This project is also much like the previous project named Biodiversitet Nu.

WWF's objective of their project is to collect data about ecological diversity in Danish water in order to highlight sea areas conditions and biological diversity. The application used for this project has the possibility for volunteer participants to register observations of about 75 species (World Wildlife Fund (WWF), 2015).

This project is also making use of social media in order to reach the public with etc. motivational challenges. Indicated in area 1 of figure 9, Opdag Havets' Facebook page contains a link for their mobile application, which makes it easy for visitors to find the application from the Facebook page. This is similar to what Biodiversitet Nu also utilized their Facebook page for.

Also indicated in area 2 of figure 9 the amount of followers of the page is also displayed. This display of followers is a mandatory feature when creating a Facebook page, but the functionality provides a quality stamp for the project of the amount of Likes is high. The high display of followers indicates a public recognition of the project. However, the amount of Facebook Likes Opdag Havet has is low compared to project Biodiversitet Nu. Also indicated in area 3 of figure 9 is a direct link for Opdag Havets' website is displayed.

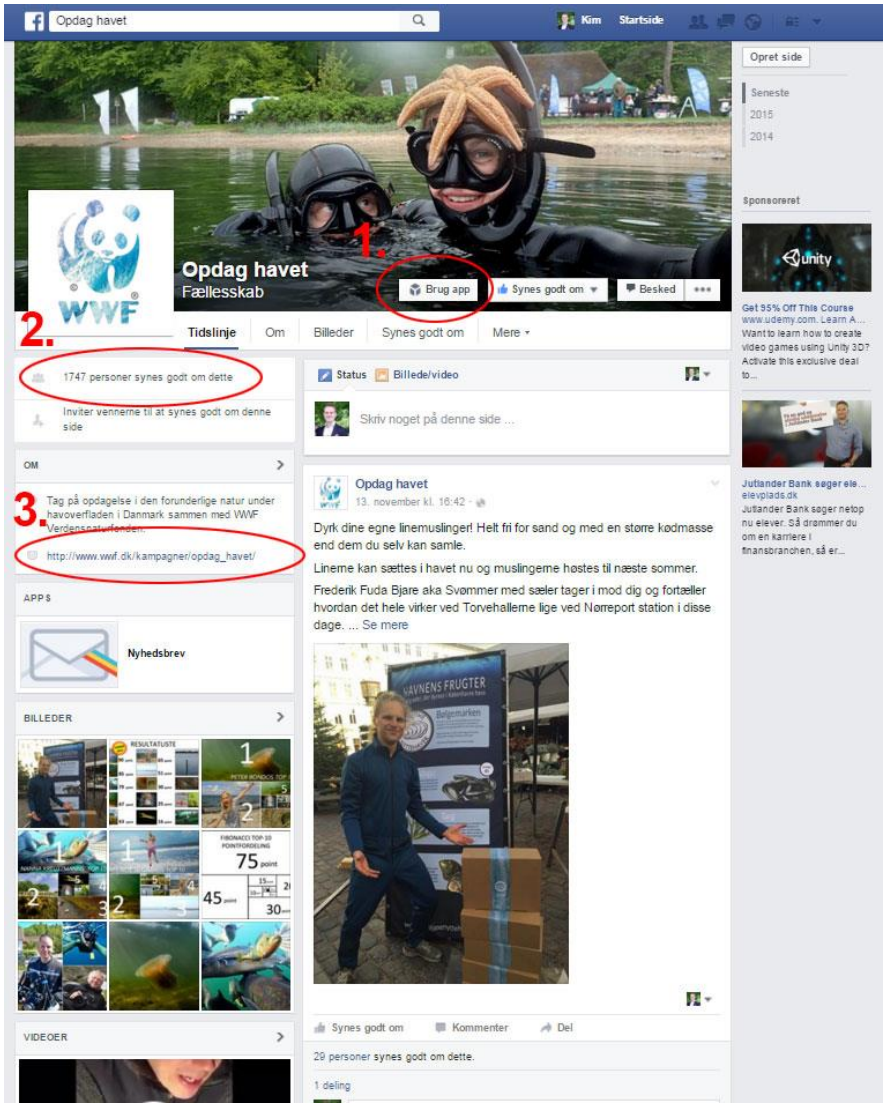

Figure 9 - Screenshot of Opdag Havets Facebook page (World Wildlife Fund (WWF), 2015)

Opdag Havet is not making use of any gamification functionalities. The application is strictly a reporting system, where volunteer participants are able to report or review their observations.

Within figure 10 a screenshot of the Opdag Havets' website is illustrated. This page on the website contains a brief and concrete description about the objective of the project.
Compared to Biodiversitet Nu – Opdag Havets website and project in general do lack some motivational factors for engaging visitors of the website and volunteer participants. Indicated in area 1 of figure 10, a link for both the Apple and Android mobile application is listed.

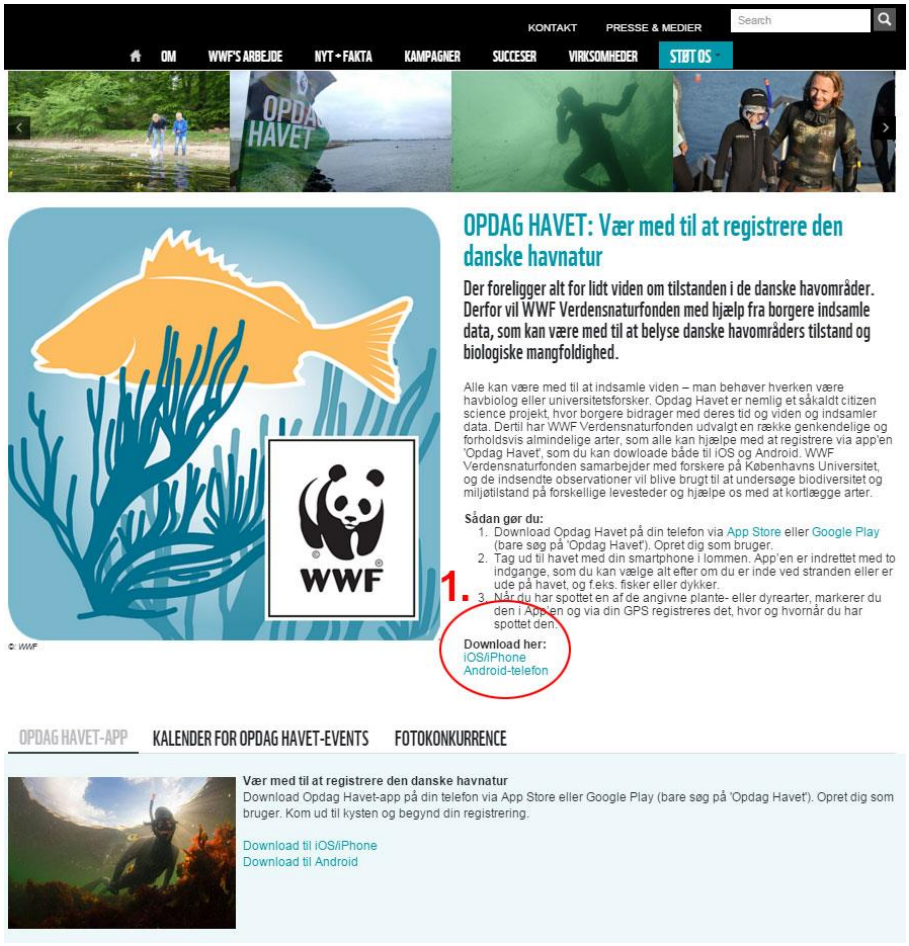

Figure 10 - Screenshot of Opdag Havets website with links for the mobile applications (World Wildlife Fund (WWF), 2015)

The project named Opdag Havet by WWF is a potential popular citizen science project. However, this paper believes that the project complicates the volunteer participants limiting the list of species able to report. This limitation could be the reason why only 1750 registrations have been provided by volunteer participants at this point in time. The lack of motivational factors such as gamification elements is possibly some of the major reasons why this project is not benefitting from the highly developed application for mobile devices.

2.6.3 eBird

Mentioned earlier within this paper's introduction, eBird is an experienced citizen science project originating from 2002 as a digital web based project, but has roots from the beginning of 1900s and is one of the oldest citizen science projects (Cohn, 2008; Silvertown, 2009).

eBird is making use of the technological benefits available on the internet. On eBirds homepage ebird.org it is possible for all individuals to register as a volunteer participant (Audubon and Cornell Lab of Ornithology, 2002). No exclusion or inclusion criterions are required except being able to access the internet.

When a user has been registered, the project makes it optional for registered participants to enter personal information such as home address. The form is illustrated within figure 11.

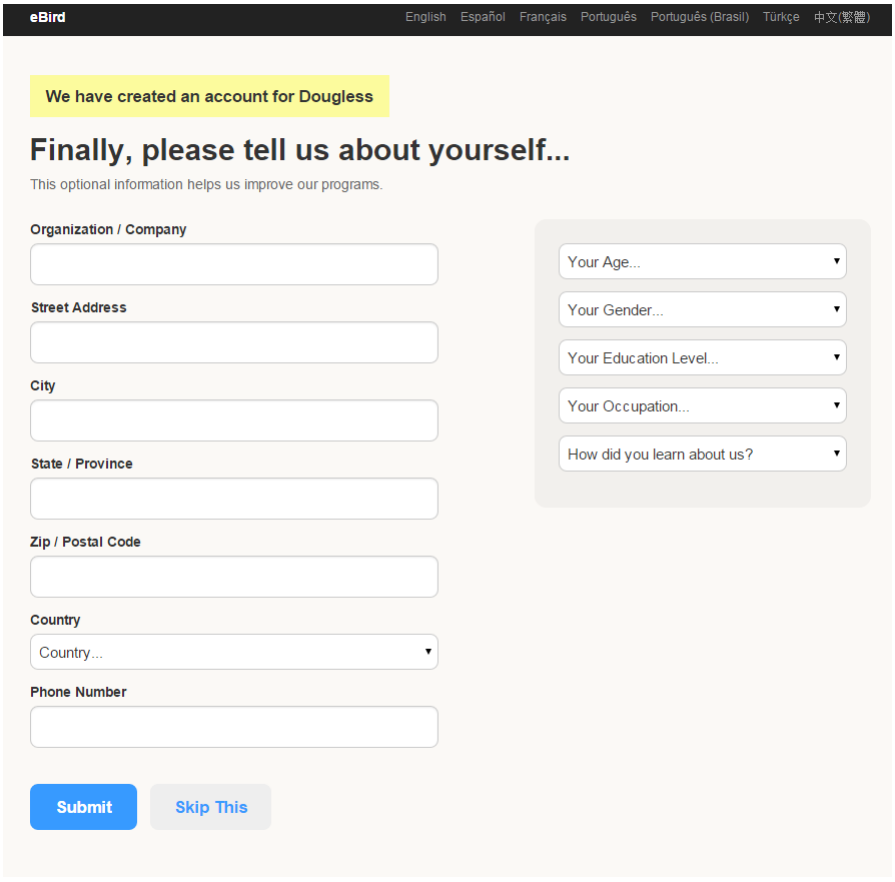

Figure 11 - eBird's user identification form (Audubon and Cornell Lab of Ornithology, 2002)

Enabling the volunteer participants to provide their personal information makes it possible for eBird to collect personal data about the volunteer participants' diversion around the world. This information could benefit a marketing campaign about eBird to focus on relevant areas around the world etc. areas with a low amount of volunteer participants found.

When volunteer participants of the project are contributing an observation of a bird, a three step process is performed by the volunteer participant. In figure 12, the first step is illustrated.

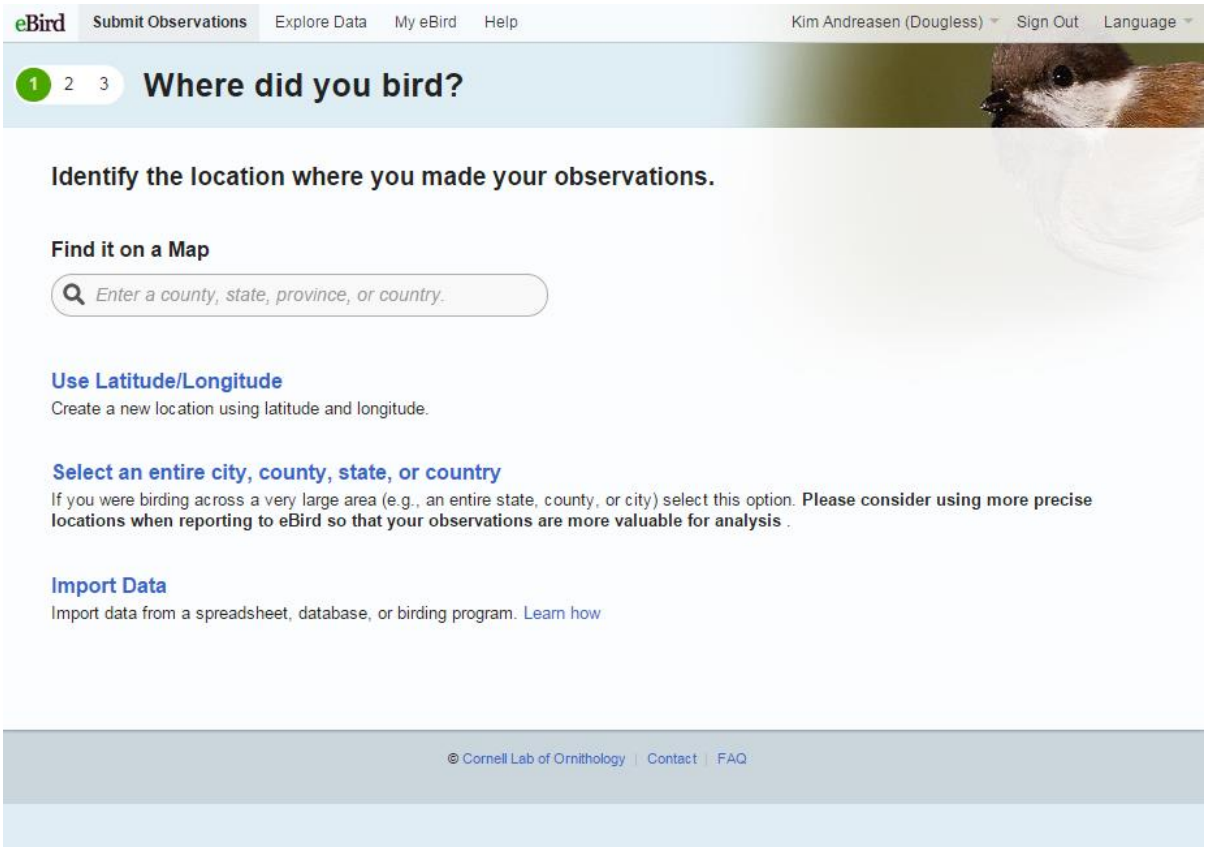

Figure 12 - eBirds first step in reporting observation for a volunteer participant (Audubon and Cornell Lab of Ornithology, 2002)

Similar to the two previous Danish citizen science projects, eBird is also making use of geo-location functionality by marking the location on a map or providing the latitude or longitude coordinates. This method is also used within the other citizen science projects addressed. The use of geo-location and the use of a map as method will be considered as a possibility for the application developed within this project.

In the second step of eBirds reporting process, the participants are required to provide the data of the observation and the observation type used when observing a bird or birds. The second process is illustrated within figure 13.

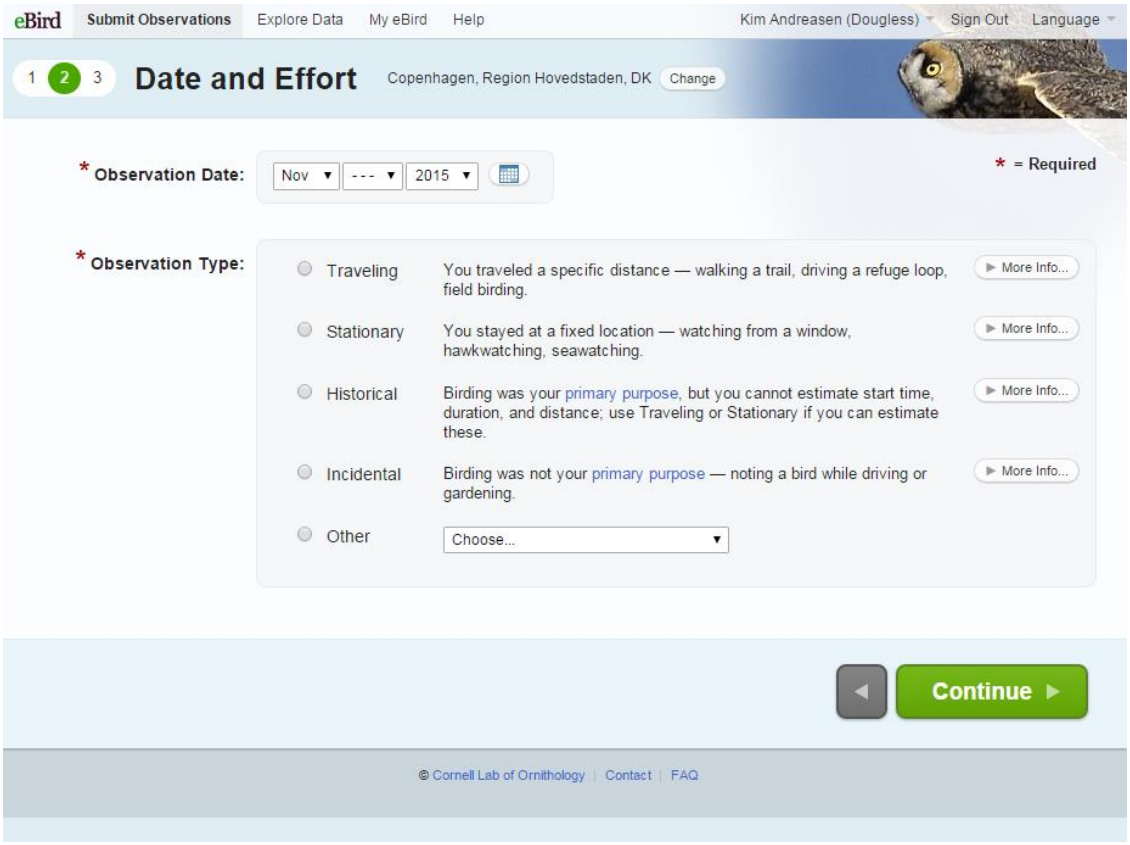

Figure 13 - eBird's second step in reporting observation (Audubon and Cornell Lab of Ornithology, 2002)

As seen within figure 13, the input form is brief and easy understandable. This form is most likely designed to provide efficiency and good user experience for the volunteer participants.

Within the third step of the process illustrated in figure 14, the participants are required to select the bird or birds observed.

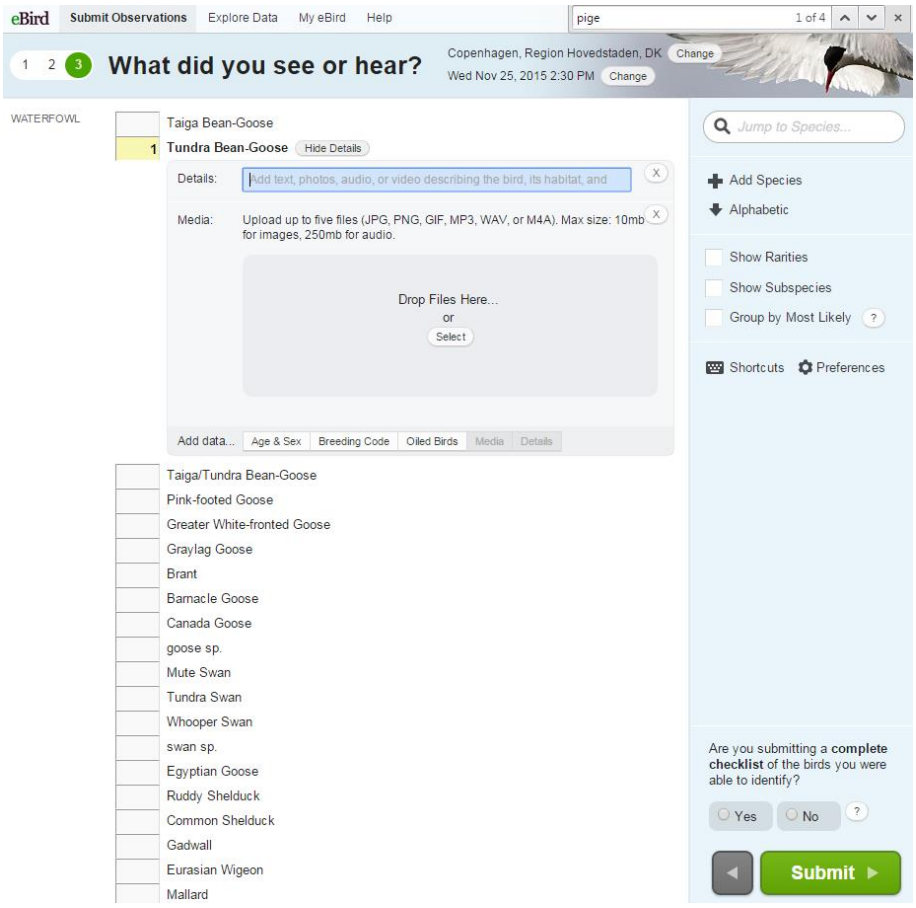

Figure 14 - eBird's third and final step of reporting an observation (Audubon and Cornell Lab of Ornithology, 2002)

The list of birds is complex and hard to grasp. This form would benefit to improve the simplicity of the form.

When the observation has been contributed with and registered by the volunteer participants, a review of the report is displayed on the screen. An example is illustrated within figure 15.

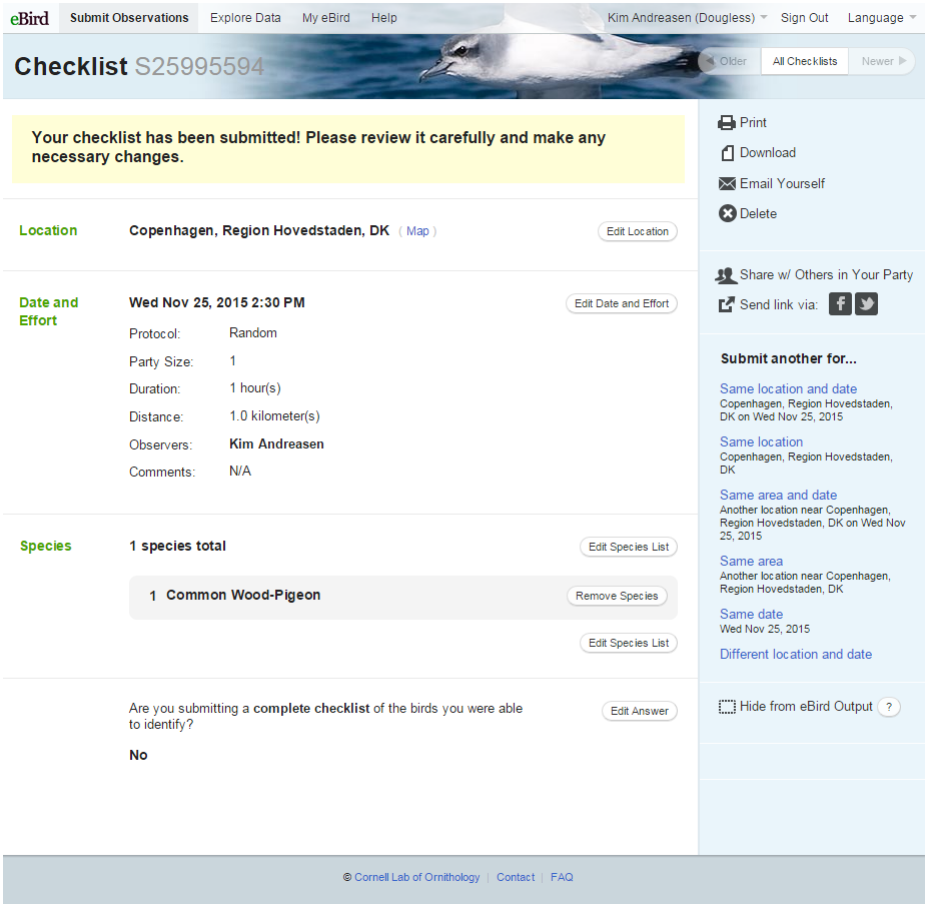

Figure 15 - eBirds report review of a contributed observation by a volunteer participant

The review of the observation provided by the volunteer participant is a well-functioning feature to notice the individual if wrong information has been provided.

A missing element of eBirds project is that there is not made use of a mobile application for providing observation directly from the field. This missing element has properly been considered and decided by the scientist of eBird and explained with a good reason. Although, the benefit from enabling the volunteer participants to provide observations directly to the database on the location, would most likely increase the amount of observations provided.
The standards of web development almost dictate that a responsive framework should at least be implemented on a website. Implementing a responsive framework could improve an already excellent citizen science project as eBird.

2.6.4 UVjægeren.dk

The last project addressed within this investigation and analysis, is not recognized and does no state themselves as a citizen science project. However, the project is still relevant for this papers investigation.

Uvjægeren.dk is a Danish website for spearfishers in Denmark. The website is probably an amateur- and spare time website enabling an interesting application used by Danish spearfishers (Torben Heimbürger and Søren Andersen, 2015). Even though it is an accessible and online website the service when used, is not functional but the idea of the application is still relevant for this project.

That being said, the service for Danish spearfishers is named Spot Kort or Location Map when translated into English (Torben Heimbürger and Søren Andersen, 2015). This Spot Kort enables Danish spearfisher to register different kinds of reports about spearfishing based on geographical locations (Torben Heimbürger and Søren Andersen, 2015). The method of using geographical reports is similar to the use the previous addressed citizen science project used.

This service is potentially an engaging solution for spearfishers who are interested in registering reports about fish. The downside of the service is the usability and functionality which is not working properly. However, the website is utilizing a map as the main interface when registering and displaying data (Torben Heimbürger and Søren Andersen, 2015)

Indicated in area 1 and figure 16, an overview of four categories is available to the user of the application. On the right of the map, a listing of recent forum topics and latest forum comments is also available to the user.

This enables the visitors to find related and interesting content on the website which could motivate visitors to return to the website.

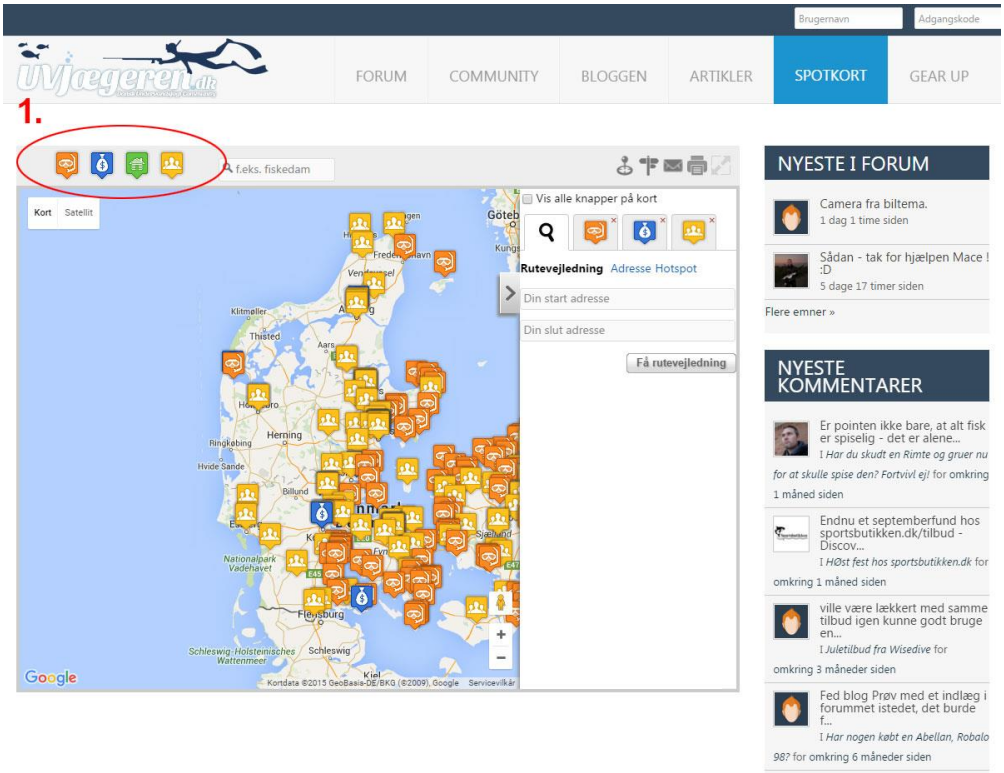

Figure 16 - Screenshot of the application found on UVjægeren's website (Torben Heimbürger and Søren Andersen, 2015)

UVjægeren.dk is also making use of social media to reach out to the spearfishers' active on Facebook. Indicated in area one of figure 17, an overview of UVjægeren.dk's total amount of Facebook page likes, which is about 1.500 Facebook users. This amount of Likes is not as high compared to the Facebook page that the project Biodiversitet Nu's has gained, but considering the narrow target group, the amount is impressive.

In the second area of figure 17, a direct link to UVjægeren.dk's website is found. This enables a direct connection between the Facebook page and the website which can be used for promotion and exposure of the UVjægeren.dk.

Figure 17 - Screenshot of UVjægeren.dk's Facebook page (Torben Heimbürger and Søren Andersen, 2015)

The functionality of UVjægeren.dk's website is potentially useful for engaging and motivating Danish spearfisher in registering observations about fish and other observations relevant to other spearfishers. This functionality is enabling users to report four different categories which are;

- Recommended spearfishing locations
- Spearfishing shops
- Shelters and sleeping places at the coast
- Location of other spearfishers

Unfortunately, the service on the website is functioning poorly.

2.6.5 Findings From Related Work

The investigation of the four described and explained projects brings suggestions and consideration which can be used for improving this project's final application and also making it the one of the best designed projects based on scientific theory.
Additionally, this project will also benefit from learning the bad elements implemented and discovered from this investigation. Following there is pointed out four major benefits gained from this investigation.

Map as interface - All the four discussed and analyzed projects utilized an interactive map for locating the volunteer participant's observations. An interactive map enables the users of the services to easily point out the location of where the observation was made. Most mobile devices have a GPS tracking feature enabled which could be merged with the use of the interactive map when a report is made using a mobile device.

Social media - Biodiversitet Nu and NaturTjek are making use of the social media to recruit volunteer participants and inform them about latest news, changes and so on. Making use of the social media enables a fast path to communicating with the public.

Data parameters - Many of the data parameters discovered through the investigation of these four projects was similar to the data parameters provided by the scientist of Fiskeatlas. eBird is also registering the volunteer participants' place of living which could be used for marketing purposes when a promotion of the project is needed to recruit more participants.

Mobile accessibility – The two Danish citizen science projects mentioned in this investigation are making use of a mobile application which enables a swift contribution of an observation directly from the field by a volunteer participant. This paper believes that this accessibility from a mobile device is highly useful in a citizen science project. Volunteer participants could potentially lose knowledge about fish observed before getting on a computer for contributing an observation.

Desktop accessibility – In contrary to the benefit of enabling volunteer participant to contribute observations directly on the location, it should also be possible to access the application from a computer without the use of a mobile application. A desktop accessibility could also be used to advance the functionalities of the application compared to a mobile device which should have a simple and quick interface.

2.7 Establishing Requirements

From the previous investigation and analysis of citizen science concept, benefits, challenges, governance structures and related work, it is possible to establish requirements for the application that will be developed for the scientists of Fiskeatlas.
However, there is missing concrete requirements established by the Danish spearfishers being the volunteer participants, which the application also are being developed for.

In order to establish requirements for the Danish spearfishers as user of the application, it is necessary for the spearfishers to communicate out these requirements.
There exist a wide variation of software development methodologies for designing and developing computer software applications for specific target groups with specific requirements. The various approaches are different and bring different benefits and challenges to the project.

In this project there are chosen a specific method which is proper for this project to establish the requirements for end users.

The method chosen for establishing the requirements establishment are recognized and known as Rapid Application Development (RAD) (Sharp et al., 2007). An element of RAD is used for establishing requirements based on the target group(s) needs. This element of RAD is known and recognized as Joint Application Development (JAD) (Sharp et al., 2007). The RAD methodology will be the method chosen in this project to develop the application with.

RAD is a software development methodology, which prioritizes iterative development and the rapid installation of prototypes, instead of large amounts of pre planning processes (Sharp et al., 2007). The avoidance of extensive pre planning allows software to be written and developed faster compared to other development methods such as Waterfall software development methodologies, which makes it easier to change requirements using RAD (Sharp et al., 2007).

Various software development methodologies was considered for choosing and appropriate method for developing this application considering the low amount of amount of time being available during this papers project. A waterfall methodology was not possible to consider since the time required for establishing the users' requirements is extensive and could end up spending all four month which was allocated for this entire project to deliver a prototype within (Sharp et al., 2007).
The choice of RAD was based on the spiral life cycle model which RAD has been designed and structured upon. The spiral lifecycle model is a recognized software development methodology originating from 1988. Two essential elements are fundamental to a spiral life cycle model which is risk analysis and prototyping. These two elements are implemented within the model in an iterative way which allows ideas and progress to be evaluated again and again through iterations (Sharp et al., 2007).
Within a life cycle model the process encourage alternative solutions to be considered and iterations were problems or potential problems are readdressed (Sharp et al., 2007). The life cycle model of software development is illustrated within figure 18.

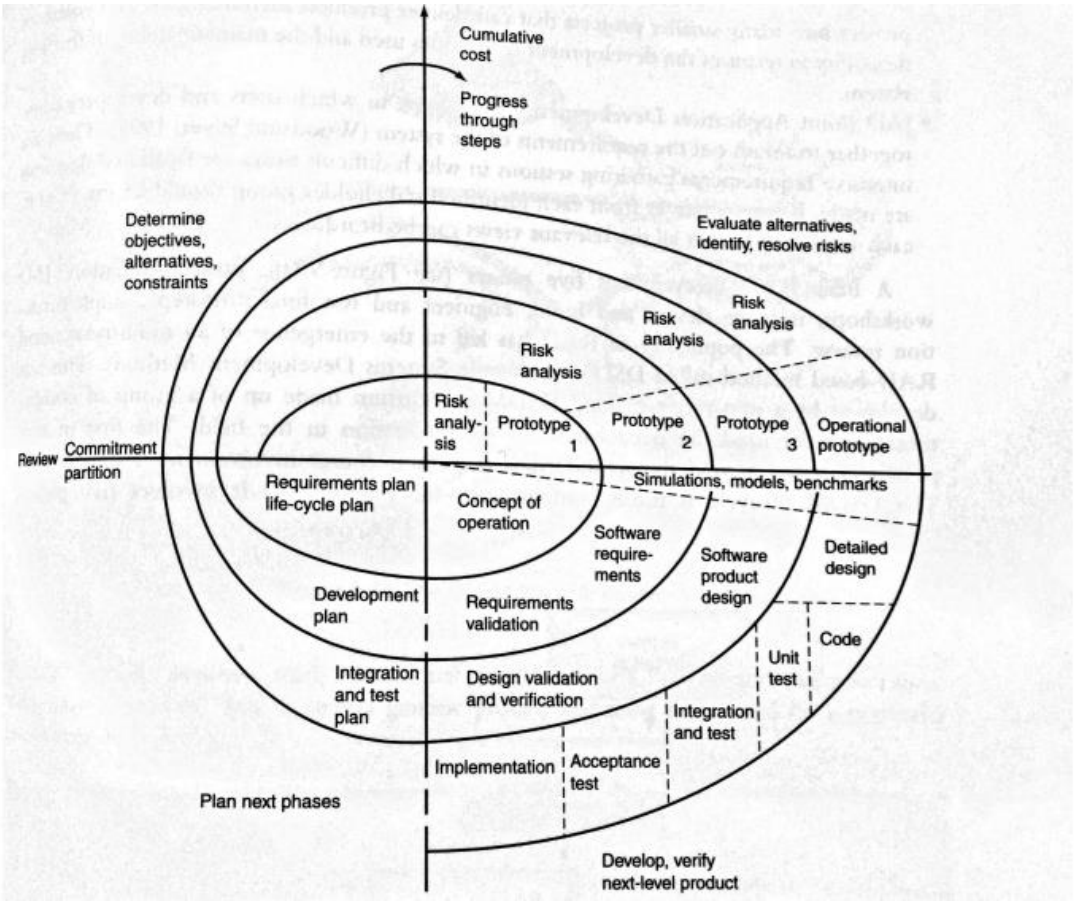

Figure 18 - The spiral life cycle model of software development (Sharp et al., 2007)

RAD is a software development method which includes the user-centered perspective and decrease the risk of caused by changing requirements during the process of the project. The two main elements of RAD are listed and following described.

Time limited cycles – Cycles of about six month, were at the end of each cycle a prototype or partial prototype must be delivered. This element is also known as time-boxing. The force of time-boxing enabling projects to deliver several results which deliver prototypes incrementally and increases the dynamic of the application development and maintenance (Sharp et al., 2007).

Joint Application Development (JAD) – This second element of RAD is a workshop which objective is to bring the developers together with the user of the application being developed. Throughout a JAD workshop the requirements of the application is established based on the user's perspective. The workshop focuses on intensive decision making involving all stakeholders of the final application (Sharp et al., 2007).

RAD is used when the project has a focused scope and is well defined and narrow. The RAD team is normally consistent of around six people or less (Sharp et al., 2007).

A typical RAD lifecycle contains five phases where JAD is one of the five phases. The five phases are: project initiation, JAD workshop, iterative design and development, testing and implementation review (Sharp et al., 2007). The RAD life cycle model is illustrated in figure 19.

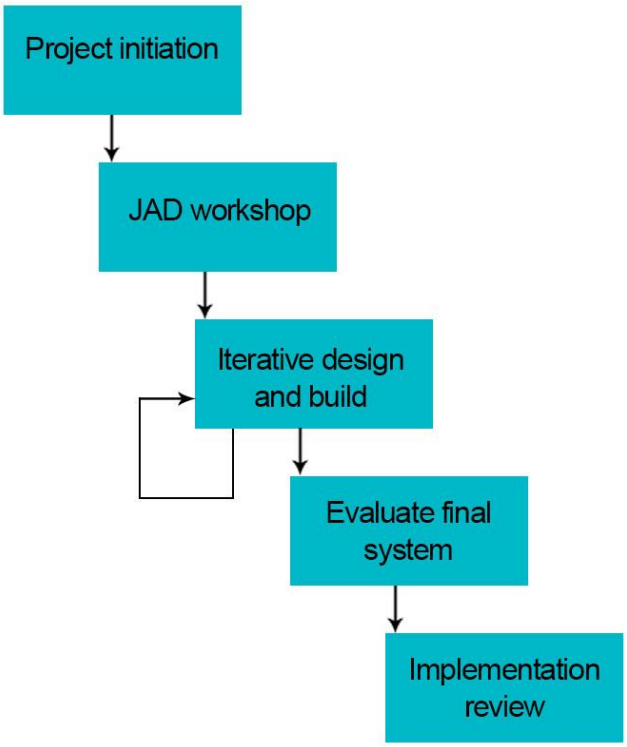

Figure 19 - A Rapid Application Development life cycle model for software development (Sharp et al., 2007)

As illustrated in figure 19, the process of RAD begins with a project initiation which has been completed within this papers project. The project initiation has been conducted up until this point has all background analysis and theory have been uncovered as well as a problem statement have been established.

The investigation and analysis chapter have not been able to proceed into the second phase of the RAD cycle yet. The stakeholders of the project have to be included to be able to proceed into the second phase of the RAD cycle.

This paper will now proceeds into the second phase of the RAD process model and a conducted JAD workshop with the relevant stakeholders will be described in details. The last three phases: iterative design and build, evaluate final system and implementation review will be documented later within this paper.

2.7.1 JAD Workshop

This JAD workshop consists of five phases which is; JAD project definition, research, preparation, the session and the final document (Wood and Silver, 1995). The JAD workshop phases are illustrated in figure 20.

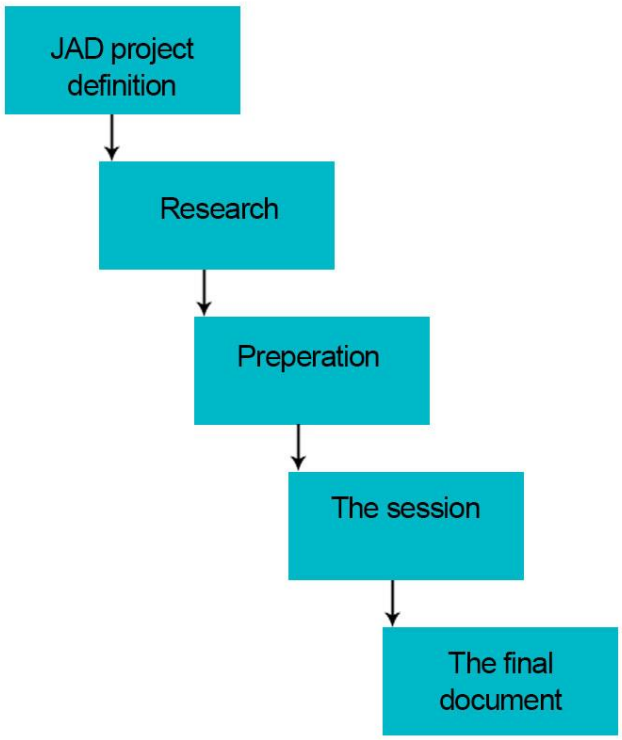

Figure 20 - The five phases of the Joint Application Development (JAD) workshop (Wood and Silver, 1995)

JAD includes approaches for; increasing user participation, accelerate development and improving the quality of requirements. JAD consists of a workshop where users and developers as stakeholders, meet to establish the requirements for the application being developed (Sharp et al., 2007; Wood and Silver, 1995).

The five phases of JAD is elaborated as follows.

Phase 1: JAD Project Definition - Identifying the applications objective and what is wanted from it (Wood and Silver, 1995). This phase has been completed during the research leading up to the problem statement within the first chapter of this paper.

Phase 2: Research - Gathering more details about the user's requirements (Wood and Silver, 1995). The theory about the user's requirements has been establishing during this chapter's deep investigation and analysis of the problem statement. The theory of the user's requirements will be confirmed during the session of the JAD workshop.

Phase 3: Preparation - Preparing visual aids and a working document (Wood and Silver, 1995). This phase has not been described in this paper yet, but it will be established after the definition of JAD's five phases.

Phase 4: The session - The session is the actual workshop of JAD where the definition of project models and processes are established (Wood and Silver, 1995). This phase will also be further elaborated on after this definition of JAD's five phases.

Phase 5: The final document - A comprehensive synthesis of system requirements will be compiled and distributed to the stakeholders of the JAD team for review (Wood and Silver, 1995). A final document will conclude this chapter which enables the beginning of the design phase and process of the RAD model (figure 19).

2.7.2 Preparation

The facilitator of the JAD workshop has the primary responsibility, which in this case is the writer of this paper. Well preparation is highest priority when conducting a JAD workshop. It is important that all participants understand their responsibility during the process and that all information will be prepared and sent to the participants before the workshop is conducted. When the workshop was prepared, there were four categories of tasks (Wood and Silver, 1995).

- Conducting pre-workshop preparation
- Creating a workshop agenda
- Arranging workshop logistics
- Preparing the participants

Each of the four categories was prepared and following tasks was performed.

Conducting pre-workshop preparation - The history and context of the project were documented and distributed within an e-mail for the participants as well as project objectives. The workshops environment was also documented as well as a description of hidden issues and built-in constraints. Open issues was also described and in contrary the benefits of the project was described too (Wood and Silver, 1995).

Creating a workshop agenda - A session agenda was established as well as introductory material for the participants to understand their role (Wood and Silver, 1995). The JAD workshop agenda can be found in Appendix K of this paper.

Arranging workshop logistics - Arrangement for a meeting room and setup has been planned (Wood and Silver, 1995). The meeting room was hosted within the facilitator's apartment located on Amager in Copenhagen

Preparing the participants - An advertisement was distributed on Facebook for advertising the workshop. The advertisement is found in Appendix J. The participants who volunteered the JAD workshop were informed about the length of the workshop and what their role as stakeholder influenced the project. Participants who are not core stakeholders were informed. Information about what is expected from the participants was also distributed before the JAD workshop was conducted. Information about objectives deliverable outlines and agenda was distributed as well (Wood and Silver, 1995).

2.7.3 The session

The JAD workshop was held the 8th of November 2015. The facilitator of this JAD workshop was managed by the writer of this paper and followed according to the planned agenda found in Appendix K. The facilitator of this workshop was responsible for keeping the session on track and moving forward if discussions got stuck. The JAD workshop involved following structure elements (Wood and Silver, 1995).

- Start and ending on time.
- Making sure the workshop followed the agenda.
- Reach agreement on objectives and basic rules of the workshop.
- Keeping the workshop on track by focusing on the objective.
- Resolving arising issues. If no solutions were available, the issue will be documented as an open issue and the workshop will move on.
- Performing group exercises to help building a general understanding and commitment.
- Asking participants open questions to generate new ideas.
- Listening carefully and without judging the participants input and opinions.
- Asking closed questions about the participants input to clarify.
- Using templates to help structure the discussion (Etc. establishing ground rules).
- Involving all participants.

In addition to the structure elements recently describes, there were also established ground rules for the JAD workshop (Wood and Silver, 1995).

- There are no dumb questions.
- Everyone Is a participants at the workshop.
- Lengthy issues will be written down and tabled.
- Individuals are allowed to finish their thoughts.
- Criticize the product, not the people.
- Silence when others are speaking.
- Documents needs to be approved by the workshops participants.
- Avoid side conversations.
- Seek group understanding and not always individual understanding.
- Stick to facts. Be specific and give examples.
- Limit discussions to a certain amount of minutes.

The decisions, requirements and results of the JAD workshop were documented by processing the working document (Appendix L) into a Final Document which will be described within following section.

2.7.4 Final document

It is essential for the success of a JAD workshop that all elements addressed, discussed and agreed throughout the meeting was documented as a final list and reviewed by the participants. The facilitator of the workshop created a draft based on the working document which was processed right after the workshop. The draft was distributed to participants the same evening.

While the draft was reviewed by the participants the final document was established based on the working document. The facilitator's responsibilities when generating the final document is listed as follows.

- Structuring the final document for easy use by the project developers
- Completing the draft of the final document
- Distributing the draft to the workshop participants/stakeholders for review
- Distributing the final copy for participants to sign-off

The final document can be found and reviewed within Appendix M.

The final document was distributed to the participants of the workshop right after it had been signed-off. The following process of this project is to design, implement and experiment the application for the spearfishers and scientists of Fiskeatlas.

3 Application Design

Previous chapter established specific design criterions based on factual knowledge gained from scientific investigation, current projects and the JAD workshop.

This chapter will be become the bridge between theory and implemented prototype or product where this chapter will use the theory and final document as the basis for the application design in this paper.

The application designed within this chapter will be adapted to fit into an existing platform.

The environment used to implement this application on is the website named Underwaterhunt.dk. A more elaborate description of the website will be made within next chapter about development and implementation.

In this chapter there are three perspectives considered when designing this web application. The first perspective is the scientists of Fiskeatlas. This stakeholder requires a different a solution compared to the Danish spearfishers being the second stakeholder. The scientists require an interface where the possibility to extract data is available. This interface will not necessarily become a shared interface with the Danish spearfishers.

The second perspective of the application design is based on the second stakeholder(s) being the Danish spearfishers' requirements. Not only enabling the Danish spearfishers to report an observation, it should also be possible for them to review observations made by others and also they should be able to share an observation using social media such as Facebook or Twitter.

The third perspective considered when establishing this application design, is according to the theory covered in previous chapters. It is necessary to consider the motivational factors as well as the challenges when considering working with a citizen science concept.

All perspectives will be prioritized elements during this application design. The first perspective designed for is based on the criterions established by the Danish spearfishers documented within the final document of the JAD workshop.

3.1 Designing For The Spearfishers

This section considering the Danish spearfishers will start by reviewing the requirements established during the JAD workshop and documented within the final document.

The first element considered for the website is the layout of the front page which will feature elements for leading visitors to the data reporting application. The design layout for the front page will be elaborated on within the next section.
Following, the design layout of the reporting application will be elaborated on considering structure and functionality.
The third and last design layout explained on for the Danish spearfishers' requirements is the form page used for contributing an observation with. This form page will be the location on the website where the scientific parameters required by Fiskeatlas will be implemented to fill out as text input fields.

Since this page also involves the requirements established by Fiskeatlas, their requirements will also be considered.

3.1.1 Website Home Page

As mentioned, the design layout of the home page will be established as the first approach to meet the Danish spearfishers' requirements.

The home page of www.underwaterhunt.dk will feature multiple elements. Some elements will be used for navigation and other elements used for engaging visitors of the website.

Illustrated in figure 21, the front page will contain a header where the logo and navigation is located. The navigation will contain two links. One link leading visitors to an article archive containing a list of articles about spearfishing topics. Another link will be leading the visitors to the application page.

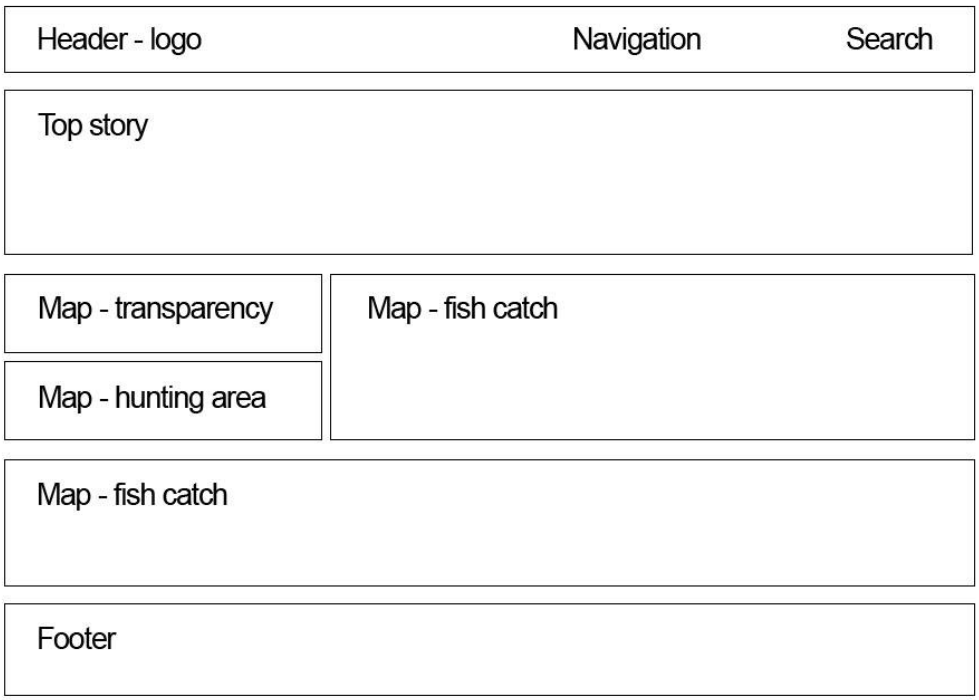

Figure 21 - Design layout for home page on www.underwaterhunt.dk

Below the header illustrated in figure 21, a top story banner will be located which will feature the latest news article about spearfishing. The page element will serve the objective to increase the visitors' engagement on the website.

Below the top story banner illustrated in figure 21, a group of elements leading to the application is located. Two smaller elements will be leading the visitors to observation of water clarity or hunting areas. These observations will be located within the application. The larger banner will be leading the visitors to observations about fish caught which also will be displayed on the application page.

The fourth row also illustrated in figure 21, will feature random news articles about spearfishing which in theory also increase visitor engagement on the website.

The footer illustrated in the bottom of figure 21, will contain links to the social media profile of www.underwaterhunt.dk.

3.1.2 Application Page

As mentioned, the second design layout established based the spearfishers' requirements is the reporting application page is the main feature of this project.

The reporting application page contains the same header and footer as illustrated in figure 21, but the inner elements of the page is different from the home page.

Illustrated in figure 22, the design layout is going to contain an interactive map area where the visitors will be able to interact with a map to locate a specific observation contributed by etc. another volunteer participant.

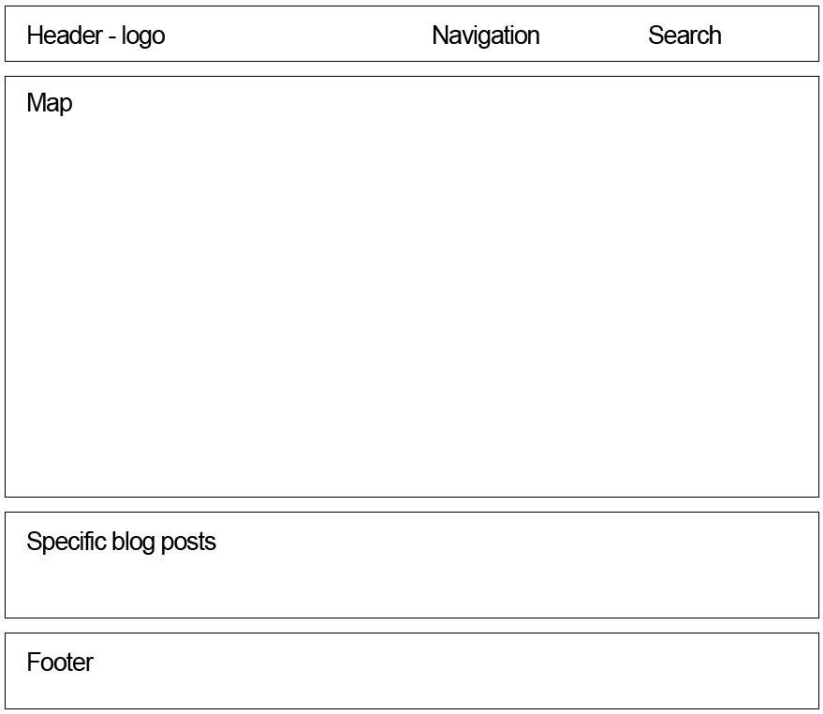

Figure 22 - Design layout for reporting application page on www.underwaterhunt.dk

Below the map element illustrated in figure 22, a blog post element will feature blog posts made by Fiskeatlas scientists on www.underwaterhunt.dk. This element will serve the objective of motivating the visitors of the website to return at some other time again in the future.

3.1.3 Application Form Page

The third and last design layout established based on the spearfishers' requirements, is the application form page which will serve the objective of inputting observation into the database, contributed by the volunteer participants.

In figure 23, the previous elements of the header and footer are illustarted.

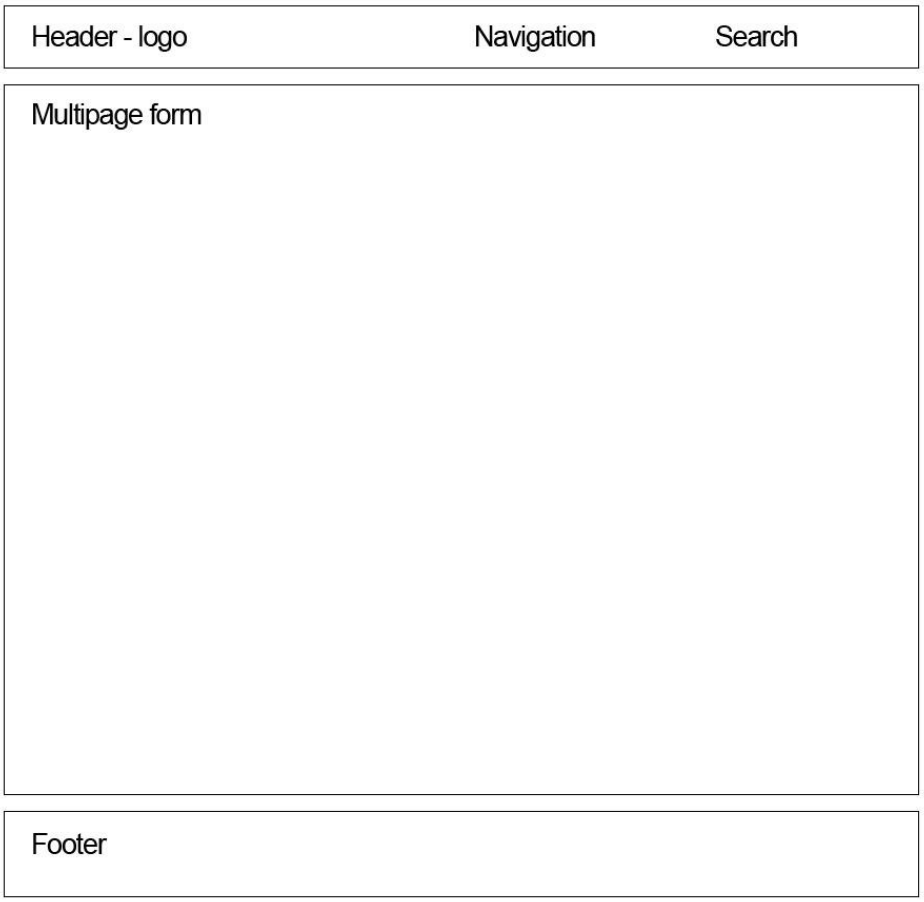

Figure 23 - Design layout for application form page on www.underwaterhunt.dk

Different from the two previous design layouts illustrated in figure 21 and 22, figure 22 is expected to contain a multipage form which will display the data input fields for the specific data parameters required by the scientists of Fiskeatlas.

3.2 Designing For The Scientists

The other stakeholder or target group designing the data collection service for is the scientist of Fiskeatlas. These scientists basically need the ability to get into the database and export the data they are collect to solve their scientific objective.

3.2.1 Data Interface

The database management system implemented for the website - www.underwaterhunt.dk, is a MySQL database (Oracle Corporation, 2015). This MySQL data will be used as the data management of the observations contributed and registered by the volunteer participants. MySQL brings the functionality to export data tables.

The ideal solution for the scientists could be a custom in-built WordPress (CMS) solution, since that solution potentially could deliver a better user experience for them to export data tables with. A direct export from www.underwaterhunt.dk's database to Fiskeatlas database would make the efficiency event better. Although, a solution like that will be prioritized within the next design, implementation and experimentation phase of the spiral life cycle model used in this papers project.

The alternative solution for this design iteration is implementing phpMyAdmin (phpMyAdmin contributors, 2015) for Fiskeatlas scientists. PhpMyAdmin enables a web interface for accessing registered by volunteer participants, located within the MySQL database of the website.

3.3 Designing According To Theory

Background theory gained from papers investigating the citizen science concept has been revealed within the first and second chapter of this paper. The theory was also documented within the Final Document of the JAD workshop and according to the requirements established the design layout for meeting these theoretical requirements will be described in this section.

3.3.1 Motivational Factors

Motivational factors have earlier in this paper been addressed and scientific knowledge proves that motivational factors are important for not only the volunteer participants but also for the scientists involved and managing the citizen science project.

It has also been revealed that other current citizen science projects are making use of motivational factors such as gamification and social media. The final document that was established during the JAD workshop also requires motivational factors implemented such as social media and rating systems.

In this project, there will be prioritized to implemented gamification features and social media integration for the volunteer participants and scientists to use.

The way social media has been implemented within this project is done by created a Facebook and Twitter account representing and promoting the website www.underwaterhunt.dk.

Underwaterhunt.dk on Facebook - To complete this projects objective a Facebook page will be created. Similar to the other current citizen science projects addressed within the previous analysis chapters, the utilization of Facebook will create a more likely reason for Facebook users to visit the website of Underwaterhunt.dk and become volunteer participants of Fiskeatlas the citizen science project.

The Facebook page that will be created for the website, application and citizen science project is designed and illustrated using a wireframe. The design structure for Facebook pages is fixed, but the content and minor changes in page structure can be edited and manipulated.

In figure 24, the wireframe of the Facebook page is illustrated.

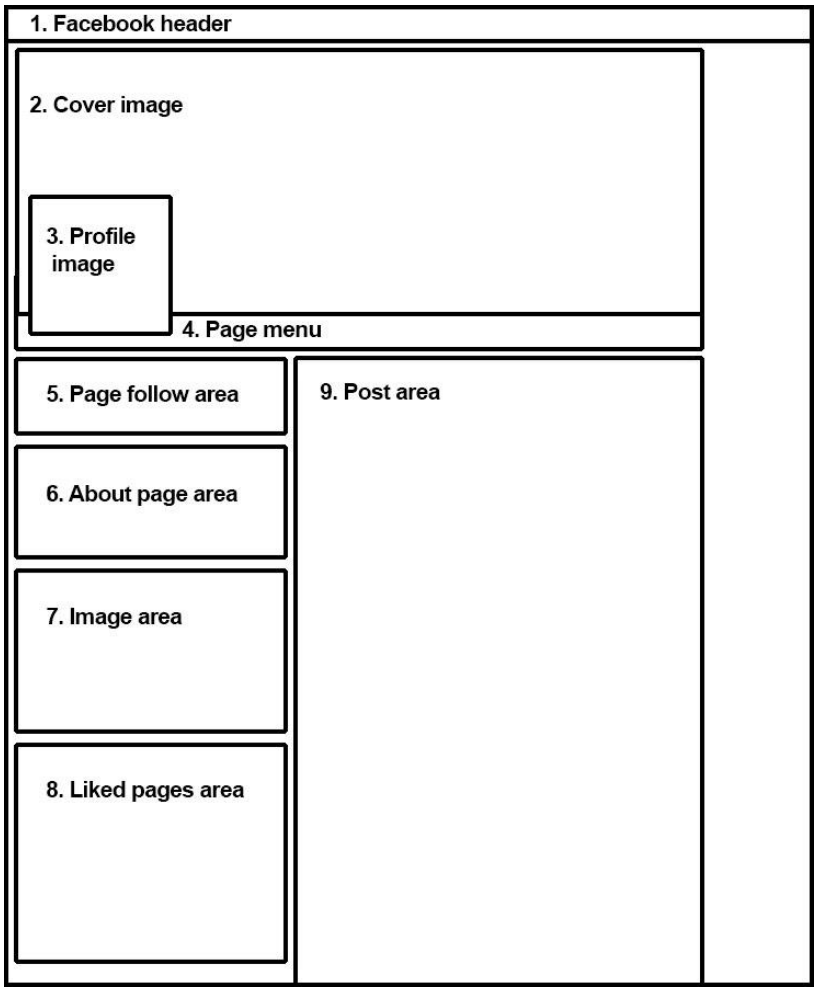

Figure 24 - Wireframe of www.underwaterhunt.dk's Facebook page

The wireframe of the Facebook page has been divided into different areas. The most influential areas of the Facebook page which is illustrated within the wireframe are area 4, 5, 6 and 9.

Area 4 can be changed and for this page on Facebook it is chosen to add; timeline, about, Like button, images and videos within the Facebook page menu.
Indicated in area 5 it is possible to display the amount of Likes of the Facebook page. The more Likes of the page, the more implicit approval of based on Facebook users it is anticipated to get. Area 6 of figure 24 is chosen to display a short elaborate text about the website as well as a direct link to the website. Area 9 of

figure 24 is expected to be the most dynamic area where features of recent posts, website updates and blog posts will be displayed within that specific area.

This design will motivate and engage Facebook users to visit www.underwaterhunt.dk and likely get more volunteer participants to join Fiskeatlas - the citizen science project.

Underwaterhunt.dk on Twitter - As well as the previous designed Facebook page, a Twitter page has also been designed for motivating and recruiting volunteer participants from Twitter. In addition, Twitter's page frame is fixed and only minor changes can be applied to the page.

Illustrated in figure 25 the wireframe of the Twitter page is designed.

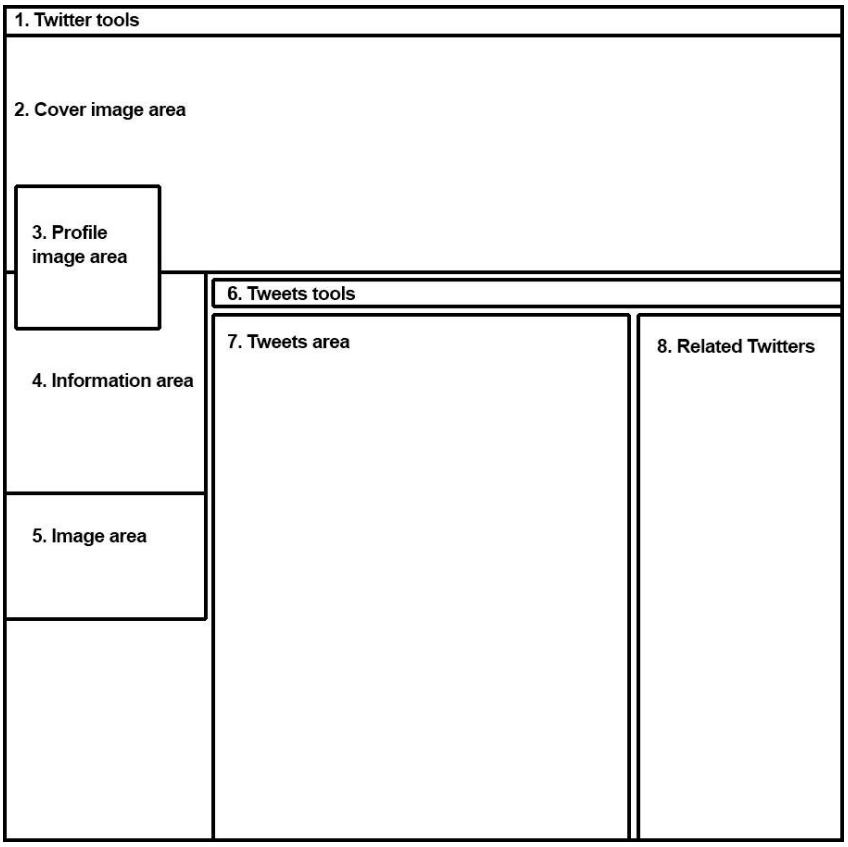

Figure 25 - Wireframe of www.underwaterhunt.dk's Twitter page

The wireframe of the Twitter page similar to the Facebook page has been divided into different areas. The most influential areas located on the Twitter page is area 4 and 7.

Area 4 will contain the information about the website and a direct link to the website. Area 7 will feature the most recent post, updates and blog posts.

This design will presumably motivate and engage Twitter users to visit www.underwaterhunt.dk and likely recruit more volunteer participants of the citizen science project.

3.3.2 Data Quality

Required by the scientist of Fiskeatlas involved within this project, certain data quality features is established. The data quality features designed within this section is designed for the multi-page form used to contribute an observation with.

Illustrated in figure 26, the expected design for the first draft of the multi-page form is established.

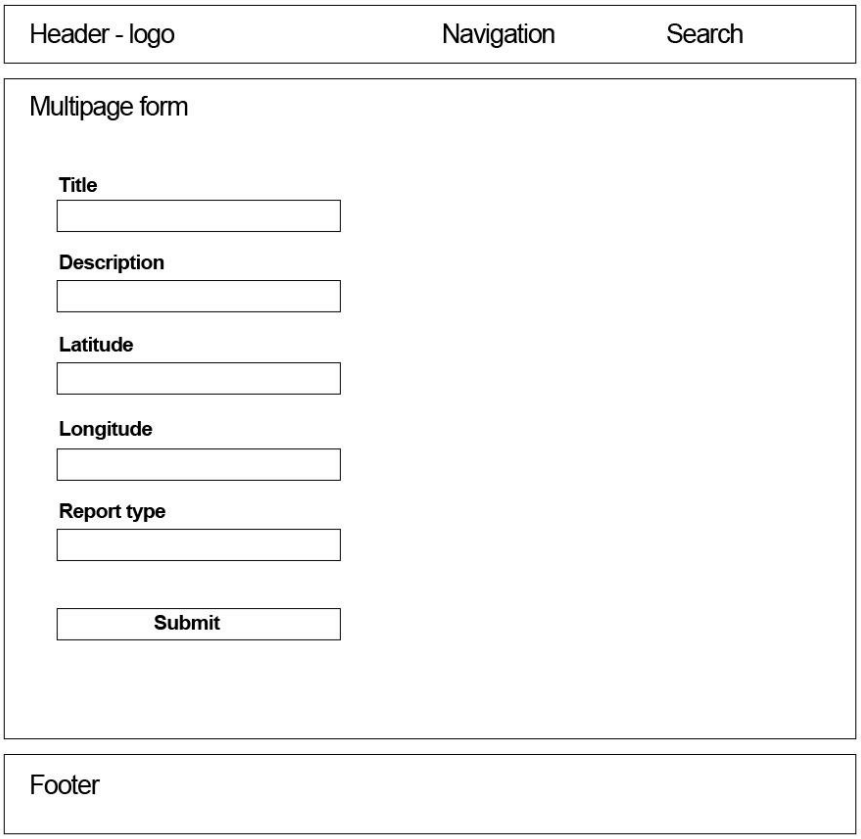

Figure 26 - Required data fields of the report form

Indicated in figure 26, five different input fields have been designed. The users of the website will able to enter text and numbers within the form and submit them to the websites database. This is the first draft for the multi-page form where the user experience will be experimented with after the first development and implementation is completed. If the structure of the multi-page form is ideal, more input fields required by Fiskeatlas will be added in RAD's next iteration of design, implementation and experimentation.

3.4 RAD Iteration – Application Design

In the end of previous chapter, it was decided to use Rapid Application Development (RAD) as the software development method in the project of this paper. As illustrated in figure 19 this software development method includes an iterative development method which enables this project to iterate back to the design for improving and adding features revealed during the future user experience experimentation. This design chapter covers the design for first iteration. Missing elements that would meet the requirements will be designed and developed within next RAD iteration

3.4.1 Design Iteration One

This iteration is named Iteration One and this iteration includes the design of the prototype that this project will deliver described in the end of this paper. Following there will be developed and experimented with user experience based on this design chapter. Within the previous described design phase of the first iteration there has been covered the fundamentals for establishing the first prototype for developing a reporting application for the Danish spearfishers. The first iteration will not deliver an ideal and complete product, but the first iteration will deliver a prototype closer to a final product.

Next chapter will describe and explained the implementation of the design plans from this chapter.

4 Development & Implementation

In this chapter there will be developed and implemented an application which meets the requirements and designs established within the final document and the previous design chapter. According to the software development model used in this project is expected to implement an initial prototype for the first iteration of RAD. This chapter will cover the implementation according to the final document and the previous design chapter. This chapter will result in a usable prototype of the final product, which will be experimented with in next chapter.

The first objective within this chapter to describe the technicalities of the platform or website this application will be implemented within. The second objective of this chapter is to describe the implementation of the interactive map used for displaying observations made by the volunteer participants. Following, an explanation of the backend implementation will be elaborated on as well as the social media integration of the project and application.

4.1 Platform Implementation

It is necessary for the application being developed to be easily accessible for the volunteer participants as well as meeting the requirements established within the final document and the previous design chapter. In addition, the service is also required to be accessible for the scientists of Fiskeatlas to gather data from.

Making the application easily accessible, it will be implemented on an existing platform available through the internet. The application will be developed and implemented on the Danish spearfishing magazine website developed by the writer of this project. The website can be accessed through the following domain name - www.underwaterhunt.dk.

The application will function as one of the primary features of the website and will be able to be accessed through the main navigation. The application being developed will be available to all volunteer participants with an internet access, a web compatible device and a common web browser. However, these simple accessibility requirements just described will only enable the application to be easy accessible for the users, but not necessarily easy to use. To solve that issue the application will be optimized for all common devices such as desktop-, tablet- and mobile devices. Responsive web design and development will be used to solve complete that objective.
The website where the application is implemented on offers a responsive framework for all common devices with access to the web. The responsive framework is a highly recognized framework implemented on many other websites. The framework is known as Bootstrap (MIT, 2015).

Bootstrap delivers the functionality to adjust the user interface on the website for mobile-, tablet- and desktop devices (MIT, 2015). Using Bootstrap as a responsive website framework, it is possible to improve the aspect of the service being easy to use for all volunteer participants with different devices for accessing the internet.
Even though this website delivers a responsive framework, the user experience of the website and application is still required to be optimized and experimented with using recognized user experience experimentation method which will be conducted in next chapter of this paper.

The website www.underwaterhunt.dk is managed by a Content Management System (CMS) known as WordPress (GPLv2, 2015). This CMS delivers a great platform for users to manage website content, but also enables the user with free developing availabilities since WordPress is an open source project (GPLv2, 2015). This CMS will manage the content created by the volunteer participants and the application developed within this project.

The development of the application will be described and elaborated on in following sections of this chapter.

4.2 Interactive Map

The implementing the application on the website www.underwaterhunt.dk was initiated by implementing the interactive map functionality. Different interactive map API's was are available as open source on the internet, but the API used in this project is Google Maps API's (Google inc., 2015).

Implementing the Google map API on a page is performed by utilizing several elements. Initially, there has been developing a page template in WordPress for the interactive map to be displayed.
To define the area of the WordPress page template were the Google map displayed within, is defined using a specific HTML id-tag called "map". The field where the map has been implemented is illustrated in figure 27.

```
19          <div class="row">
20              <div class="col-xs-12 col-sm-12 col-lg-12 content-outer">
21                  <div class="col-xs-12 col-sm-12 col-lg-12 kort-right-bar-inner">
22                      <div id="map">
23
24
25                      </div>
26                  </div>
27              </div>
28          </div>
```

Figure 27 - Map HTML container

In figure 27, several HTML div-tag containers are implemented. Basically, the inner HTML div with the HTML id-tag "map" is the container where the Google map is contained and displayed within. The entire HTML code of the page can be inspected within the Appendix D.

To display the map, it was necessary to load the Google Maps API which is done using a specific JavaScript file. The code loading the API is illustrated in figure 28.

```
25          <script src="https://maps.googleapis.com/maps/api/js"></script>
```

Figure 28 - Loading Google Maps API

By implementing Google Maps API, it is possible to utilize the functionalities enabled by the API. To display the map, a load function is used. Illustrated in figure 29, it is possible inspect the JavaScript code used to display the map.

```
89          function load()
90          {
91              var map = new google.maps.Map(document.getElementById("map"),
92              {
93                  center: new google.maps.LatLng(55.95996, 11.76407),
94                  zoom: 7,
95                  mapTypeId: 'roadmap'
96              });
```

Figure 29 - Load function of the map

This entire script can be inspected in Appendix C.

The map on the page displays three different report categories. The reports are imported from the www.underwaterhunt.dk's MySQL database using a XML output from the database. This output is illustrated in figure 30.

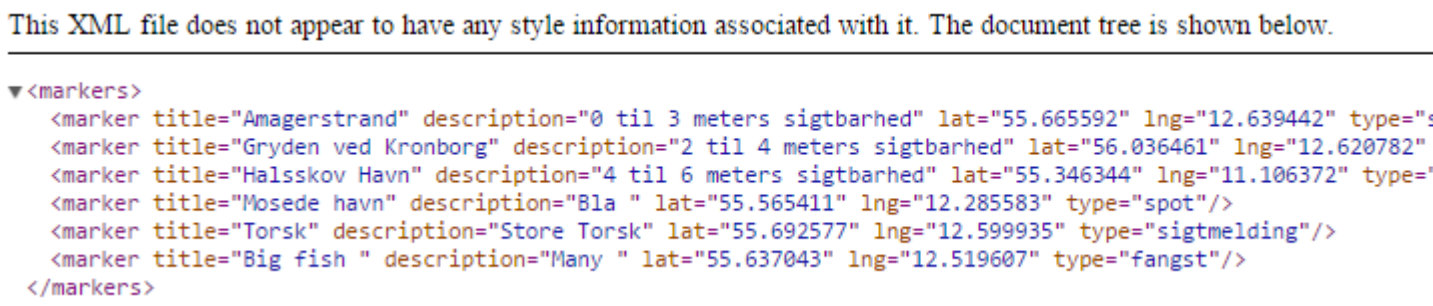

Figure 30 - Illustration of the XML data output

The XML output from the MYSQL database is generated using an established WordPress page template with a connection to the database and then displaying the data using a XML output developed using PHP. The PHP code for generating the XML output can be inspected in figure 31.

```
39  // Start XML file, echo parent node
40  echo '<markers>';
41
42  // Iterate through the rows, printing XML nodes for each
43  while ($row = @mysql_fetch_assoc($result)){
44    // ADD TO XML DOCUMENT NODE
45    echo '<marker ';
46    echo 'title="' . parseToXML($row['title']) . '" ';
47    echo 'description="' . parseToXML($row['description']) . '" ';
48    echo 'lat="' . $row['lat'] . '" ';
49    echo 'lng="' . $row['lng'] . '" ';
50    echo 'type="' . $row['type'] . '" ';
51    echo '/>';
52  }
53
54  // End XML file
55  echo '</markers>';
```

Figure 31 - XML output

This XML output illustrated in figure 31 is following loaded as input into the application using JavaScript code which also loads the Google map API features. The code which loads the XML output into the map is illustrated in figure 32.

```
132                 downloadUrl("/?p=521", function(data)
133                 {
134                     var xml = data.responseXML;
135                     var markers = xml.documentElement.getElementsByTagName("marker");
136 
137                     for (var i = 0; i < markers.length; i++)
138                     {
139                         var title = markers[i].getAttribute("title");
140                         var description = markers[i].getAttribute("description");
141                         var type = markers[i].getAttribute("type");
142                         var point = new google.maps.LatLng(
143                         parseFloat(markers[i].getAttribute("lat")),
144                         parseFloat(markers[i].getAttribute("lng")));
145                         var html = "<b>" + title + "</b> <br/>" + description;
146                         var icon = customIcons[type] || {};
147                         var marker = new google.maps.Marker({
148                         map: map,
149                         position: point,
150                         icon: icon.icon
151                     });
152 
153                     bindInfoWindow(marker, map, infoWindow, html);
154                     }
155                 });
```

Figure 32 - XML data input

The interface of the interactive map is also developed to deliver an intuitive method for displaying the reports made by other volunteer participants of the project.

In order to provide an overview of the observation that has been contributed by the volunteer participants, customized markers have been implemented to the map. The code for displaying the customized markers is illustrated in figure 33.

```
31              var customIcons = {
32                  sigtmelding:
33                  {
34                      icon: '<?php bloginfo('template_url');?>/img/markers/marker_sigt.png'
35                  },
36                  fangst:
37                  {
38                      icon: '<?php bloginfo('template_url');?>/img/markers/marker_fangst.png'
39                  },
40                  spot:
41                  {
42                      icon: '<?php bloginfo('template_url');?>/img/markers/marker_spot.png'
43                  }
44              };
```

Figure 33 - Enabling customized markers

Displaying the markers on the map is performed using the same code script used for loading the XML output, which can be inspected in figure 32.

A full screen view for mobile- and tablet device users was necessary to implement since the interactive map was not easy to control without this functionality implemented into the application. This issue was realized during the development. The code snippet for implementing this full screen functionality is illustrated in figure 34.

```
51          function CenterControl(controlDiv, map)
52          {
53
54              // Set CSS for the control border.
55              var controlUI = document.createElement('div');
56              controlUI.style.backgroundColor = '#fff';
57              controlUI.style.border = '2px solid #fff';
58              controlUI.style.borderRadius = '3px';
59              controlUI.style.boxShadow = '0 2px 6px rgba(0,0,0,.3)';
60              controlUI.style.cursor = 'pointer';
61              controlUI.style.marginTop = '10px';
62              controlUI.style.marginBottom = '10px';
63              controlUI.style.textAlign = 'center';
64              controlUI.title = 'Klik for at rapportere et punkt.';
65              controlDiv.appendChild(controlUI);
66
67              // Set CSS for the control interior.
68              var controlText = document.createElement('div');
69              controlText.style.color = 'rgb(25,25,25)';
70              controlText.style.fontFamily = 'Roboto,Arial,sans-serif';
71              controlText.style.fontSize = '11px';
72              controlText.style.paddingLeft = '8px';
73              controlText.style.paddingRight = '8px';
74              controlText.style.paddingTop = '8px';
75              controlText.style.paddingBottom = '8px';
76              controlText.innerHTML = 'Rapportér';
77              controlUI.appendChild(controlText);
78
79              // Setup the click event listeners: simply set up a link to the form page.
80              controlUI.addEventListener('click', report);
81
82              function report()
83              {
84                  /*alert ("Gå til formular!");*/
85                  document.location.href = "/?p=58";
86              }
87          }
```

Figure 34 - Code snippet enabling a button for full screen mobile/cellphone view of the map

The described code scripts and elements composed deliver the one of the elements of the first prototype of this RAD iteration. In figure 35 the current state of the interactive map element of the application is illustrated.

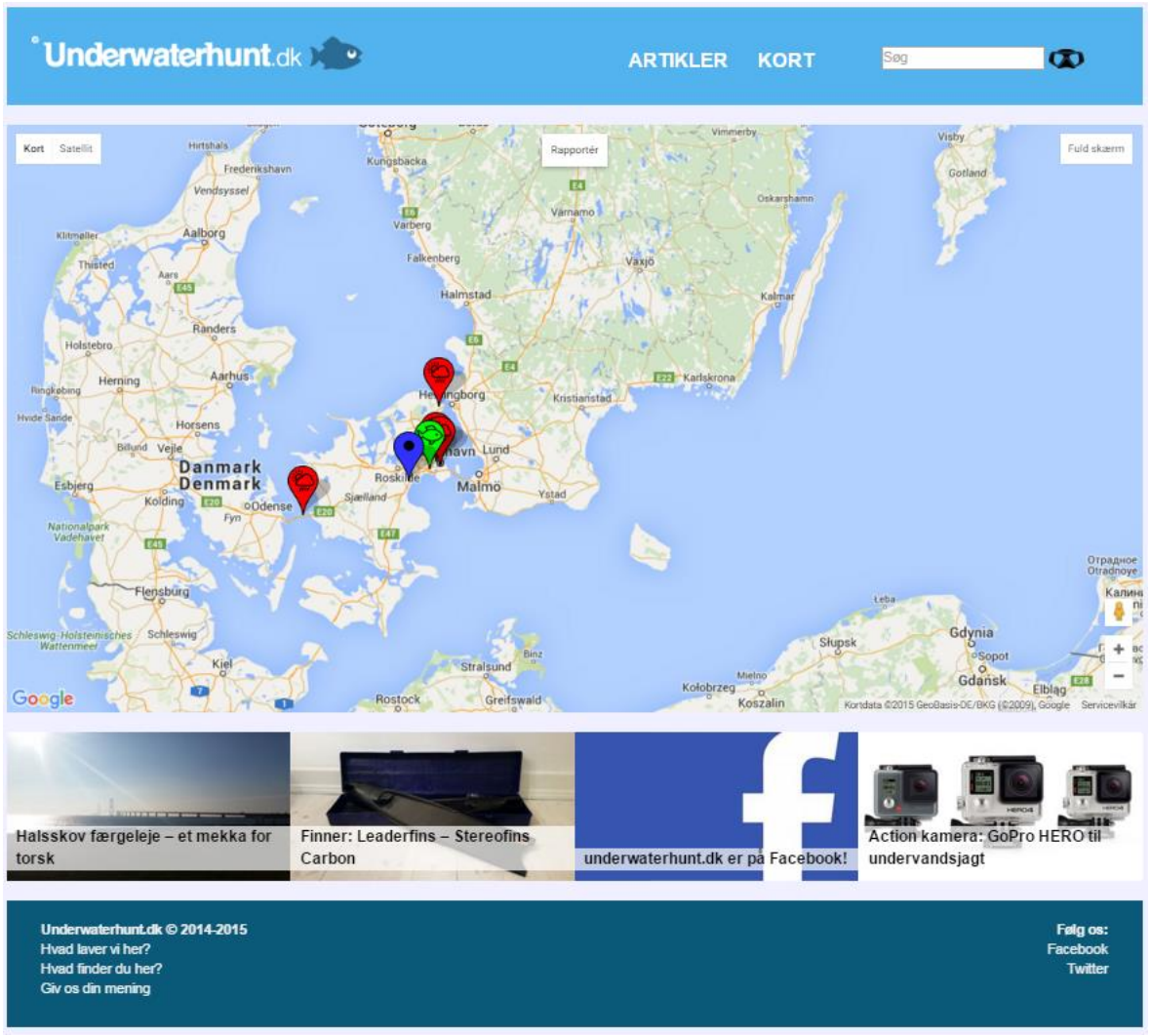

Figure 35 - Interactive map and interface in desktop view

The interactive map is initialized and loaded with a pivot point centered on Denmark. The argument for that choice is based on the location of the target group being the Danish spearfishers. The map has the functionality to display a map in an illustrated way or as an actual satellite image. This makes it possible for the spearfishers to investigate exact locations of where they have been hunting and observing fish. Below the map an element displaying random articles about spearfishing is implemented. The objective of this element is to engage visitors either stay longer on the website or to return again because of interesting content. This is one of the motivational methods brought into use. However, the most ideal solution within the featured article banner would be displaying the post by Fiskeatlas blog. Unfortunately, that was not possible to implement in this iteration of RAD.

As mentioned earlier, the website delivers a responsive framework which this interactive map page has been developed accordingly to. Illustrated in figure 36, the mobile view of the interactive map is illustrated.

Figure 36 - Interactive map and interface in mobile view

The implementation of a responsive design for mobile and tablet devices makes it possible for Danish spearfishers to report an observation on the location, right after exiting the water.

4.3 Implementing Data Input Form

Enabling the possibility for the spearfishers to report observations into a database a web form has been developed for this purpose. This web form has been connected with the interactive map. Illustrated within figure 35 and 36 a button in the top middle of the map with the text 'Rapportér' is illustrated. This button is directing the visitors when clicked, to a web form where observation details can be entered in order to register an observation into the database.

The JavaScript snippet that enables the visitors being directed is illustrated in figure 37.

```
82                  function report()
83                  {
84                      /*alert ("Gå til formular!");*/
85                      document.location.href = "/?p=58";
86                  }
```

Figure 37 - JavaScript function enabling a page direct to the data form

The JavaScript code snippet illustrated in figure 37 simply directs the visitors to page with the page identification 58.

The page that the visitors are navigated to contains a multi-page form displaying a few of the required parameters for the visitor to enter data into.

Within a file named functions.php, a form function was enabled in order to provide data within the database. The code snippet for implementing this multi-page form can be inspected within Appendix B. The code snippet for the page template can be inspected within Appendix E. In addition, illustrated in figure 38 the code snippet for constructing the multi-page form can be found.

```
309         if ( $page == NULL )
310         {
311             echo '
312                 <form method="post" action="' . $this_page .'">
313                     <label for="title" id="title">Title: </label>
314                     <input type="text" name="title" id="title" />
315 
316                     <label for="description" id="description">Description: </label>
317                     <input type="text" name="description" id="description" />
318 
319                     <label for="lat" id="lat">Latitude: </label>
320                     <input type="text" name="lat" id="lat" />
321 
322                     <label for="lng" id="lng">Longitude: </label>
323                     <input type="text" name="lng" id="lng" />
324 
325                     <label for="type" id="type">Type: </label>
326                     <select name="type" />
327                         <option value="sigtmelding" selected>Sigtmelding</option>
328                         <option value="fangst">Fangst</option>
329                         <option value="spot">Spot</option>
330                     </select>
331 
332                     <input type="hidden" value="1" name="page" />
333 
334                     <input type="submit" />
335                 </form>';
336         } //  Start Page 2 of Form
```

Figure 38 – The code snippet of the multi-page form

Illustrated in figure 38, the code snippet enables a few of the required parameters established by the scientists of Fiskeatlas. The rest of the data elements will be developed in next RAD iteration.

The data entered within form fields is stored in the mentioned MySQL database, which consist of a custom made table for storing the observations. The entire multi-page form code snippet can be found within Appendix E. In figure 39 the PHP code snippet for inserting the data into the database is illustrated.

```
337         elseif ( $page == 1 )
338         {
339             //  Grab the POST data that the user provided
340 
341             $title          =   $_POST['title'];
342             $description    =   $_POST['description'];
343             $lat            =   $_POST['lat'];
344             $lng            =   $_POST['lng'];
345             $type           =   $_POST['type'];
346             $page           =   $_POST['page'];
347             $form_id        =   $_POST['form_id'];
348 
349             //  Assign the table and inputs for our upcoming INSERT function
350 
351             $page_one_table = 'markers';
352             $page_one_inputs =  array
353             (
354                 'title'         =>      $title,
355                 'description'   =>      $description,
356                 'lat'           =>      $lat,
357                 'lng'           =>      $lng,
358                 'type'          =>      $type
359                 /*'page'            =>      $page*/
360             );
361 
362             //  Insert the data into a new row
363             $insert_page_one  =   $wpdb->insert($page_one_table, $page_one_inputs);
```

Figure 39 - PHP code snippet for inserting data into the database

The form will be display using a method delivered by WordPress itself. The shortcode functionality within WordPress enables the system to post the shortcode on a page. Once the page is requested by a visitor on the website, the multi-page form will be displayed.

The shortcode implemented on the page within the CMS is illustrated within figure 40.

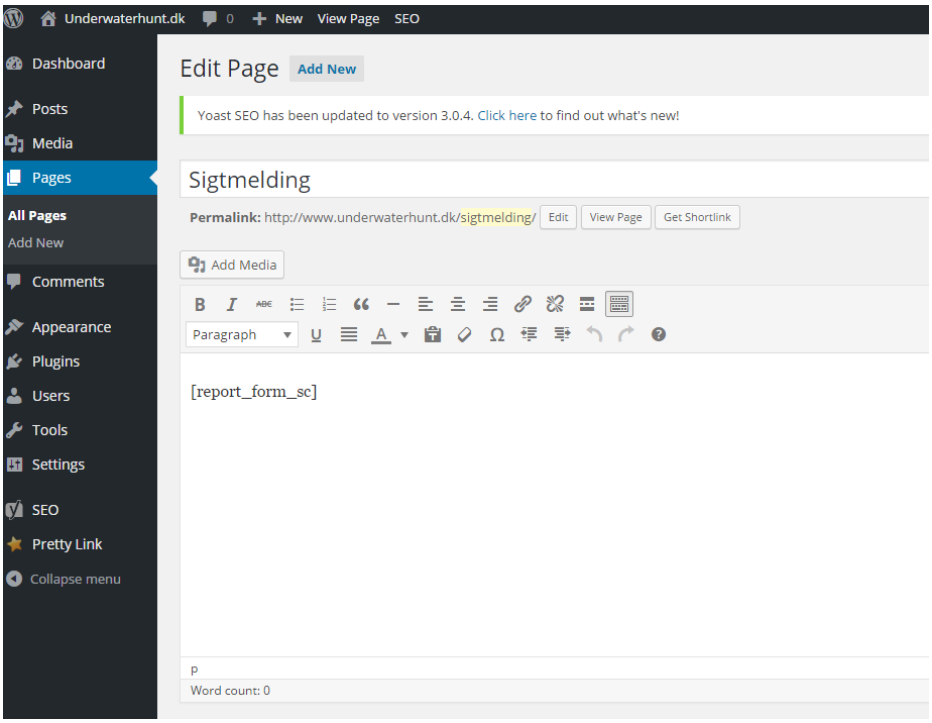

Figure 40 - Shortcode implemented on page in WordPress

As illustrated within figure 40, the short code can be inspected within the content field as [report_form_sc].

The result of the multi-page form implemented on the page is illustrated within figure 41.

Figure 41 - Data form in large view

As illustrated within figure 41, a desktop view of the form is displayed. The title and description is required to be filled out using letters. The latitude and longitude fields are required to be filled out using numbers with decimals in following format - 45.324232.

In addition, the type of observation being contributed with in the form has to be selected among following options; water clarity, hunting area or fish caught.

Within figure 42, the form is displayed in mobile view.

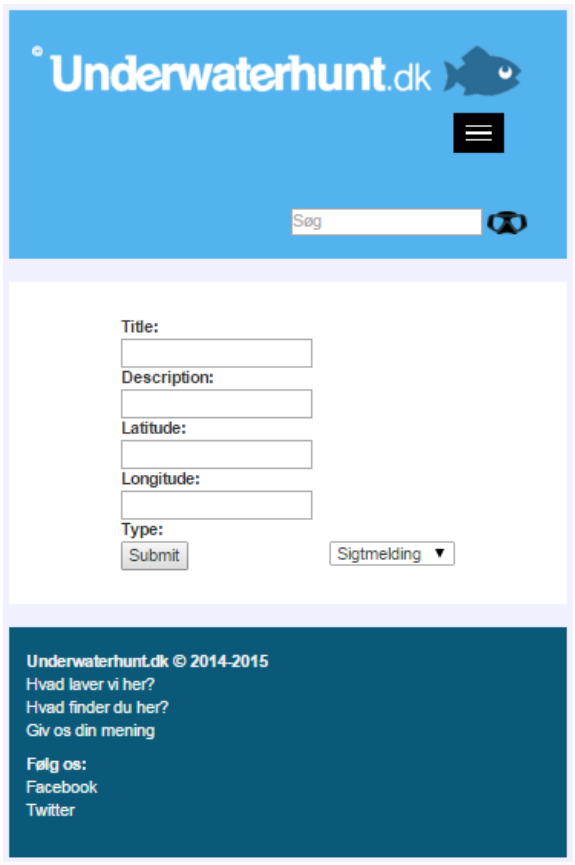

Figure 42 - Data form in extra small view

The final prototype of the reporting application of this RAD iteration will as following be displayed figure 43.

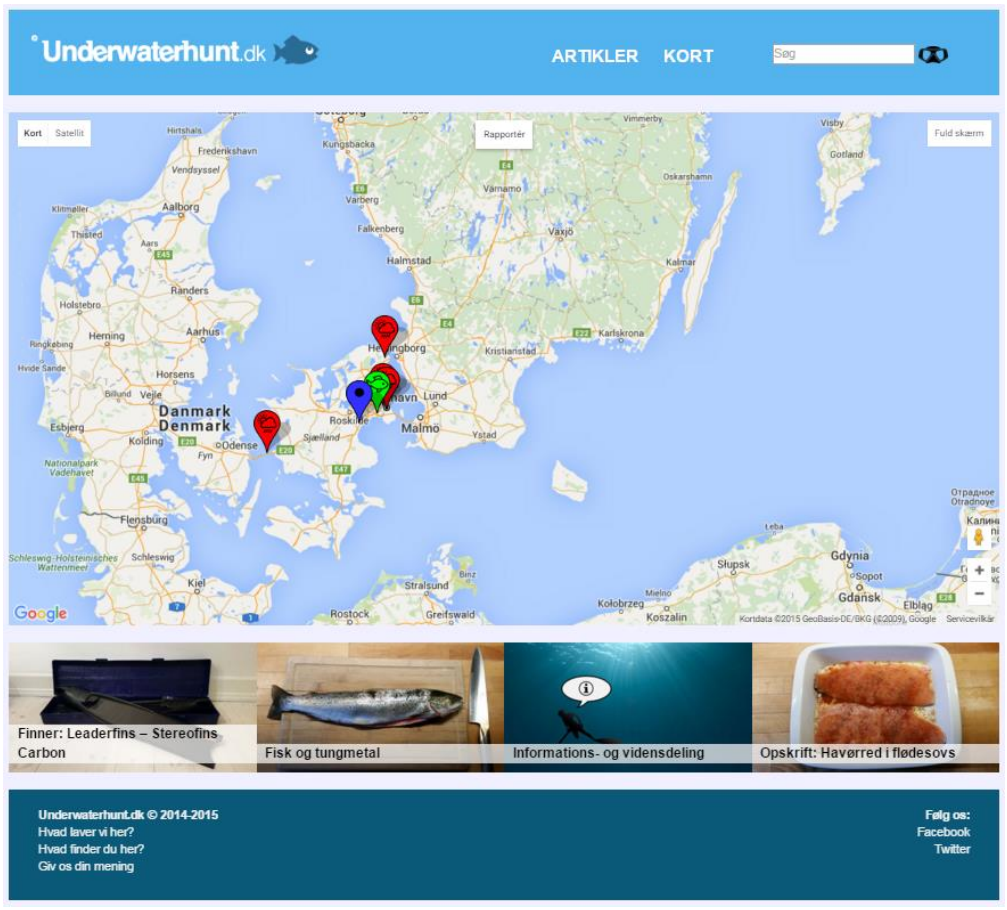

Figure 43 - The final product of the reporting system

This form will enable the Danish spearfishers to contribute an observation into the database of the website – www.underwaterhunt.dk.

4.4 Enabling Fiskeatlas Database Access

The scientists of Fiskeatlas require access to the data stored within the database of the website. During this iteration there was no possibility to develop a custom data export feature within the CMS. The reason was the lack of developing time resources. As an alternative, the scientists of Fiskeatlas are able to use the access which phpMyAdmin delivers to MySQL databases (phpMyAdmin contributors, 2015).

The interface is accessed through following URL - http://www.underwaterhunt.dk/phpmyadmin/.

The interface of phpMyAdmin connected to this website is illustrated in figure 4.18.

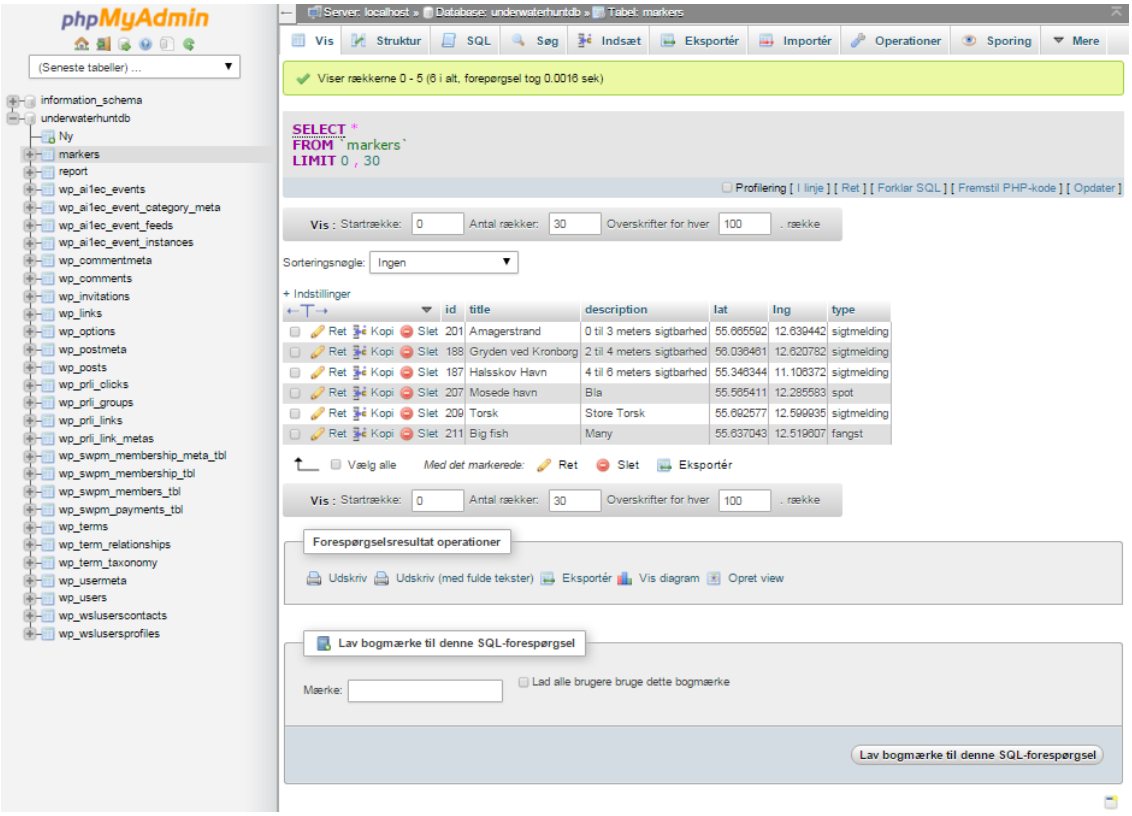

Figure 44 - MySQL database interface

Within figure 4.18, a custom table is displayed which contains the current required data parameters established for this reporting system. Within phpMyAdmin, it is possible to export data tables which will be the current solution for the scientists of Fiskeatlas until a more ideal solution is established.

4.5 Utilizing Social media

In order to meet the requirements of motivating and engaging the volunteer participants and getting the citizen science project exposed to the public, there has been implemented certain tools for increasing the features of www.underwaterhunt.dk.

In figure 45, a screenshot of the CMS is illustrated where the tool called Yoast SEO plugin has been implemented within the system. Yoast SEO plugin is a recognized WordPress plugin for improving the search engine optimization of a website managed by WordPress.

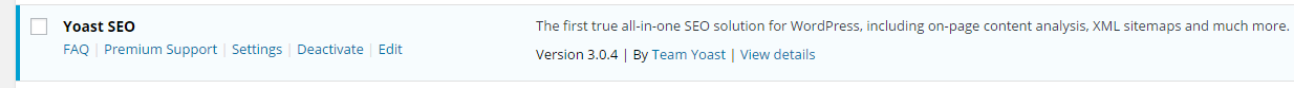

Figure 45 - Yoast SEO WordPress Plugin (Joost de Valk, 2003)

Illustrated in figure 46, one of the website articles details is illustrated. The details enable the possibility to manipulate the content displayed on Facebook when sharing the article on social media such as Twitter and Facebook. This enables the managers of this project and the scientists of Fiskeatlas to expose content the project properly on social media.

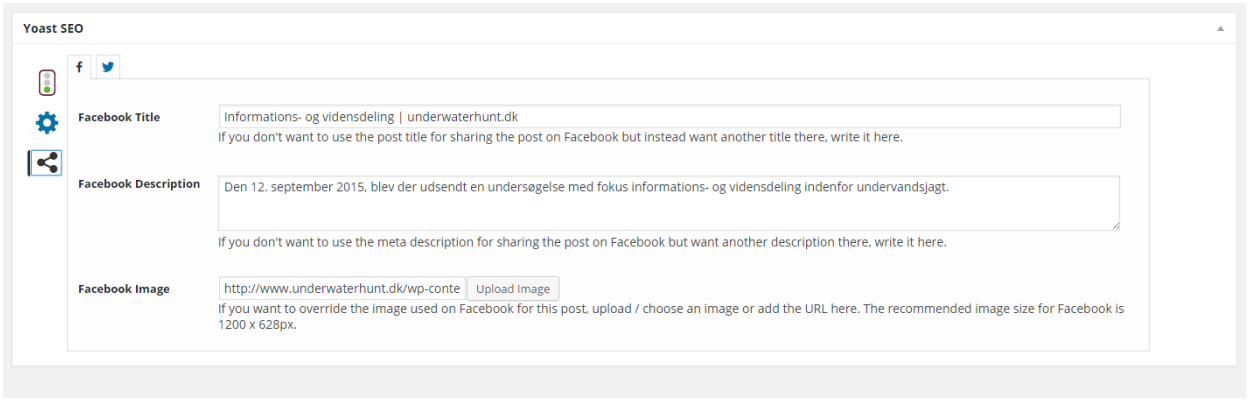

Figure 46 - Settings for Facebook Search Engine Optimization

Similar to figure 46, there has also been enabled the possible to edit the output for Twitter sharing of the content on www.underwaterhunt.dk. This feature is illustrated within figure 47.

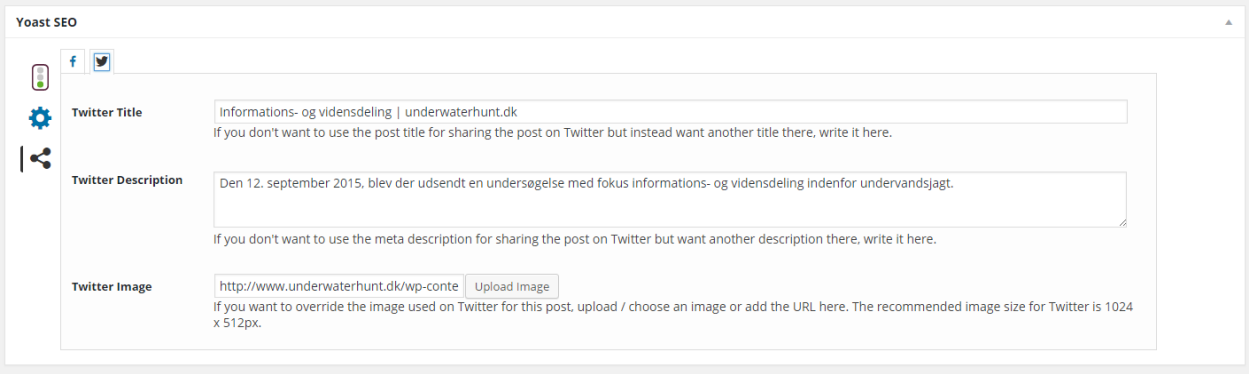

Figure 47 - Settings for Twitter Search Engine Optimization

4.5.1 Facebook

According to the wireframe designs made within the previous chapter, the Facebook page of www.underwaterhunt.dk has been created.

In figure 48, the Facebook page is displayed.

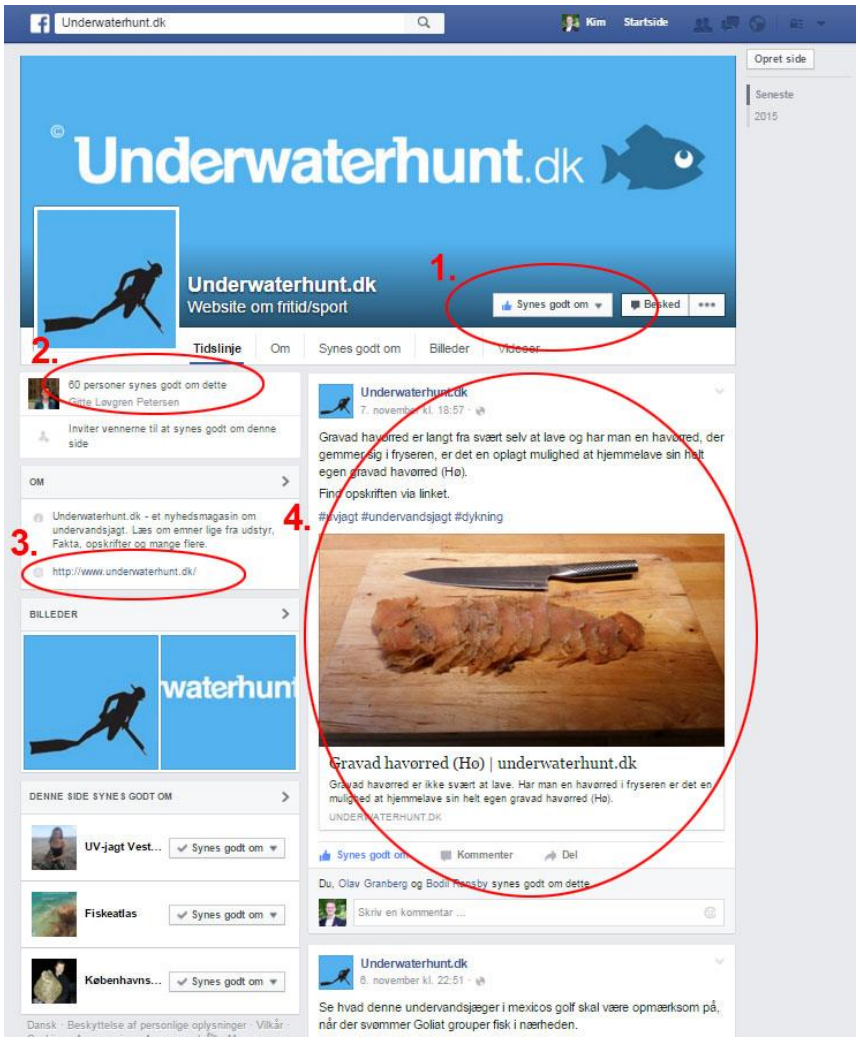

Figure 48 - Screenshot of [www.underwaterhunt.dk's](http://www.underwaterhunt.dk) Facebook page

Illustrated in figure 48, there are several indications of prioritized tools which were required to utilize. Within area 1 it is possible for the Facebook user to Like the Facebook page. This functionality makes it possible for the Facebook page to post new content on the page and the Facebook users who liked the page will get a direct notification about the update. This will enable a more direct contact to the volunteer participants and new potential participants of the project.
Within area 2, a display of the page followers is available. It is expected that more Likes works as a quality stamp for the content and the project in general. Therefore it is interesting to get as many Facebook users to like the page as possible.
Within area 3 there is provided a short elaborate text about the website in general and a direct link. This link will assumingly direct more visitors to www.underwaterhunt.dk.
Within area 4, a chronological list of page post is listed. This list displays the articles shared by the manager of www.underwaterhunt.dk.

4.5.2 Twitter

Similar to the Facebook page previously described a Twitter page with the same objective has been created.

Illustrated in figure 49, the Twitter page is displayed.

Figure 49 - Screenshot of www.underwaterhunt.dk's Twitter page

The screenshot illustrated within figure 49 displays the Twitter page established to promote the application developed in this project. Within area 1 of the figure shows; the amount of Tweets, who the page follows and how many followers the Twitter page got.
The more followers, the more Twitter users it is possible to reach out to when making a Tweet. The second area displayed within figure 49 contains a short elaborate description about the page as well as a direct link for the website. The third and last area displayed contains a list of the Tweeter posts. This area is expected to engage Twitter users to visit the website.

These social media accounts will make it possible for www.underwaterhunt.dk to reach out to a higher number of potential volunteer participants of the citizen science the project developed for in this paper.

4.6 RAD Iteration – Development & Implementation

Similar to the design chapter, the Rapid Application Development (RAD) method will be continued. This chapter uncovers the implementation of the first iteration.

4.6.1 Implementation Iteration One

This chapter continues iteration one of these RAD methods used for software development. This iteration includes the development and implementation of the first prototype created for the Danish spearfishers to contribute and observation with. In addition, this prototype enables the scientists of Fiskeatlas to export collected observations from the database storing the observations. The last element of the prototype of this iteration developed was the element of motivating and engagement potential volunteer participants using social media.

The application, form, website other relevant pages development in this chapter can be visited via following URLs[1].

- Facebook – www.facebook.com/underwaterhunt/
- Twitter – www.twitter.com/uvhuntdk
- Underwaterhunt.dk front page – www.underwaterhunt.dk
- Underwaterhunt.dk application page – www.underwaterhunt.dk/undervandsjagt-og-sigtmelding/
- Underwaterhunt.dk form page – www.underwaterhunt.dk/sigtmelding/
- Underwaterhutn.dk XML page – www.underwaterhunt.dk/map-data-feed/

Following there will be experimented with the user experience using the prototype developed and implementation within this chapter.

[1] Be aware that the pages can be changed after the release of this paper due to further development.

5 Experimentation Methods

The previous design and implementation of the first RAD iteration has been completed and the next phase of the iteration is the user experience experimentation. To conduct a user experience experimentation it is necessary to establish the methods used to structure and properly complete the user experience experimentation. The objective of this project is to develop an application with the best user experience possible measured using specific metrics.

This chapter will uncover the methods used and considered when planning and conducted this user experience experimentation. The results collected from this experimentation will be statistically processed within next chapter to measure and conclude how well the user experience is performing.

5.1 Usability Experimentation Preparation

In order to conduct a user experience experiment there has been defined two study goals; a study goal based on the spearfishers' requirements and a study goal of the project has also been established.
The reason to define these study goals is to figure out the proper metrics to measure, process and conclude on (Tullis and Albert, 2008).

5.1.1 Study Goals

To define the two study goals a decision about how the data from the experiment will be processed has been made. One amongst two different recognized methods of processing data has been chosen. The two methods to choose from is either known as formative- or summative methods of processing data (Tullis and Albert, 2008).
In this project, it has been chosen to use the method of summative data handling. The objective of summative user experience experimentation is to evaluate how well a prototype, meets its objectives. Summative experimentation focuses on evaluating a certain set of criteria's. The summative experimentation evaluation, will answers following questions (Tullis and Albert, 2008):

- Did the service meet the user experience goals of the project?
- Have there been made improvements from one version to another?

These questions will be addressed when finishing a RAD iteration of design and development according to the life cycle process.

5.1.2 User Goals

For the user experience experiment it is also necessary to define the user goal in order to understand what the users are trying to accomplish. This boils down to measuring two primary aspects of the user experience which in general concerns about performance and satisfaction (Tullis and Albert, 2008).

Performance measure is about what the user actually does when interacting with the application and the satisfaction measure is about what the user says and thinks about interacting with the application (Tullis and Albert, 2008).

The requirements established during the JAD workshop and documented within the final document, should basically provide a goal of overall positive user experience when boiled down to one goal. It is therefore interesting for this project to make sure that the system in general delivers a positive user experience to the user of the application.

To figure out if the application delivers an overall positive user experience based on the experiment, it will be necessary to measure two different kinds of metrics during the experiment. One metric will be a performance metric and the other metric measured will be a self-reported metric with a focus on what the user thinks and feels using the service. These two kinds of metrics will complement each other since the performance metric will be an objective measure based on numbers. The other metric will be a subjective measure based on the experiment participant's opinion. This setup will make it possible to triangulate and calculate possible correlation of the metrics measured for improving the accuracy and quality of the results.

5.1.3 Final Usability Study

Based on the study-and user goals, it has been decided to experiment with the user's overall positive user experience. Similar to the project named - Opdag Havet, they assumingly also strive to create a good user experience, but it is not enough to only deliver a great user experience. An application needs to be engaging and maybe even addictive.
Specific performance metrics could be useful to the experiment compared to others, but what matters is what the volunteer participants think and feel about their experience using the application. Self-reported metrics must be considered as the primary metric when measuring the overall user experience, where performance metrics will be considered as the secondary metric. Both parameters will be analyzed for any correlations.

5.2 Study Details

Prior to the experiment, the general methods of experiment details have been considered as well. Structuring a user experiment properly will decrease the risk of any unexpected failures and mistakes (Tullis and Albert, 2008).
Performing the proper preparations there has been considered the following conditions: budget and time, participants, data collection and data cleanup. These elements has been considered and documented as follows.

5.2.1 Budget & Time

The budget and time relevant to this user experience experiment depends on the evaluation method, metrics, participants and the tools available (Tullis and Albert, 2008).

When conducting an experiment with a large number of participants (more than a dozen) there is typically an effect on the budget and time (Tullis and Albert, 2008). The most impacted parameter is time. Collecting participants and conducting the experiment can be a resourceful matter. In this case, spearfishers are a small group of people scattered around the country which makes it hard to recruit participants for the experiment.

Also considered is time dedicated for processing the data collected during the experiment. The experiment and data processing will begin in the end of November 2015 and end in the middle of December. This period will include the actual experiment and data processing. This structure will become the standard experiment method for the following experiments of the RAD iterations.

5.2.2 Participants

Recruiting the proper participants within a user experience experiment has a major impact on the findings. The steps used to recruit the proper participants are as follows:

- Participants must be a spearfisher
- Living in Denmark
- Active user of the internet
- Interested in sharing information

Based on the inclusion criterions and the wide scatter of potential experiment participants, the methods used for selecting participants is a nonprobability sampling method. The reason is that the method chosen does not involve random selection of participants. More specific grouped, the nonprobability sampling method used within this project is a purposive sampling method based on the specific approach of finding Danish spearfishers to recruit (Johnson and Christensen, 2012). Being ideally specific about the purposive sampling method there was used a Quota sampling method for recruiting participants (Johnson and Christensen, 2012). This method enables this project to select participants nonrandom according to the criterions established above (Johnson and Christensen, 2012).

The amount of participants recruited for the user experience experiment for this initial RAD iteration was required to be at least 20 participants, because of the limited time available. The recommended amount of participants for a summative user experience experiment is between 50 to 100 participants (Tullis and Albert, 2008). The low amount of participants required for the initial RAD iteration will result in high variance of the data collected. The following RAD iteration will strive to recruit at least 50 participants.

In addition, the Code of Ethics established by the American Educational Research Association was considered during the experimentation[2].

5.2.3 Data Collection

The data collected during the user experience experiment will initially be stored using Google Drive Form tool (Google inc., 2015).

Two forms are made as tools for collecting data. The first form is a self-reported questionnaire intended to be answered by the participant of the experiment. This form will contain an after-scenario questionnaire which is a recognized questionnaire to measure user experience based on three focus points (Tullis and Albert, 2008). The form can be reviewed within Appendix F.
The second form used as tool for collecting data, is also a questionnaire which is answered by the facilitator of the experiment. This questionnaire has an objective to gather the performance metric data. The questionnaire can be inspected in Appendix G.

[2] http://www.aera.net/Portals/38/docs/About_AERA/CodeOfEthics%281%29.pdf

5.2.4 Data Cleanup

Data collected from an experiment with participants do in most cases not deliver clean data tables. Cleanup is necessary to perform after the experiment and before analyzing. Following methods was used to clean up the data before processing.

Filtering data - Extreme values will be handled if appearing (Tullis and Albert, 2008). In addition, participants which showed that they do not fit into the inclusion criterions will be removed from the data tables.

Creating new variables - Processing the original data can be necessary (Tullis and Albert, 2008). If other metric data or a combination of metric data is needed they can be added. It is although necessary to process the collected data from the experiment with caution.

Verifying responses - If the responses provided by the participants appear to show a similar wrong understanding of the question, the question or experiment will be investigated and evaluated (Tullis and Albert, 2008).

Evaluating consistency - All data is required to have a consistent registartion (Tullis and Albert, 2008). It is important to check the consistency of collected data on regular basis during the experimentation. Evaluating consistency is especially important with self-reported metrics since the data is contributed based on the participant's subjective opinion which can be scattered if poor questions are asked (Tullis and Albert, 2008).

Transferring data - Data will be captured using Google forms and processed using Excel to develop and establish descriptive graphs and statistical calculations.

The mentioned methods for processing data are necessary to establishing a framework for the experiment to be conducted within. The more stable frame the experiment can be conducted within there more accurate and reliable data can be collected.

5.3 Measured Experimentation Metrics

The experimentation conducted included two metric categories being measured and collected. The first metric category being measured and collected is the self-reported metric for measuring the overall positive user experience using the After-Scenario Questionnaire (ASQ). The other metric category is actually two performance metrics measured and collected. One performance metric measuring task success and the other performance metric measured is time-on-task. The reasons for choosing these three metrics will be elaborated on as follow.

5.3.1 Self-reported Metric

The question of the developed application which matters the most, is figuring out what the user thinks about the application and how they experience the application. The term for describing this type of data is subjective data or preference data (Tullis and Albert, 2008). Self-reported data provides the most important information about the user opinion about the application and their interaction with it.

After Scenario questionnaire - within this experiment there is used the recognized After-scenario questionnaire (ASQ). The ASQ contains three fundamental questions concerning usability of an application. The questions used in this project experiment are formulated as follows (translated from Danish to English).

- Overall, I am satisfied with the ease it was to create a report.
- Overall, I am satisfied with the amount of time it took to create a report.
- Overall, I am satisfied with the help that was available when I created a report.

Enabling the participants to answer the three questions, is using a Likert scale which stretches from strongly disagree to strongly agree. The first question represents effectiveness. The second question represents efficiency and the last question represents satisfaction (Tullis and Albert, 2008). The final questionnaire can be inspected within Appendix F.

5.3.2 Performance Metric

When interacting with an application in order to complete a task the user is performing an action which is possible to measure. The way of measuring this action is based on performance metrics. Without a task, performance metrics is not possible to measure (Tullis and Albert, 2008). This type of metric is the most proper way to evaluate the effectiveness and efficiency of many different products. The performance metrics is also useful to estimate the magnitude of a specific usability issues. Two performance metrics has been chosen to be measured for each participant of the experimentation. Following there is a description of what the two performance metrics are and how they are benefited from in this project.

Task success - The first performance metric being measures is known task success which is a common usability metrics that can be measured for any user experience experimentation studies. This metric can be used to measure the completion of a task (Tullis and Albert, 2008).

Although, it has been considered how to handle the metric if the participant cannot complete a task nor needs help to complete the task. In this experiment, the measurement of the task success metric can result in three different outcomes (Tullis and Albert, 2008). These outcomes are listed as follows.

- Complete success (Without assistance) = 1.0
- Partial success = 0.5
- Gives up = 0.0

One limitation of this categorization of task success is that it does not differ between the types of reason why the participant gives up

Time-on-task - Time on task is the second measured performance metric which is an excellent way to measure the efficiency of an application. The time-on-task is a metric which is significantly important for an application which is used repeatedly by a user. The more often a task is performed by the same user, the more important efficiency becomes (Tullis and Albert, 2008).

The method for recording the time-on-task metric during an experiment is typical performed using a digital stopwatch. When measuring time-on-task during the experiment, it is important to be consistent about when to start and stop the clock during. In this projects experiment, it is chosen to start the measurement when the participant is asked to start contributing a fabricated observation provided on a piece of paper. The clock is stopped, when the report has been given within the system or if the participant says he or she gives up.
A rule about when to pause the time during the experiment has been established. The participant is able to ask for help during the experiment, but the time will not be paused.
An experiment with a non-successful completion will not be included in the time table since this will provide a biased data set. However, a non-successful experiment will be registered for further processing

6 User Experience Experimentation Results

The experimentation was conducted on duration of ten days. The experiment stretched from the 27th of November 2015 until the 6th of December 2015. 20 spearfishers were recruited as participants during the experiment. Two of the experiments participants were females and 18 participants were males. The age range of the participants stretched from 22 years up to 42 years old. Within table 6.1 an overview of when the participants performed the experiment and how many performed is listed.

Participants	Date
3 participants	27/11/2015
2 participants	28/11/2015
2 participants	02/12/2015
8 participants	05/12/2015
5 participants	06/12/215

Table 1 - List of participants and dates (Appendix I)

The participants were recruited with the assistance from Copenhagen spearfishing team which is located during the winter, at Emdrup Badet.

The structure of every experiment was conducted as follows. The participant was asked the inclusion criterions which was:

1. Are you active spearfishers?
2. Are you living in Denmark?
3. Do you use the internet on a regular basis?
4. Are you interested in sharing information about spearfishing?

When the participant asked yes to the inclusion criterions the participant was explain in Danish that he or she was about to use the application developed and implemented on the website named www.underwaterhunt.dk. A laptop was provided with a browser displaying the homepage of the website. The participant was asked to contribute with either a fictional observation on the website. The participants were allowed to either give up or ask the experiments facilitator questions about what to do if in doubt. In that case, the participants could only score 0.5 on the Task success metric measured

Two questionnaires were used during each experiment. One questionnaire was answered by the participant (Appendix F). The other questionnaire was answered by the experiments facilitator (Appendix G). The results of the experiment can be found within Appendix H and I.

Following, the data results of the experiment will be processed and explained.

6.1 Self-reported Metric Results

The self-reported metric measured was collected using the After-Scenario Questionnaire adapted for this experiment (Lewis, J.R., 1995), contained three Likert scales measuring; effectiveness, efficiency and satisfaction. The questionnaire used during the experiment can be found within Appendix F and the results can be found within Appendix H. The results of the experiment has been processed and measured as follows.

6.1.1 After-Scenario Questionnaire Results

This recognized After-Scenario Questionnaire (ASQ) (Lewis, J.R., 1995) has been used within this experiment and the three Likert scales provided following results.

Effectiveness - In figure 50, the results of the participants opinion about the effectiveness of the application on www.underwaterhunt.dk is widely scattered. However, a Gaussian distribution on the Likert scale is appearing which indicates a potential well representation of the population's opinion.

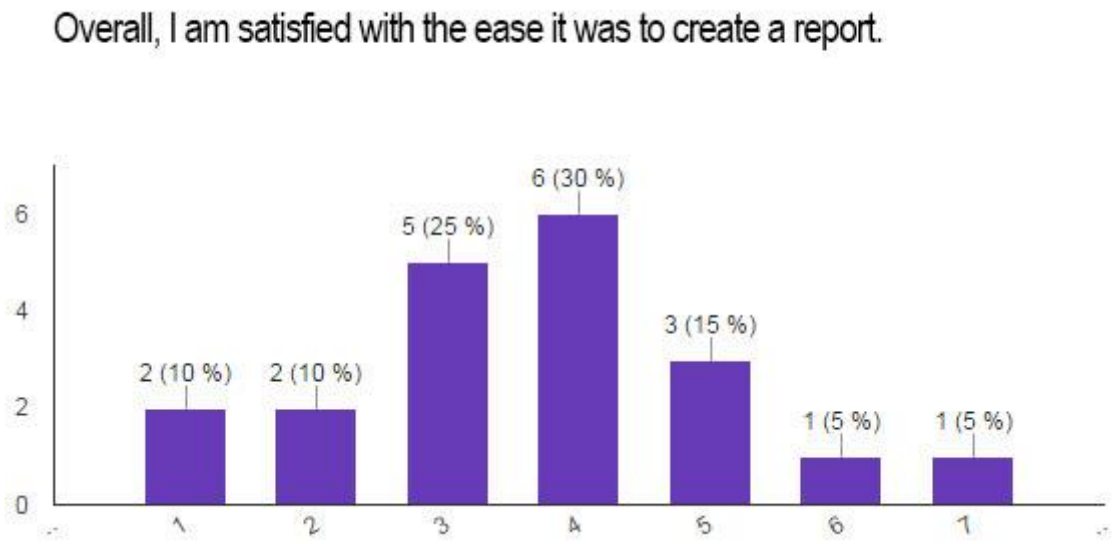

Figure 50 - Question 1 of the ASQ about effectiveness

Illustrated within figure 50, most participants clustered on interval 4 measured on the Likert scale with a sample size amount of 6 out of 20 which 30 % of the total sample size. The interval with the second highest sample size is interval 3 with 5 out 20, which is 25 % participants of the total sample size.

This indicates that the participants are mainly neutral in the opinion about the satisfied ease of use to contribute an observation using the application. The second largest group of participants clustered on in figure 50 is placed on interval 3 which indicates a smaller disagreement of the ease of use.

The objective of this questionnaire would have indicated the participants opinions being distributed in the right side of the Likert scale indicating a strong agreement in the satisfaction with the ease of use to create a report.

Efficiency - The second question of the ASQ was focusing on efficiency by questioning the participants on a Likert scale how much they agree on the application being satisfactory based on the time it took to contribute an observation. Illustrated in figure 51 the result of the second question of the ASQ is indicated.

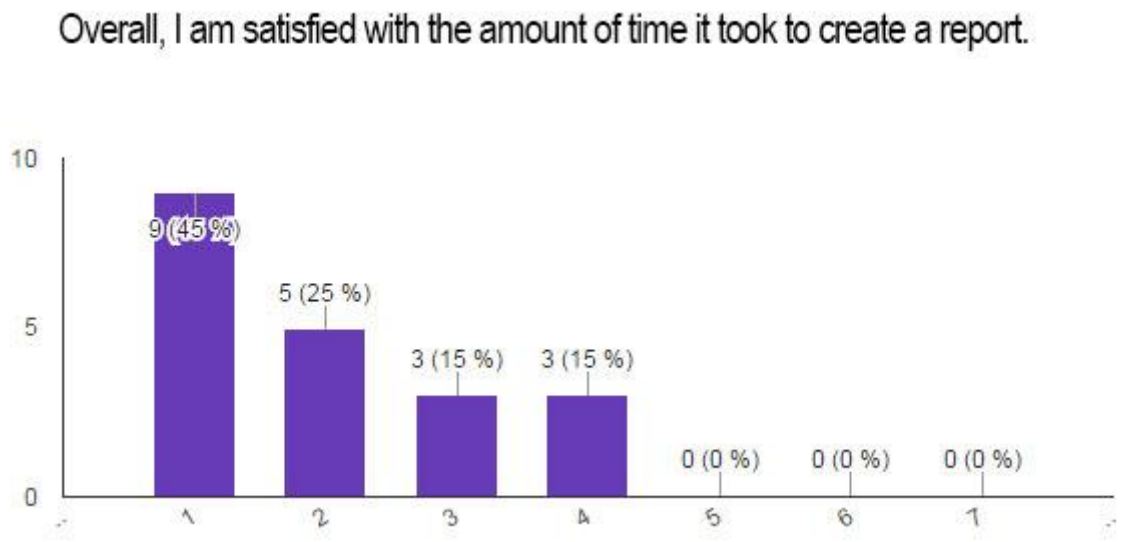

Figure 51 - Question 2 of the ASQ about efficiency

As illustrated within figure 51, 9 out of 20, which are 45 % of the total sample size, answered interval 1 of the Likert scale. This result indicates a strong disagreement on the satisfaction of time it took to contribute an observation. Almost all participants indicated disagreements with the satisfaction of time spend. This result is not a positive result since it indicates that the time required to contribute an observation takes too much time to complete.

Satisfaction - The third and last question of the ASQ measures the overall satisfactory opinion of the application when used. In figure 52, the results of the participants answers is illustrated.

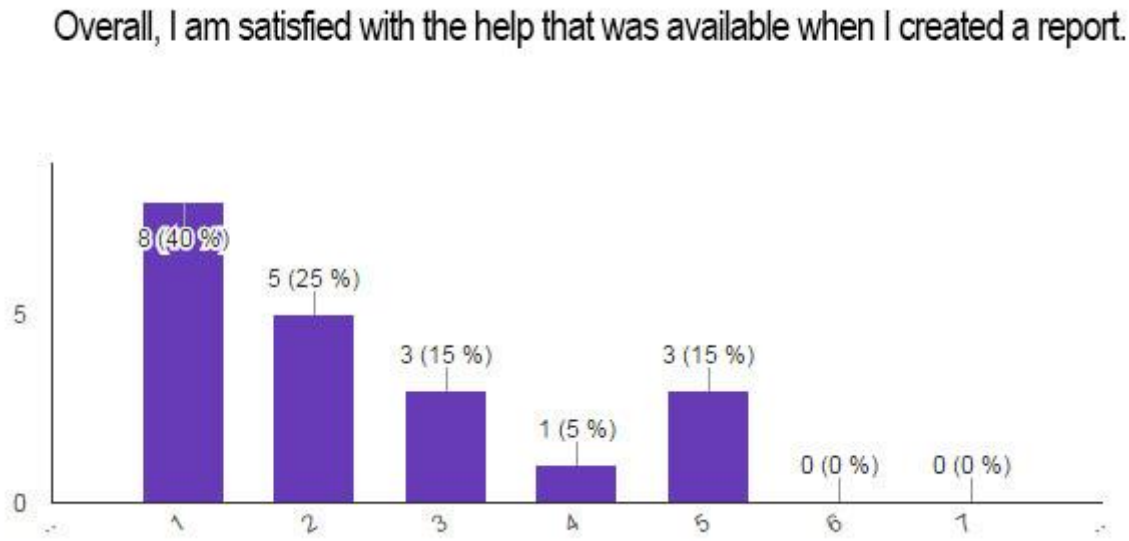

Figure 52 – Question 3 of the ASQ about satisfaction

Illustrated in figure 52, the distribution of the measurements indicates a scattered opinion about the overall satisfactory experience of the application. Unfortunately, the results are leaning towards a disagreeing opinion of the Likert scale, which indicates that the application is not delivering a satisfactory experience for the participants. The majority of participants were distributed in interval 1 with 8 out of 20, which is 40 % of the total sample size. This indicates a strong disagreement of the overall satisfaction.

6.1.2 After-Scenario Questionnaire Findings

The results of the ASQ indicate a blended opinion of effectiveness based on the participant's answers, but improvements are definitely required since the results of all three questions indicate a poor effectiveness, efficiency and satisfaction when using the application.

In addition, the results of the ASQ do show a low efficiency on time spend based on the participants believes. The time efficiency factor of the service requires major improvements. Similar to the efficiency factor, is the overall satisfaction factor also low in the opinion of the participants. These factors also need major improvements.

6.2 Performance Metrics Results

Two performance metrics was also measured during the experiment. The objective of the performance metrics was to collect objective measured of the participant's interaction with the application. Measuring task success will reveal if the participants are able to successfully report an observation based on three levels. The second performance metric measured was Time-on-task, which will reveal how much time the participant was spending when contributing an observation.

6.2.1 Task Success Results

The task success performance metric is beneficial for calculating any user experience study that includes a task. In this experiment, the task the participant is performing is contributing an observation. To measure this metric for every participant performing the experiment, the measure is collected using the questionnaire which can be inspected in Appendix G. The questionnaire has been filled out by the experiment facilitator and the task success is categorized into three levels of success which is listed as follows.

- Complete success (without assistance = 1.0)
- Partial success = 0.5 (with assistance)
- Gives up = 0.0

This success score is processed to display the amount of the participants who fall into each category. The results are illustrated within figure 53.

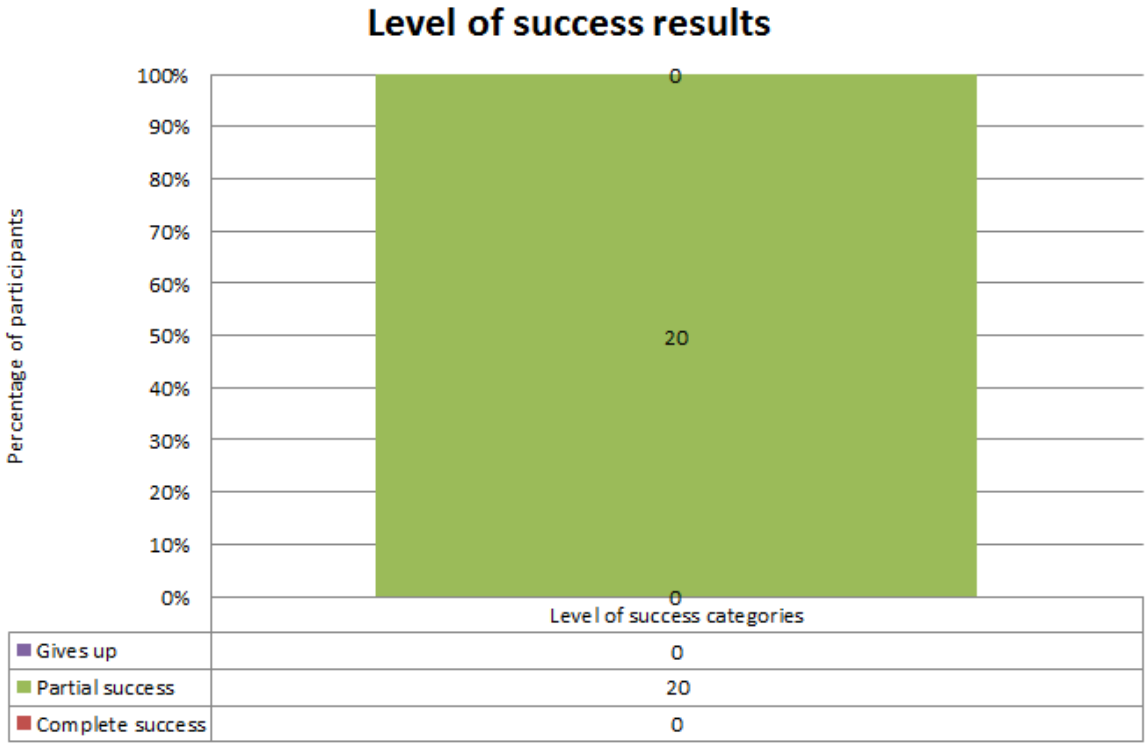

Figure 53 - Stacked bar chart showing levels of success based on task completion

The results illustrated in figure 53, reveals that all participants completed the task, but only with partial success. None of the participants gave up during the experiment, but in contrary no participants did successfully complete a contribution without asking the experiment facilitator for help.

6.2.2 Time-on-task Results

The second performance metric measured during the experimentation was provided by the facilitator. Data can be reviewed within Appendix I. The Time-on-task metric is recognized as an excellent way of measuring efficiency (Tullis and Albert, 2008).

The facilitator registered the measured time-on-task metric of each participant using a digital stop watch. The time was measured in seconds for making it easier to process the data later.

The results of the experiment have been process and the calculation of the geometric mean of the time on task has been made. Most user experience specialists suggest that the geometric mean is a less biased parameter when calculating time (Tullis and Albert, 2008). Geometric mean computes the logarithm of all sample values, computes the mean of the logarithms and following calculate the antilogarithm (Tullis and Albert, 2008). The geometric mean is the most proper for measuring central tendency when data sample follow a log-normal distribution as illustrated in figure 54.

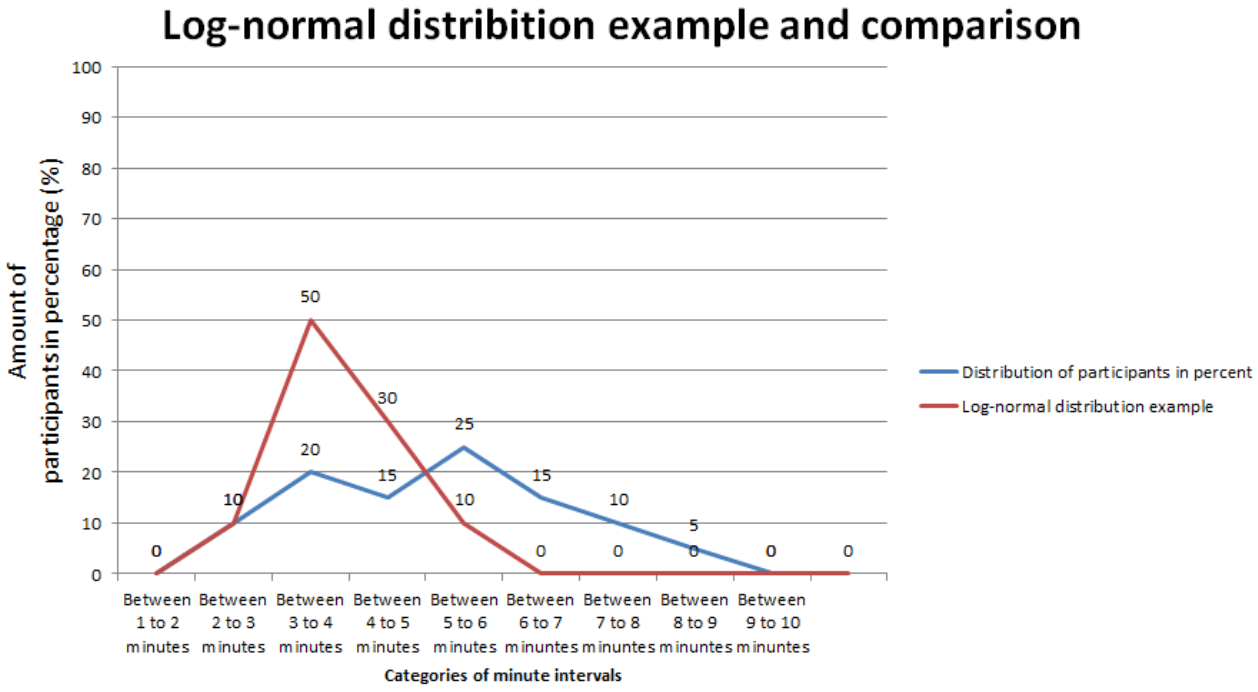

Figure 54 - Log-normal distribution example and comparison

In comparison, the mean simply adds up the values and divide the sum by the number of sample values. The median is the 50th percentile was half the sample values are higher than the median and half the sample values are lower.

Within table 2, the calculated results of the inferential statistic variables are listed.

User Experience Experiment - Iteration 1	
Inferential parameters	Values
Geometric mean of time-on-task	290,8649256
Count	20
Alpha	0,05
Standard deviation	97,78465868
Confidence interval	42,85522876

Table 2 - Table containing inferential statistics of Time-on-task data

Using the variables from table 2 to calculate the 95 % confidence interval which will reveal which interval of where the population is expected to appear within. Inspect figure 55 to find the processed data being visualized.

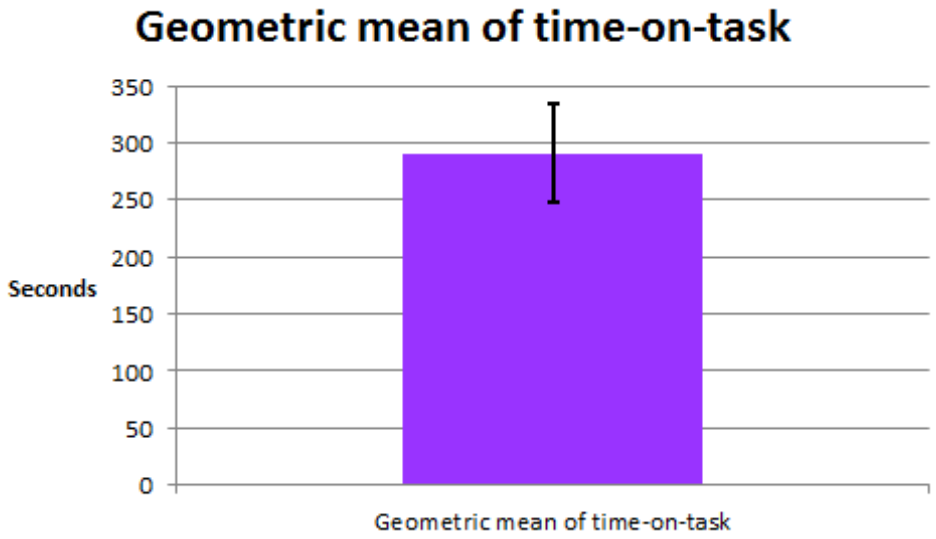

Figure 55 - Geometric mean time-on-task for experiment iteration with confidence interval

Illustrated within figure 55 and listed within table, the geometric means has a value of 290.86 with a confidence interval on 42.86 indicated above and below the geometric mean value. This indicates that the population, with 95 % certainty, will appear in the time interval of 248 and 332.86 seconds.

Reducing the scatter of the population and the geometric mean of the time-on-task is needed for improving the efficiency in time of the application.

Threshold - It is also in this projects interest to analyze the data by categorizing the time into intervals. This has been done within this data analysis. The intervals are established by minutes. The fewer minutes spend on the task, the better and more efficient the service will become. In figure 56, the distribution of participants in time categories illustrated.

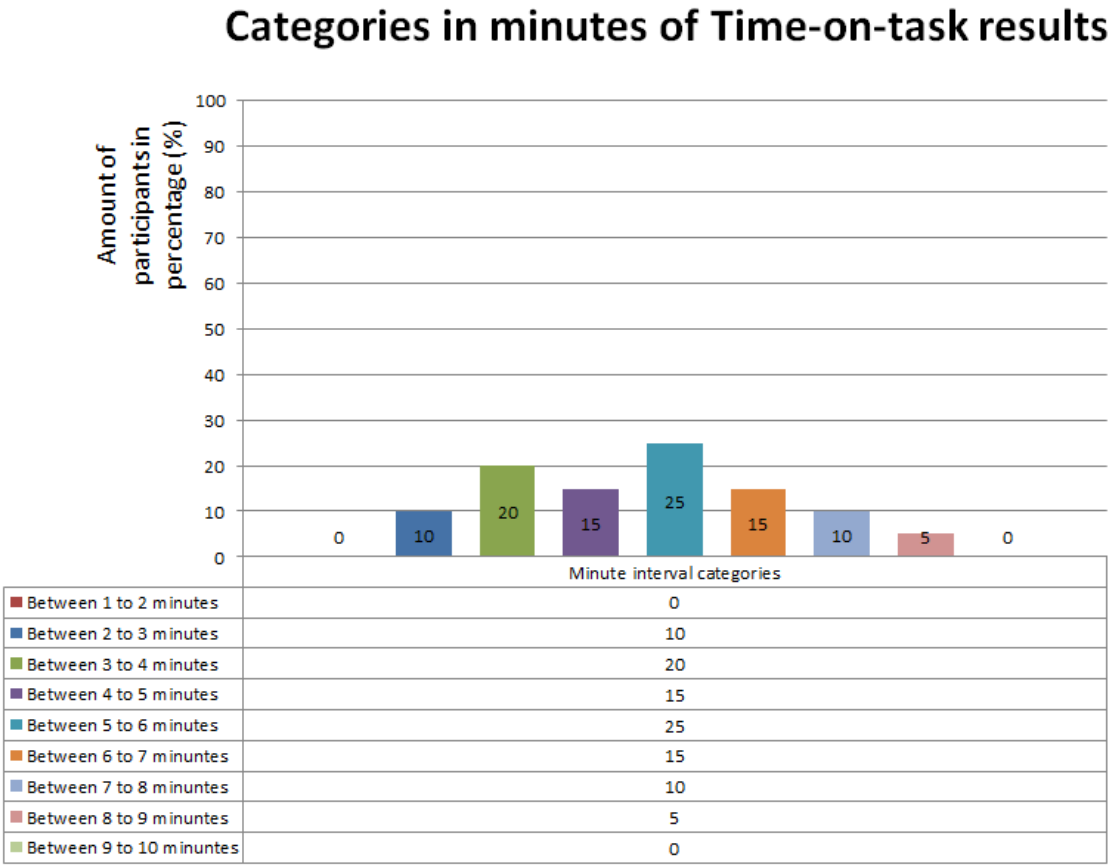

Figure 56 - Percentage of participants who completed the experiment in different time intervals

Revealed within figure 56, the highest percentage of the participants spending time on the task is distribution in the interval from 5 to 6 minutes. The objective of future RAD iterations will be moving the majority of participants into the lower intervals in minutes.

6.2.3 Performance Metric Findings

The findings gained when measuring performance metrics and thereafter processing them indicates a low efficiency in time spent contributing an observation. Contributing an observation should not require more than two minutes of time to spend. This will be a main focus to improve in next RAD iteration. As well as a poor level of success, the participants should be needing help from a facilitator when contributing an observation. Instructions can be implemented within the system, but it is no interested to require personal assistance.

6.3 Metric Correlations

Both metrics measured during the experimentation are recognized as two different types of metrics as explained. One metric is measured based on subjective data measured and the other metrics is based on objective data measured. However, the metrics has independently been chosen with the focus to measure the following user experiences; effectiveness, efficiency and satisfaction.

The self-reported metric, which was the first question of the ASQ, represented effectiveness similar to the performance metric named task success. These two metrics will as follow be calculated and analyzed if any correlation appears among them.
In addition, the will also be calculated and analyzed of any correlation is among the the second question of ASQ and the performance metric named time-on-task.
Although, it has been realized that no performance metrics has been measured which reflects satisfaction. In this case, no correlation can be made between the missing performance metric and the subjective metric measured representing satisfaction. It is necessary to establish a performance metric for next RAD iteration which will measure satisfaction.

6.3.1 Effectiveness Correlation

As mentioned, a calculation and analysis of collection between of the effectiveness has been conducted. However, it was not possible to calculate any correlation of the two metrics since the performance metric – task success was insufficient. As illustrated in figure 57, the task success parameter was distributed as the same result by al 20 participants.

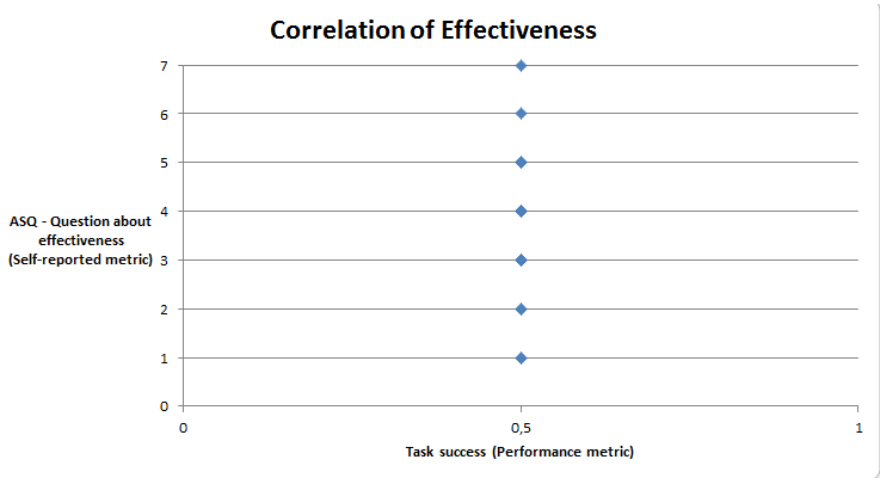

Figure 57 - Scatter plot illustrating the correlation of the efficiency metrics

A prioritization for next RAD iteration will be improving the metric measured for task success in order to measure the correlation event though the participants do not complete the contribution without help.

6.3.2 Efficiency Correlation

The second correlation conducted was between the two metrics representing efficiency. This correlation calculation delivered useful results.
The calculated correlation coefficient resulted in following value; r = -0,28. The scatter of the correlation can be inspected within figure 58.

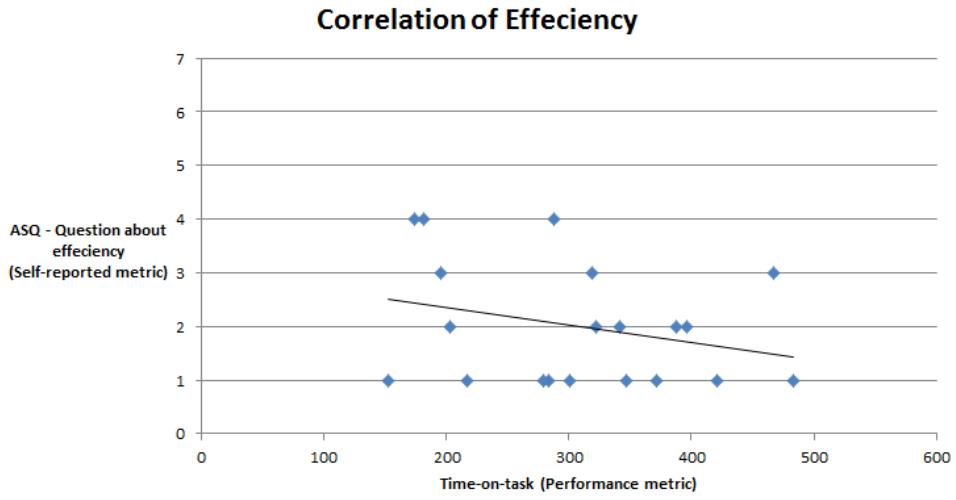

Figure 58 – Scatter plot illustrating the correlation of the efficiency metrics

According to table 3, the value gained from calculating the correlation coefficient based on the metrics of effectiveness, it can be concluded that there appears to be little of any correlation among the results.

Size of Correlation	Interpretation
90 to 1.00 (-.90 to –1.00)	Very high positive (negative) correlation
.70 to .90 (-.70 to -.90)	High positive (negative) correlation
.50 to .70 (-.50 to -.70)	Moderate positive (negative) correlation
.30 to .50 (-.30 to -.50)	Low positive (negative) correlation
.00 to .30 (.00 to -.30)	Little if any correlation

Table 3 - Rule of Thumb for Interpreting the Size of a Correlation Coefficient

6.4 User Experience Experimentation Findings

The general findings of the first iteration of the user experience experiment reveals that the application is still in its early phases of development. Both self-reported- and performance metrics indicates that the application does not deliver great user experience using the prototype developed during the first RAD iteration.

Indications of correlating metrics between the self-reported metric collected using the ASQ and the performance metric of time-on-task is found, but did not indicate any significant correlations either.

7 Discussion

Throughout this project it has been possible to establish an argument for joining together the scientist of Fiskeatlas and the Danish spearfishing community. Assumptions, investigations and discoveries were made during the first chapter of this paper. The process made it possible to establish a problem statement for this project to continue a more thorough and academic investigation and analysis approach. Requirements were established during the end of the analysis chapter in this paper. These requirements were established together with the participation and contribution from spearfishers and the scientists from Fiskeatlas. A single iteration according to the Rapid Application Development process was performed which included design, implementation and experimentation. An experimented prototype was the result of the first RAD iteration.
This results currently ends at this discussion chapter were this paper will address the biggest challenges discovered during this project as well as the benefits gained. This discussion will be used for the future second Rapid Application Development iteration of this project. In addition, the objective of this discussion is also that other citizen science projects or similar projects will benefit by reading this paper in their development towards a future state of the art, of citizen science.

7.1 Experiment Results

The first Rapid Application Development iteration ended in this paper with the results of the experiment. To improve the application based on how it works now, it is necessary to reflect upon the results gained from the user experience experiment. As described earlier there was measured to kinds of metrics; self-reported- and performance metrics. These two kinds of metrics harmonized in a proper way to provide a subjective and objective perspective on the performance of the service.
Even though it was concluded in previous chapter that both metrics when processed, showed a poor results, it is following possible to consider how the application can be approved. To figure out how to improve the product it is necessary to compare the final document found in Appendix M, with the application and figure out what is missing to be implemented for improving user experience for both spearfishers and scientists.

7.1.1 Measured Metrics

Another aspect to consider about the chosen measured metrics would be performing a proper triangulation between the self-reported- and performance metrics. The After-Scenario Questionnaire reveals the effectiveness, efficiency and satisfaction of the service. In comparison, the two performance metrics chosen reveal efficiency (Time-on-task) and effectiveness (task success), but no performance metric was used to reveal an objective performance measurement of satisfaction.

If a performance metrics could measure the satisfaction of the use of the application, it could be beneficial to establish a triangulation method for reviewing the respective self-reported- and performance metrics against each other to reveal a correlation if any.

In addition, to enable proper triangulation methods for establishing accurate, reliable and quality data from the experiment, it will be beneficial to also document the participants comments during the experiment while the facilitator ask them questions with focus on; effectiveness, efficiency and satisfaction.

7.2 Background Knowledge

Throughout the introduction and following analysis chapters much knowledge was investigated as well as current citizen science project. Scientific research material was used for establishing documented and proven reasons for implementing and making use of certain features and methods when developing the application. It was also necessary to study and investigate the papers focusing on citizen science and the elements of the concept. Gained through the investigation was following three topics discovered which means a great part to a citizen science project.

7.2.1 Data Quality

As discussed with the scientist of Fiskeatlas, there was mentioned that volunteer participants are assumingly not well at remembering all details when contributing an observation, needed for proper documentation. Fiskeatlas has over the years established certain requirements for the observations to obtains into their database and become part of the empirical data used for writing a book about fish species living in Danish waters.

A certain tools was uncovered named MIT's Total Data Quality Management (TDQM) model which as mentioned is a method for analyzing and improving the data required from the volunteer participants. This TDQM model could be applied within the developed application to improve the existing data parameters required by the scientist from Fiskeatlas, for improving their data.

It is recognized, however, that Fiskeatlas has spent years of experience developing their table of data parameters which delivers a certain high amount of data quality as well, when implemented within the final product of this papers project.

7.2.2 Data Reliability

Another high level topic relevant for this papers project and for all citizen science projects in general, is data reliability. Uncovered within the analysis of this paper, data reliability is about the trust of volunteer participants and the intention of joining a citizen science project as well as what abilities do the volunteer participants have available when recognizing species.

Optional participant training is considered to be developed and made available for volunteer participants. Educating the participants in recognizing species would increase data reliability. However, not all participants are likely to join optional trainings.
A method for gamifying the improvement of data reliability could be utilized by providing certificates to experienced participants. This method could help motivate and engagement participants to contribute with reliable observations to reach better certificates.

7.2.3 Motivation & Engagement

Mentioned in the analysis, as a proven method by papers and one of the most important and effective elements of a citizen science concept is the motivational and engaging factors for the volunteer participants. Enabling the public to voluntary contribute time, effort and data without individuals necessarily benefitting from the project themselves, will briefly result in a decreasing amount of participation. It can be assumed that the public would join a project for a good cause, but each individual will lose interest since they do not gained anything from it themselves unless this benefit has been implemented. Time is money and a volunteer participant is also aware about that phrase. Throughout this project it is clear to remember that motivational and engaging factors are needed for keeping a citizen science project alive. Current citizen science project is also aware about this and established competition within the group of volunteer participants.
It is equally important to keep motivating the volunteer participants of a citizen science project as it is important collecting data.

7.2.4 JAD Workshop

The Joint Application Development workshop conducted after the analysis within the project, the workshop was utilized to establish the requirements for the application if the website.

One of the major challenges within this project was to plan and conduct a workshop which met the proper standard expectations of such an event. Recruiting volunteer participants for several days to establish requirements for the application was a difficult task. It is suggested that such a workshop is planned and prepared several month ahead of time for all the participants to be available at a certain date of time.

The Joint Application Development workshop conducted within this project included four Danish spearfishers as participants and one facilitator. More facilitators for managing the workshop are suggested for similar projects. Additionally, the project would have benefited from having the scientist of Fiskeatlas to join the workshop as well. As the scientists being the other target group of this project, it was necessary to have them establish requirements together with the spearfishers.

A critical point of the Rapid Application method is that users of the final product or service do not exactly know what they require of a product. Based on that critical point, it is a challenge to produce a perfected final document for the requirements before the development has begun. The Rapid Application Development method will be discussed further later within this chapter.

7.3 Application Development

As part of the RAD iteration, the development phase was performed right after the design was established. The development phase was a challenging phase since many elements and dependencies was necessary to develop in order to deliver a working prototype from of the initial RAD iteration.
Initially it was necessary to prepare and adapt the existing website for the service to be implemented. After the environment of the website was ready, a custom connection between the front-end and the backend had to be established in order to register data and display them on an interactive map. The map was also a challenge implementing, since the interface was needed to be adapted for this project. A final prototype was delivered as a result of the the first RAD iteration, which is possible to review and improve ongoing. In this section there will be discussed some aspects of the development.

7.3.1 Improving The Standards of Contributed Observations

The observations displayed on the map are an alternative solution to what the spearfishers would benefit from and what the website would benefit from. At this point, the observations are displayed as data directly from the back-end of the website. The technical elements of the observations displayed could be improved and optimized for search engine optimization (SEO) and improving the content management system integration. As mention within this paper, the website is managed by WordPress as content management system which is an open source system. WordPress enables developers to create custom page types, which in future development can be used to manage and display all reports in a more search engine optimized way. Using the custom post types for the reports would also enable the spearfishers to share their contributed observation on Facebook or Twitter, with the rest of the spearfishing community in Denmark.

7.3.2 Blog of Fiskeatlas

The theory described and explained within the analysis chapter, elements of motivation and engagement for the volunteer participants is an important factor to implement for keeping participating volunteers in the project and to get new volunteer participants to join. The requirements established during the JAD workshop documented within the final document, stated that a blog where the scientists could post updates and facts for the spearfishers would be beneficial as a motivational and engaging element of the application. The same method for improving the observation can be used for developing and establishing the blog for the scientists of Fiskeatlas. This blog is purposed to be used for promoting the progress of the project - Fiskeatlas and for motivating the volunteer participants over time.

7.3.3 Timeframe of The Iteration Development

The timeframe for the first iteration of this project was dependent on the Joint Application Development workshop conducted in the beginning of November. As mentioned earlier within the paper, Rapid Application Development method does not allow design, development and testing to be started before the requirements for the final product is establish by the stakeholders. Dependent on those terms, it was only possible to begin the first iteration in the beginning of November and finish in the end of December the following month, where the experimentation was finished. The timeframe of the iteration made sense since a functional prototype dependent to enable the user experience experiment. This was to ensure that the product was progressing and no bad elements were developed.

Challenges occurred during the four month of investigating, developing and experimentation. For a citizen science project it is difficult for one person to cover all corners of such an investigation, development and experimentation. At least two more developers and researchers of a project or similar project is recommended. Although the service is not fully developed, the knowledge gained before finishing the product of the first iterations is very useful.

7.4 Rapid Application Development

As previously described within this paper, the Rapid Application Development method required that iterations of design, development and experimentation was necessary to conduct in order to benefit from the software development model. The first development iteration has been completed within this project and future development iterations are required for delivering a final proper application for the spearfishers and data collection system for the scientists of Fiskeatlas.

7.4.1 First Development Iteration

Completing the first development iteration of the application and system revealed that the project is not able to deliver a final product yet. The finished iteration not only delivered an initial prototype but it also revealed issues occurring during the iteration which is necessary to fix for the next iteration being conducted in the future. Safe to state, is that not all user requirements have been met yet with the initial prototype. Additionally, the first iteration showed a missing measured metrics of the user experience experimentation was and is still needed.

7.4.2 Future Development Iteration

It is not certain to know how much iteration is necessary to perform for this project to deliver a proper and complete system for the scientist of Fiskeatlas and a completed application for the spearfishers. The amount of iterations can only be assessed between iterations.

7.5 Software Development Methods

This project decided to choose a specific software development process to keep the development phase within a structured and managed framework. Rapid Application Development which was the method chosen is categorized within the paradigm known as spiral life cycle development model. Advantages and disadvantages is enabled when a certain development method is chosen.

7.5.1 Spiral Life Cycle Development

It is necessary to discuss whether or not a spiral life cycle development method was the ideal development model chosen for this project. In general, a spiral life cycle method involves a phased progression of activities leading to the release of a software product. This methodology has been used since 1988 and is a framework for software development in which development proceeds in sequences through a series of phases, starting with system requirements analysis proceeds to a design, development and experimentation phase and leading up to prototype release and maintenance. The initial step of a spiral life cycle method is to understanding the user's needs in the most clear and understandable way.

Advantages - Utilizing a spiral life cycle method enables a group of advantages. One of the major benefits is that a minimal waste of time and effort is reduced since no software development is begun before the user requirements are clear and settled. Establishing the final user requirements in the analysis of the process can improve the quality of the final product.

Disadvantages – The most major disadvantage discussed is the problem about user not knowing what they in fact require from the final product before it is even developed and tested.

Throughout this project, the spiral life cycle model has been applied to the development and more specifically was Rapid Application Development applied. The advantages and disadvantages just described also appeared in different levels during this project.

Another question regarding the choice of software development method used is relevant when questioning the question about the spiral life cycle model being ideal for this project?

7.5.2 Other Software Development Methods

Based on the question within the previous section, about spiral life cycle method being the ideal choice for software development model it is with interest to discuss if other models or methods would be more proper for this project.

Two other software development methods could also benefit the final product of this project if they were made use of. But would any of them have been a better choice compared to the spiral life cycle method used?

Lean - Lean software development is another model for developing software based on a set of principles for achieving quality, speed and customer satisfaction. The ideology of Lean is to eliminate anything that is not adding value and only focusing the elements absolutely needed. It is commonly stated that projects that are utilizing a Lean model enables a strong competitive advantage because the final product will rapidly and disciplined respond to the users requirements instead of predicting the future.

Utilizing a Lean development method within this project would have beneficial to rapidly meet the requirements of the spearfishers and scientists, but since other current and similar state of the art projects are released and public it was rather interesting focus to develop an innovative with great user experience. Additionally, no other Danish project are focusing on the same target group as this project is which makes it possible to invest more time in the development process within the risk high competition.

Agile - A different model for software development which could have been made use of in this project is known as agile software development. This development method is developed as an alternative to other heavyweight development methods that once were popular. Some of the main focus points of the agile model are; user is highest priority, changing user requirements, frequently delivery of software, simplicity and much more. Projects who meet these- and the rest of the focus points can be considered as agile. Most commonly is the Scrum management model the most used within a project.

Implementing an Agile software development method such as Scrum as management framework within this papers project would benefit from the agility of the development. The model would make the development more flexible and new requirements could be made without changing and approving requirement documentation before progressing, which is the situation with Rapid Application Model. An agile model also appears to require a team of users to establish new requirements for the software, which is not currently available.

7.6 Future Software Testing & Experimentation

In the last phase of the development iteration within this project, user experience experimentation was conducted for measuring the effectiveness, efficiency and satisfaction of the application. This project would have or will in the future benefit from other experimentation or testing methods which would complete other objectives of this project. Developing a piece of software where technical issues potentially could occur it would be beneficial to consider following discussed testing and experimentation methods.

7.6.1 Regression Testing

Regression testing is a general recognized method for uncovering simple and complex software bugs after a development has been finished. Typically, a regression test is conducted prior to a user experience experimentation phase including the user. The purpose of regression testing is to solve bugs which could interfere with the user's experience with the application.

7.6.2 User Acceptance Testing

In an addition to the regression testing which was suggested, a User Acceptance Testing (UAT) could also be implemented as an addition to a regression test for making sure the new implementations or developments meet the user's requirements assessed by etc. project managers.

7.7 Involvements

One of the last topics addressed within this discussion will be the involvement of focus groups or stakeholders. As it was explained previously within this paper, the main focus groups involved Danish spearfishers and the scientists of Fiskeatlas. It is relevant to discuss the argument for involving Fiskeatlas as a project as well as the Danish spearfishers.
Was and are both groups the ideal choice to involve in this project. It is interesting to be critical about this project to highlight the questions of the chosen groups being the proper choice and solution. Could this project have benefitted from other or additional involvements?

7.7.1 Fiskeatlas

The project named Fiskeatlas, that was teamed up with in this project was contacted by the writer and manager of this paper, motivated by the public request written on Fiskeatlas website. The writer of this project noticed by chance this request made by the scientist of Fiskeatlas.
The other Danish citizen science projects discovered in this paper are potentially also possible to join, but these projects appeared to be well adjusted for digital development, that it is assumed that many boundaries would be made for this project to work within. The odds for most creativity and free development were calculated and the highest odds were to join Fiskeatlas project.

Basically, any citizen science projects working with marine biology could have been in this projects interest to join, but it is desired to see the benefits by helping Fiskeatlas with their scientific objective.
Being able to develop a piece of software for Fiskeatlas, which can make it possible to more efficiently collect observations about marine life, compared to Fiskeatlas manual method, enables this papers project to work free from any boundaries. Fiskeatlas did not make any kind of etc. design, development or method requirements to develop this system. This made it ideal for this project to work in any academic direction as needed. Additionally, the free boundaries also made it possible to focus on only spearfishers as volunteer participants.

7.7.2 Danish Spearfishers

Through the prolonged investigation within this paper it revealed that Danish spearfishers is a good an ideal choice for being target group for citizens joining this project as volunteer participants. Additionally, the writer of this project is also a spearfishing enthusiast and was aware about this group of people being open-minded about the scientific objective and digital progress relevant for this project.

7.7.3 Future Involvements

Within the previous two section there has been argued for the reason two include the two focus groups within this project, but it is also necessary to consider if any other involvements could have been benefitted this project.
Not every citizen science projects operating in Denmark is focusing on marine diversity and those who do are as mentioned well advanced within technology. The alternative would have been to consider doing the scientific data processing on the projects own terms. Not having a third party like Fiskeatlas would remove any boundaries in relation to development, but a lot of resources on processing data would then be needed.
Another alternative for future involvements would have been another population for volunteer

participants. Not only Danish spearfishers observe fish in the Danish waters. The same do amateur fishermen or professional fishermen. The reason for choosing spearfishers could easily also have been fishermen, but the project required to focus on a specific target group.
When the system has been ideally optimized it could be duplicated for other populations observing fish in Danish water or international waters.

7.8 Future Perspective

This project has being focusing on developing a data collection system for the scientist of Fiskeatlas and a reporting service for the Danish spearfishers to contribute observations within. The final product of this project could potentially be interesting for not just the Danish spearfishers, but also amateur fishermen, scuba divers and many other groups of people who are in observing fish at Danish sea and shores. Although, the idea is not to merge all these groups together and create one service on one website. It is hypothesized that an online magazine concerning the sport or hobby these mentioned groups are connected to.

On a global scale, the current project could potentially be scale up and focus on a global collection of fish observed around the world. The scale up would require an international language spoken website, but the internet enables the possibility to digitally reach out to the rest of the world of spearfishers.

8 Conclusion

This paper is the documentation of a master thesis in computer science with a focus on user experience development and a composition of two focus groups to complete a scientific objective.
This paper describes and explains the Danish spearfishers' interest of sharing information among each other through social media. In an parallel approach, there was also described and explained an actual demand sought after by a group of scientists of a project known as Fiskeatlas which on a low-practice way collected data about fish observed in Danish waters.
Approach through an establish problem statement this paper took responsibility for the task of enabling the interest and tendency of the Danish spearfishers to provide their shared observation to the scientists of Fiskeatlas. This paper focused on establishing requirements based on both focus groups to develop an application which automatically could collect observation contributed by Danish spearfishers and provide the observation to Fiskeatlas database. This application was based on scientific theory of citizen science methods, the Danish spearfishers- and the scientist's requirements for the application established using a Joint Application Development workshop.
The design, development and experimentation of the application was performed based on a spiral life cycle software development model and managed by a method known as Rapid Application Development. An iteration of design, development and experimentation was performed and documented within this paper.
The experimentation with one of the focus groups being the Danish spearfishers, focused on the overall user experience which was measured using two different metric groups categorized as self-reported- and performance metrics. The two metrics was measured with the purpose of revealing objective and subjective data, which was used to reveal if any correlations could be made among the two measured metric categories.
A correlation was revealed among the two metric categories measured, which showed that the application developed through the first iteration provided a low effectiveness, efficiency and satisfaction of user experience. Additional iterations of design, development and experimentation are still required in order to provide an ideal application for the users and the scientist of Fiskeatlas.

9 Literature

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10 Appendix A – XML Data Feed

```
<?php
/*
Template Name: Custom Feed
*/

require("dbinfo.php");

function parseToXML($htmlStr)
{
$xmlStr=str_replace('<','&lt;',$htmlStr);
$xmlStr=str_replace('>','&gt;',$xmlStr);
$xmlStr=str_replace('"','&quot;',$xmlStr);
$xmlStr=str_replace("'",'&#39;',$xmlStr);
$xmlStr=str_replace("&",'&amp;',$xmlStr);
return $xmlStr;
}

// Opens a connection to a MySQL server
$connection=mysql_connect ('localhost', $username, $password);

if (!$connection)
{
die('Not connected : ' . mysql_error());
}

// Set the active MySQL database
$db_selected = mysql_select_db($database, $connection);
if (!$db_selected)
{
die ('Can\'t use db : ' . mysql_error());
}

// Select all the rows in the markers table
$query = "SELECT * FROM markers WHERE 1";
$result = mysql_query($query);
if (!$result)
{
die('Invalid query: ' . mysql_error());
}

header("Content-type: text/xml");

// Start XML file, echo parent node
echo '<markers>';

// Iterate through the rows, printing XML nodes for each
while ($row = @mysql_fetch_assoc($result))
{
// ADD TO XML DOCUMENT NODE
echo '<marker ';
echo 'title="' . parseToXML($row['title']) . '" ';
echo 'description="' . parseToXML($row['description']) . '" ';
echo 'lat="' . $row['lat'] . '" ';
echo 'lng="' . $row['lng'] . '" ';
echo 'type="' . $row['type'] . '" ';
echo '/>';
}

// End XML file
echo '</markers>';
?>
```

11 Appendix B – Multi-page Form Script

```
1.  add_shortcode('report_form_sc','report_form');
2.
3.  function report_form()
4.  {
5.  global $wpdb;
6.  $this_page   =  $_SERVER['REQUEST_URI'];
7.  $page    =  $_POST['page'];
8.
9.  if ( $page == NULL )
10. {
11. echo '
12. <form method="post" action="' . $this_page .'">
13. <label for="title" id="title">Title: </label>
14. <input type="text" name="title" id="title" />
15.
16. <label for="description" id="description">Description: </label>
17. <input type="text" name="description" id="description" />
18.
19. <label for="lat" id="lat">Latitude: </label>
20. <input type="text" name="lat" id="lat" />
21.
22. <label for="lng" id="lng">Longitude: </label>
23. <input type="text" name="lng" id="lng" />
24.
25. <label for="type" id="type">Type: </label>
26. <select name="type" />
27. <option value="sigtmelding" selected>Sigtmelding</option>
28. <option value="fangst">Fangst</option>
29. <option value="spot">Spot</option>
30. </select>
31.
32. <input type="hidden" value="1" name="page" />
33.
34. <input type="submit" />
35. </form>';
36. } //  Start Page 2 of Form
37. elseif ( $page == 1 )
38. {
39. //  Grab the POST data that the user provided
40.
41. $title                 = $_POST['title'];
42. $description           = $_POST['description'];
43. $lat                   = $_POST['lat'];
44. $lng                   = $_POST['lng'];
45. $type                  = $_POST['type'];
46. $page                  = $_POST['page'];
47. $form_id               = $_POST['form_id'];
48.
49. //  Assign the table and inputs for our upcoming INSERT function
50.
51. $page_one_table = 'markers';
52. $page_one_inputs =  array
53. (
54. 'title'               => $title,
55. 'description'         => $description,
56. 'lat'                 =>$lat,
57. 'lng'                 =>$lng,
58. 'type'                =>$type
59. /*'page'              =>$page*/
60. );
61.
62. //  Insert the data into a new row
63. $insert_page_one  =  $wpdb->insert($page_one_table, $page_one_inputs);
64.
65. //    Grab the ID of the row we inserted for later use
66. /* $form_id = $wpdd->insert_id; */
67.
68. echo '
```

```
69.  <p>Latitude: ' . $title . '</p>
70.  <p>Longitude: ' . $description . '</p>
71.  <p>Latitude: ' . $lat . '</p>
72.  <p>Longitude: ' . $lng . '</p>
73.  <p>Type: ' . $type . '</p>
74.  ';
75.
76.  } //End Page 2 of Form
77.  } // End multipage_form() function
```

12 Appendix C – Google Maps Script And Marker Plot

```
<script type="text/javascript">

//<![CDATA[

var customIcons = {
	sigtmelding:
	{
		icon: '<?php bloginfo('template_url');?>/img/markers/marker_sigt.png'
	},
	fangst:
	{
		icon: '<?php bloginfo('template_url');?>/img/markers/marker_fangst.png'
	},
	spot:
	{
		icon: '<?php bloginfo('template_url');?>/img/markers/marker_spot.png'
	}
};

function CenterControl(controlDiv, map)
{
	var controlUI = document.createElement('div');
	controlUI.style.backgroundColor = '#fff';
	controlUI.style.border = '2px solid #fff';
	controlUI.style.borderRadius = '3px';
	controlUI.style.boxShadow = '0 2px 6px rgba(0,0,0,.3)';
	controlUI.style.cursor = 'pointer';
	controlUI.style.marginTop = '10px';
	controlUI.style.marginBottom = '10px';
	controlUI.style.textAlign = 'center';
	controlUI.title = 'Klik for at rapportere et punkt.';
	controlDiv.appendChild(controlUI);

	var controlText = document.createElement('div');
	controlText.style.color = 'rgb(25,25,25)';
	controlText.style.fontFamily = 'Roboto,Arial,sans-serif';
	controlText.style.fontSize = '11px';
	controlText.style.paddingLeft = '8px';
	controlText.style.paddingRight = '8px';
	controlText.style.paddingTop = '8px';
	controlText.style.paddingBottom = '8px';
	controlText.innerHTML = 'Rapportér';
	controlUI.appendChild(controlText);

	// Setup the click event listeners: simply set up a link to the form page.
	controlUI.addEventListener('click', report);

	function report()
	{
		/*alert ("Gå til formular!");*/
		document.location.href = "/?p=58";
	}
}

function load()
{
	var map = new google.maps.Map(document.getElementById("map"),
	{
		center: new google.maps.LatLng(55.95996, 11.76407),
		zoom: 7,
		mapTypeId: 'roadmap'
	});

	// Create the DIV to hold the control and call the CenterControl() constructor
```

```
65.	// passing in this DIV.
66.	var centerControlDiv = document.createElement('div');
67.	var centerControl = new CenterControl(centerControlDiv, map);
68.
69.	centerControlDiv.index = 1;
70.	map.controls[google.maps.ControlPosition.TOP_CENTER].push(centerControlDiv);
71.
72.	map.controls[google.maps.ControlPosition.TOP_RIGHT].push(new FullScreenControl(map));
73.
74.	var infoWindow = new google.maps.InfoWindow;
75.
76.	//Attach click event handler to the map.
77.	google.maps.event.addListener(map, 'click', function (e)
78.	{
79.			//Determine the location where the user has clicked.
80.			var location = e.latLng;
81.
82.			console.log('Click');
83.			console.log(location.lat());
84.			console.log(location.lng());
85.
86.			//Set Content of InfoWindow.
87.			infoWindow.setContent(
88.					'Latitude: ' + location.lat() + '<br />Longitude: ' + location.lng()
89.			);
90.
91.			//Set Position of InfoWindow.
92.			infoWindow.setPosition(location);
93.
94.			//Open InfoWindow.
95.			infoWindow.open(map);
96.	});
97.
98.	downloadUrl("/?p=521", function(data)
99.	{
100.			var xml = data.responseXML;
101.			var markers = xml.documentElement.getElementsByTagName("marker");
102.
103.			for (var i = 0; i < markers.length; i++)
104.			{
105.					var title = markers[i].getAttribute("title");
106.					var description = markers[i].getAttribute("description");
107.					var type = markers[i].getAttribute("type");
108.					var point = new google.maps.LatLng(
109.							parseFloat(markers[i].getAttribute("lat")),
110.							parseFloat(markers[i].getAttribute("lng"))
111.					);
112.					var html = "<b>" + title + "</b> <br/>" + description;
113.					var icon = customIcons[type] || {};
114.					var marker = new google.maps.Marker({
115.							map: map,
116.							position: point,
117.							icon: icon.icon
118.					});
119.
120.					bindInfoWindow(marker, map, infoWindow, html);
121.			}
122.	});
123. }
124.
125. function bindInfoWindow(marker, map, infoWindow, html)
126. {
127.	google.maps.event.addListener(marker, 'click', function()
128.	{
129.			infoWindow.setContent(html);
130.			infoWindow.open(map, marker);
131.	});
132. }
133.
134. function downloadUrl(url,callback)
135. {
136.	var request = window.ActiveXObject ?
137.
```

```
138.		new ActiveXObject('Microsoft.XMLHTTP') :
139.		new XMLHttpRequest;
140.
141.		request.onreadystatechange = function()
142.		{
143.				if (request.readyState == 4)
144.				{
145.						request.onreadystatechange = doNothing;
146.						callback(request, request.status);
147.				}
148.		};
149.
150.		request.open('GET', url, true);
151.		request.send(null);
152. }
153.
154. function doNothing() {}
155.
156. //]]>
157. </script>
```

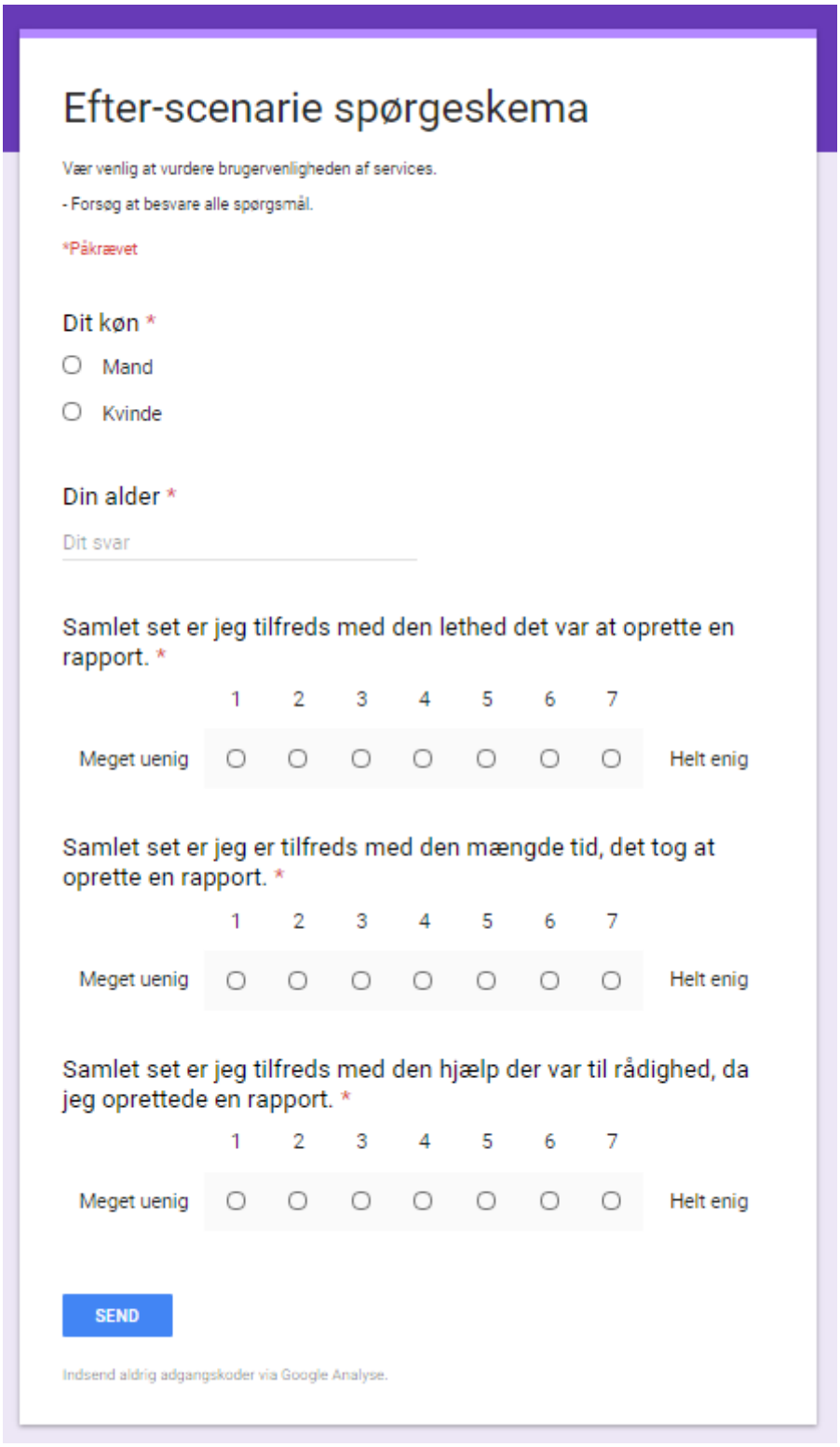
13 Appendix D – Implementing Google Maps On Page

```
<?php
/*
Template Name: Google map
*/

get_header(); ?>


<div class= "container">
<div class="row">
<div class="col-xs-12 col-sm-12 col-lg-12 content-outer">
<div class="col-xs-12 col-sm-12 col-lg-12 kort-right-bar-inner">
<div id="map">


</div>
</div>
</div>
</div>

<?php
query_posts('meta_key=post_views_count&orderby=meta_value_num&order=DESC&posts_per_page=4');
?>
<div class= "row">
<div class="col-xs-12 col-sm-12 col-md-12 col-lg-12 content-outer">
<div class="top-posts-element-outer">
<?php $posts = get_posts('orderby=rand&numberposts=4'); foreach($posts as $post) { ?>
<div class="hidden-xs hidden-sm col-md-3 col-lg-3 content-inner top-posts-element">
<a href="<?php the_permalink(); ?>">
<p class="widget-headline"><?php the_title(); ?></p>
<?php the_post_thumbnail(); ?>
</a>
</div>
<div class="hidden-xs col-sm-6 hidden-md hidden-lg content-inner top-posts-element">
<a href="<?php the_permalink(); ?>">
<p class="widget-headline"><?php the_title(); ?></p>
<?php the_post_thumbnail(); ?>
</a>
</div>
<div class="col-xs-12 hidden-sm hidden-md hidden-lg content-inner top-posts-element">
<a href="<?php the_permalink(); ?>">
<p class="widget-headline"><?php the_title(); ?></p>
<?php the_post_thumbnail(); ?>
</a>
</div>
<?php } ?>
</div>
</div>
</div>
<?php wp_reset_query(); ?>

<a class="back-to-top" style="display: inline;" href="#">Back to Top</a>
</div>

<script src = "<?php echo get_template_directory_uri(); ?>/js/gototop.js"></script>

<?php get_footer(); ?>
```

14 Appendix E – Multi-page Form Page Template

```
1.  <?php
2.  /*
3.  Template Name: Report
4.  */
5.
6.  get_header(); ?>
7.
8.  <div class= "container">
9.          <!--<div class="row">
10.                 <div class="col-xs-12 col-sm-12 col-lg-12 content-outer">
11.                         <div class="col-xs-12 col-sm-12 col-lg-12 kort-right-bar-inner">
12.                                 <div id="map_canvas">
13.
14.
15.                                 </div>
16.                         </div>
17.                 </div>
18.         </div>-->
19.
20.         <div class="row">
21.                 <div class="col-xs-12 col-sm-12 col-md-12 col-lg-12 content-outer">
22.                         <div class="col-xs-12 col-sm-12 col-md-12 col-lg-12 content-inner post-content-
    area report-container">
23.
24.                                 <?php if (have_posts()) : while (have_posts()) :the_post(); ?>
25.                                 <?php the_content('<p class="page-text-content"> Read the
    rest of this page &raquo;</p>'); ?>
26.
27.                                 <?php endwhile; endif; ?>
28.                         </div>
29.                 </div>
30.         </div>
31. </div>
32.
33.
34. <?php get_footer(); ?>
```

15 Appendix F – Self-reported Metric Questionnaire



Efter-scenarie spørgeskema

Vær venlig at vurdere brugervenligheden af services.

- Forsøg at besvare alle spørgsmål.

*Påkrævet

Dit køn *

- Mand
- Kvinde

Din alder *

Dit svar

Samlet set er jeg tilfreds med den lethed det var at oprette en rapport. *

	1	2	3	4	5	6	7	
Meget uenig	○	○	○	○	○	○	○	Helt enig

Samlet set er jeg er tilfreds med den mængde tid, det tog at oprette en rapport. *

	1	2	3	4	5	6	7	
Meget uenig	○	○	○	○	○	○	○	Helt enig

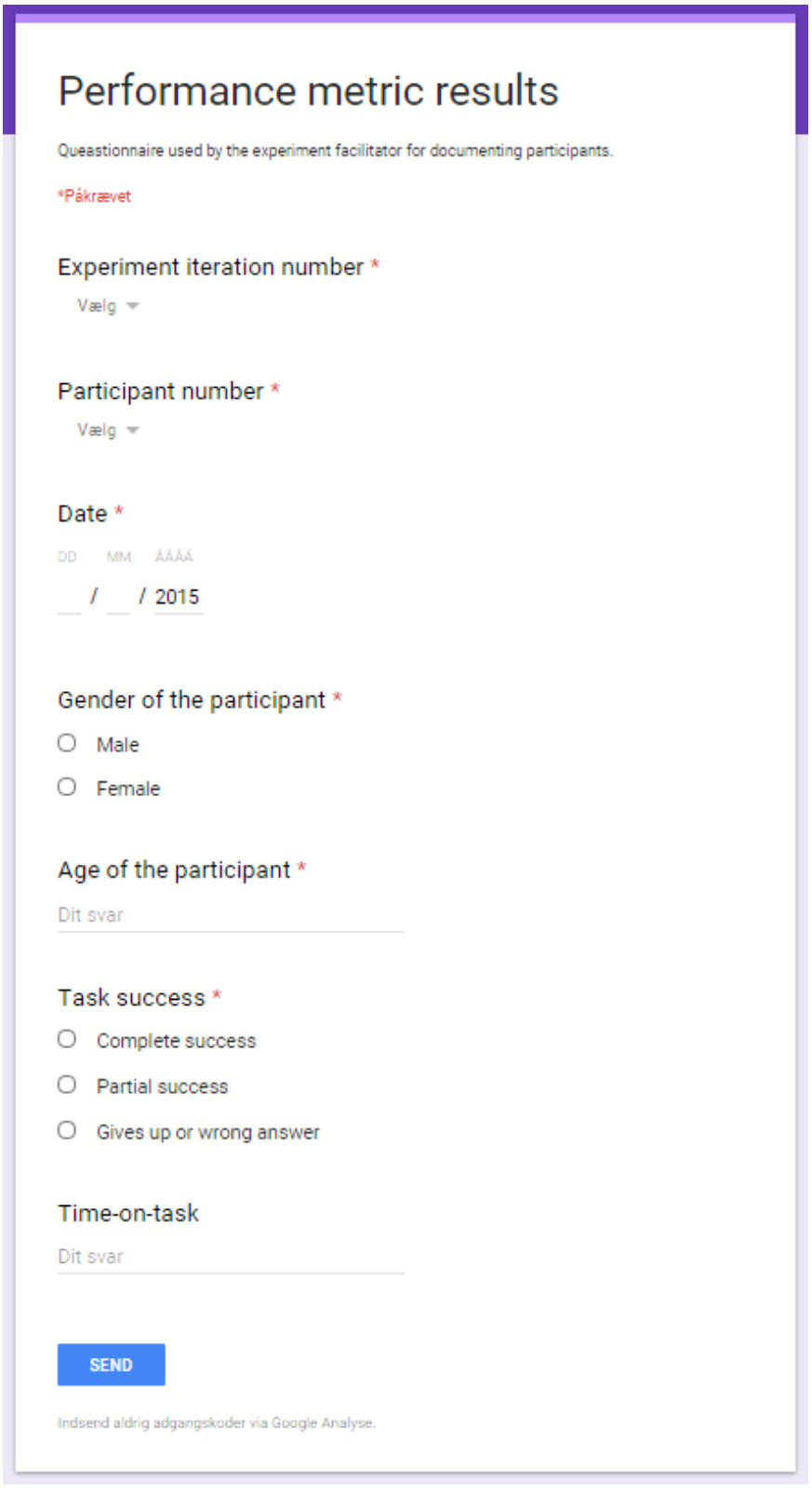
Samlet set er jeg tilfreds med den hjælp der var til rådighed, da jeg oprettede en rapport. *

	1	2	3	4	5	6	7	
Meget uenig	○	○	○	○	○	○	○	Helt enig

SEND

Indsend aldrig adgangskoder via Google Analyse.

16 Appendix E – Performance Metrics Questionnaire



Performance metric results

Queastionnaire used by the experiment facilitator for documenting participants.

*Påkrævet

Experiment iteration number *

Vælg

Participant number *

Vælg

Date *

DD MM ÅÅÅÅ

/ / 2015

Gender of the participant *

- Male
- Female

Age of the participant *

Dit svar

Task success *

- Complete success
- Partial success
- Gives up or wrong answer

Time-on-task

Dit svar

SEND

Indsend aldrig adgangskoder via Google Analyse.

17 Appendix H – Self-reported Metric Data Result Table

Timestamp	Gender	Age	Overall, I am satisfied with the ease it was to create a report.	Overall, I am satisfied with the amount of time it took to create a report.	Overall, I am satisfied with the help that was available when I created a report.
27/11/2015	Male	22	4	2	2
27/11/2015	Female	32	3	1	2
27/11/2015	Male	42	2	1	1
28/11/2015	Male	31	3	1	3
28/11/2015	Male	34	4	1	2
02/12/2015	Male	29	3	1	3
02/12/2015	Male	31	1	1	1
05/12/2015	Male	39	3	1	3
05/12/2015	Male	31	4	2	5
05/12/2015	Male	24	3	1	4
05/12/2015	Male	28	5	2	5
05/12/2015	Male	32	4	3	1
05/12/2015	Female	35	5	2	5
05/12/2015	Male	30	2	2	1
05/12/2015	Male	42	4	1	1
06/12/2015	Male	28	1	4	1
06/12/2015	Male	36	7	3	2
06/12/2015	Male	33	6	4	1
06/12/2015	Male	29	5	4	1
06/12/2015	Male	39	4	3	2

18 Appendix I – Performance Metric Data Result Table

Tidsstempel	Experiment iteration number	Participant number	Date	Gender of the participant	Age of the participant	Task success	Time-on-task in seconds
27/11/2015	1	1	27/11/2015	Male	22	Partial	322
27/11/2015	1	2	27/11/2015	Female	32	Partial	483
27/11/2015	1	3	27/11/2015	Male	42	Partial	372
28/11/2015	1	4	28/11/2015	Male	31	Partial	421
28/11/2015	1	5	28/11/2015	Male	34	Partial	283
02/12/2015	1	6	02/12/2015	Male	29	Partial	301
02/12/2015	1	7	02/12/2015	Male	31	Partial	279
05/12/2015	1	8	05/12/2015	Male	39	Partial	153
05/12/2015	1	9	05/12/2015	Male	31	Partial	203
05/12/2015	1	10	05/12/2015	Male	24	Partial	347
05/12/2015	1	11	05/12/2015	Male	28	Partial	341
05/12/2015	1	12	05/12/2015	Male	32	Partial	196
05/12/2015	1	13	05/12/2015	Female	35	Partial	388
05/12/2015	1	14	05/12/2015	Male	30	Partial	396
05/12/2015	1	15	05/12/2015	Male	42	Partial	217
06/12/2015	1	16	06/12/2015	Male	28	Partial	288
06/12/2015	1	17	06/12/2015	Male	36	Partial	467
06/12/2015	1	18	06/12/2015	Male	33	Partial	181
06/12/2015	1	19	06/12/2015	Male	29	Partial	174
06/12/2015	1	20	06/12/2015	Male	39	Partial	319

19 Appendix J – Advertisement For JAD Workshop

---------- Danish version (Original version) ----------

Hej medlemmer af gruppen.

OBS: Dette er ikke et traditionelt undervandsjagt opslag.

I forbindelse med mit speciale, søger jeg tre undervandsjægere, der skal hjælpe med at opstille design kriterier til en webservice for undervandsjægere.

Kort sagt, så er jeg i færd med at udvikle et rapporteringssystem, der vil kunne fremvise data, bidraget af undervandsjægere. Denne data vil også blive brugt til et videnskabeligt formål, som projektet Fiskeatlas arbejder på.

For at udvikle en tilnærmelsesvis optimal brugerflade, har jeg brug for meninger fra tre personer, der dyrker undervandsjagt. Ved at deltage i dette, vil man også bidrage med indhold til rapporten af mit speciale.

Hvis man er interesseret i at hjælpe projektet og har lyst til at bidrage med en mening, er jeg meget interesseret i at arrangere et møde for alle personerne på omkring en til to timer snarest muligt.

Ved interesse eller spørgsmål, kontakt mig gerne via Facebook, e-mail eller telefon.

Jeg takker på forhånd.

Med venlig hilsen,

Kim Nyegaard Andreasen

knan10@student.aau.dk

+45 26 13 05 36

---------- English version (Translated from Danish) ----------

Hi member of this group

Please note - This is not a traditional spearfishing post.

In connection with my thesis, I seek three spearfishers to help establish the design criteria for a web service used by Danish spearfishers.

In brief, I am in the process of developing a reporting system that will be able to present data, contributed by spearfishers. This data will also be used for scientific purposes by the project named Fiskeatlas.

To develop an optimal user interface, there is need for opinions by three people who do spearfishing in their spare time. By participating in this workshop, you will also contribute with content for the report of my thesis.

If you are interested in helping out this project and would like to contribute with an opinion, I am very interested in arranging a workshop with all the people interested. The workshop will last approximately one to two hours and will be held as soon as possible.

If you are interested or have any questions, please contact me through Facebook, e.mail or phone.

I thank you in advance.

Sincerely,

Kim Nyegaard Andreasen

knan10@student.aau.dk

+45 26 13 05 36

20 Appendix K – JAD Workshop Agenda

---------- English version (Revised from Danish) ----------

The Joint Application Development workshop is held sunday the 8th of November at the workshop facilitators private address, which was distributed the 2nd of November by e-mail. Four spearfishers accepted to join the Joint Application Development workshop.

The agenda of the workshop has been distributed together with the information sent through e-mail the 2nd of November 2015. The agenda of the workshop will proceed as follows.

12:00 - General introduction of the project and the facilitator

The project, the facilitator and the overall goal of the project will be explained and elaborated. Any questions by the participants will be answered.

12:15 - Introduction of the participants

The four participants is be able to introduce themselves and briefly tell what they expect from this workshop.

12:25 - Introduction and explanation of the Joint Application Develop workshop

The reason for having this workshop will be explained and the goal of the workshop will also be explained. Any questions by the participants will be answered.

12:35 - Description of the workshops ground rules

Ground rules for the workshop will be explained to keep a structured and efficient process during the scheduled time.

12:40 - Discussion of topics begins

The essential part of this workshop begins by discussing upcoming topics among the facilitator and the participants.

12:45 - Discussing assumptions

The project's assumption established will be presented and discussed with the participants. The assumptions will either stay as they are, be revised or become an open issue.

12:55 - Defining data requirements

The projects data elements established will be presented to the participants and discussed. The data elements will organized into following groups; Existing data elements, changed data elements and new data elements.

13:05 - Design project process

The process of using the service for making a report will be designed with the participants. The goals is to establish a data flow diagram.

13:15 - Design screens

The interface of the service displayed on the screen will be addressed and discussed. The goal is to establish screenflow, screen design, human-factors in screen design and GUI screen design.

13:25 - Design reports

This topic will address and discuss the service output when participants are reporting an observation. The details of the data parameters will be discussed and agreed on.

13:35 - Resolve open issues

Issues of engagement, motivation, data reliability and data quality will be discussed and resolved.

13:45 - Ending the Joint Application Development workshop

In the end of the workshop there will be determined who will receive the final document, how the participants will review the final document and closing comments will be provided for future arrangements.

14:00 - The Joint Application Development workshop ends

Food and beverages will be served to the participants as a thank you for the opinions sharing and the time spend.

The JAD workshop conducted will be the fundament for the service to be developed. The established requirements of the workshop can be edited if a documented agreement with the workshops participants is made and distributed.

21 Appendix L – JAD Workshop Working Document

---------- English version (Revised from Danish) ----------

JAD WORKING DOCUMENT

Citizen Science: Enabling Danish Spearfishers To Contribute Marine Observations For Project Fiskeatlas

8th of November, 2015

PREFACE
This document describes all decisions made in the JAD session held 8th of November 2015. When the participants approve this document, the project management can continue to the next phase of iterative design and build of the service.

JAD Workshop

The JAD workshop documented within this working document will be the foundation for the RAD iterations of design, development and experimentation of the service wanted.
The goal of this workshop is for the workshop facilitator to figure out what the users of the service being developed require for being interested in using it.
Through this workshop there has been discussed assumption, design and issues among other topics.

Workshop Agenda

The following topics on the schedule listed below have been completed together with four participants in the workshop. The following list is the topics which have been covered in the two-hour JAD workshop, the 8th of November 2015.

12:00 - General introduction of the project and the facilitator
12:15 - Introduction of the participants
12:25 - Introduction and explanation of the Joint Application Develop workshop
12:35 - Description of the workshops ground rules
12:40 - Discussion of topics begins
12:45 - Discussing assumptions
12:55 - Defining data requirements
13:05 - Design project process
13:15 - Design screens
13:25 - Design reports
13:35 - Resolve open issues
13:45 - Ending the Joint Application Development workshop
14:00 - The Joint Application Development workshop ends

Workshop Participants

Four volunteer participants joined the workshop. All four of them are active spearfishers in denmark and had an interested in sharing opinions and discussing the project issues. The list of participants is listed within table L.1.

Name	Role
Bianca Secher	Spearfisher/volunteer participant
David Rasmussen	Spearfisher/volunteer participant
Jesper Hansen	Spearfisher/volunteer participant
Mihail Gonatos	Spearfisher/volunteer participant
Kim Nyegaard Andreasen	Facilitator

Table L.1 - Table of individuals attending the JAD workshop the 8th of November.

The Final Document

The participants listed within table L.1 will receive the final document of this JAD workshop once it has been generated. Until the final document has been finished, this working document will function as the temporary document for reference.

Discussing Assumptions

The assumptions includes the project decisions agreed so far which is based on theory and experience. The assumptions has been discussed and a categorization of the assumption has been agreed on. The assumptions has either been categorized as Stay as it is, Be revised or Become an open issue. The choices is listed below the assumptions.

- Spearfishers are interested in sharing knowledge.
    - Stay as it is
- The interests of Danish spearfishers and the scientists of Fiskeatlas can be joined into one scientific purpose
    - Stay as it is
- Spearfishing will use a web based service for contributing observations with.
    - Stay as it is
- Spearfishers can be motivated using motivational factors based on egoism.
    - Stay as it is
- Spearfishers is reliable enough to provide correct data into a database
    - Stay as it is

All assumptions was agreed upon and was not required to be revised or become an open issue.

Data Requirements

The data requirements established and provided by the scientists of Fiskeatlas were presented for the participants. The challenge is that none of the parameters can be removed since the provide the data quality required by the scientific community for being useful and valid. The data is listed as follows:

1. Name of fish specie
2. Number of fish
3. Date of observation
4. Name of participant
5. E-mail of participant
6. Precise location description (above water level)
7. Habitat description (below water level)
8. Latitude
9. Longitude
10. Documentation of fish caught
11. Time stamp of report

The participants suggested additional parameters being added to the list of parameters. The parameters the participants suggested is following listed:

1. Images (can be similar to point 10 of Fiskeatlas list)
2. Rating

3. Depth of fish observed

The parameters suggested by the participants will be added to the required parameters of the report.

Designing project processes

The process of the service was the topic discussed. Suggested by one of the participants and agreed with the rest of the participants, the service needs to be simple and efficient. The process of providing a report of an observation into the database cannot take too much time.

The flowchart of the process when reporting an observation was made during the workshop and is illustrated within figure L.1

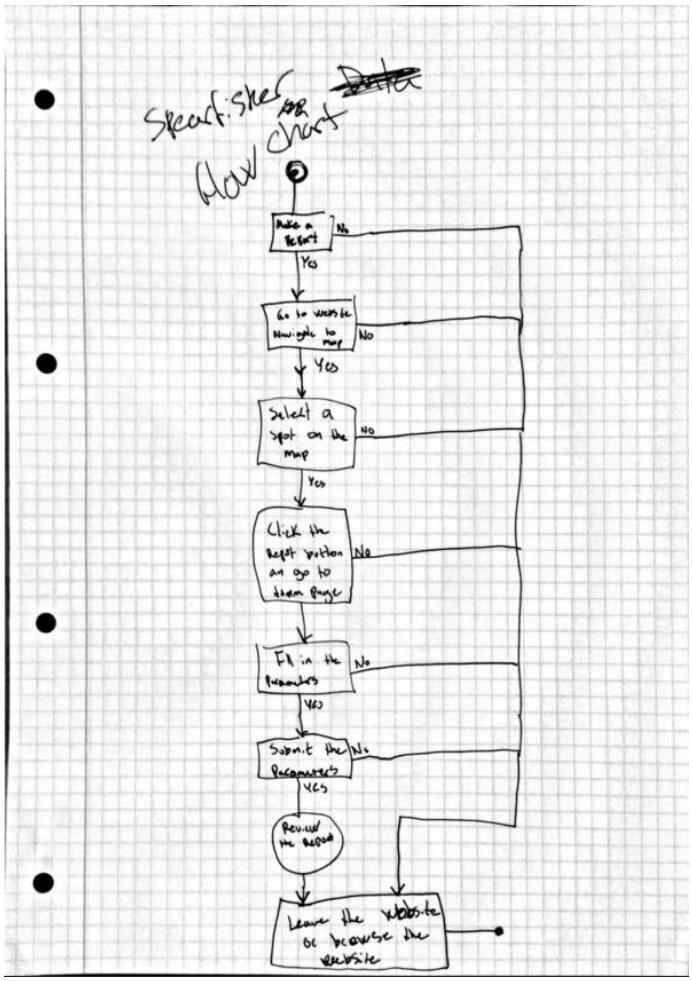


Figure L.1 - Spearfishers flow chart on service

The flowchart is a design draft for the process of contributing an observation. The final flowchart will be optimized and presented to the participants when the final document is distributed.

Designing screens

The user interface was discussed during the workshop. The relevant pages connected and influencing the concept and service was discussed and design draft was made in a collaboration.

The first page discussed and design was the home page. The draft is illustrated within figure L.2.

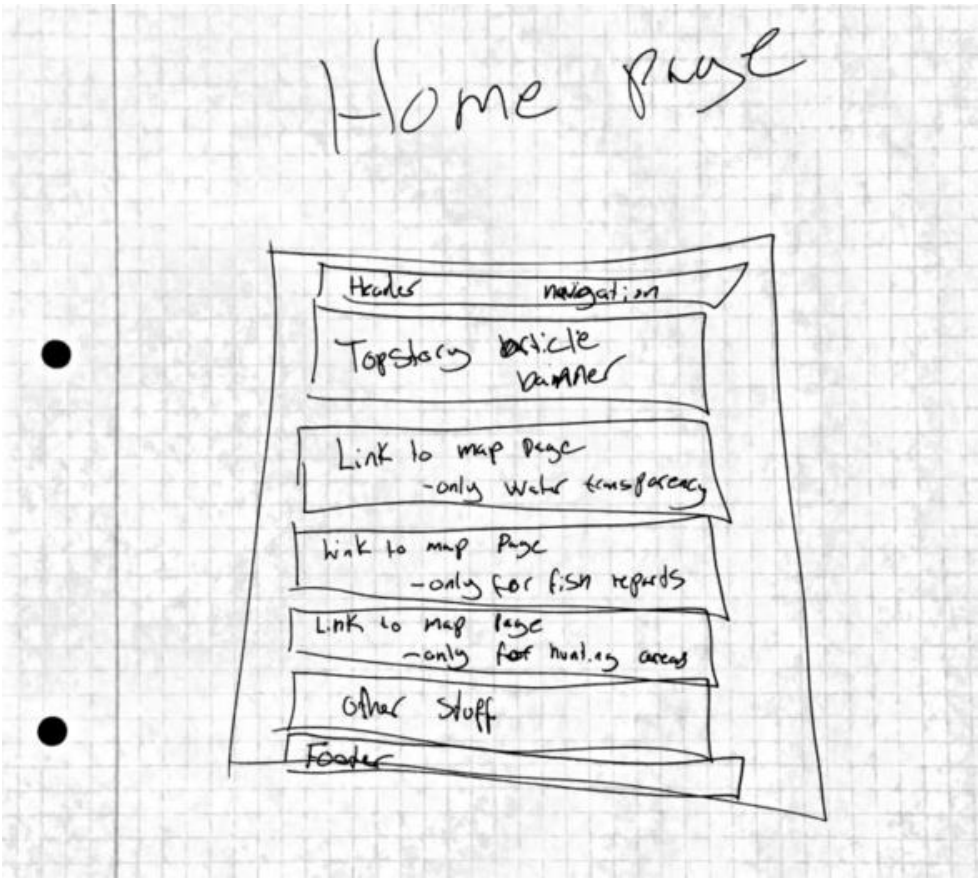


Figure L.2 - Design draft of the homepage was made in collaboration during the workshop

The design draft visualized a link to individual report categories from the homepage to the report page. This enables the visitors to navigate quickly.

The second page discussed and designed was the actual map page where the contributed observations will be visualized. In figure L.3 the design draft is illustrated.

Figure L.3 - Design draft of the map page was made in collaboration during the workshop

Illustrated in figure L.3, the map page was agreed to mainly consist of a map displaying the reports focused on Denmark.

The third page relevant for the discussion during the workshop was the form/report page. This page used by the users for provided data when reporting an observation. The design draft is illustrated within figure L.5

Figure L.5 - Design draft of the form/report page was made in collaboration during the workshop

Illustrated in figure L.5 a simple cluster of input fields is listed. An additional suggestion made by the participants was adding the possibility to scatter the input fields on a multi-page form.

The last page discussed and designed was the blog page of the scientists. This page is suggested to work as a chronological listing of blog posts with a profile description of the blogger in the top of the page. The design draft is illustrated in figure L.6

Figure L.6 - Design draft of the scientists blog page was made in collaboration during the workshop

Seen in figure L.6, the participants priority was making the page simple by listing the most recent blog posts in the top.

Designing reports

The last focused topic of the workshop dealt with the design of the reports contributed by the participants. The participants suggested design drafts for two pages relevant for the report of the service.

The first page discussed and suggested design for was the map page where reports are displayed. In figure L.7, the design draft is illustrated.

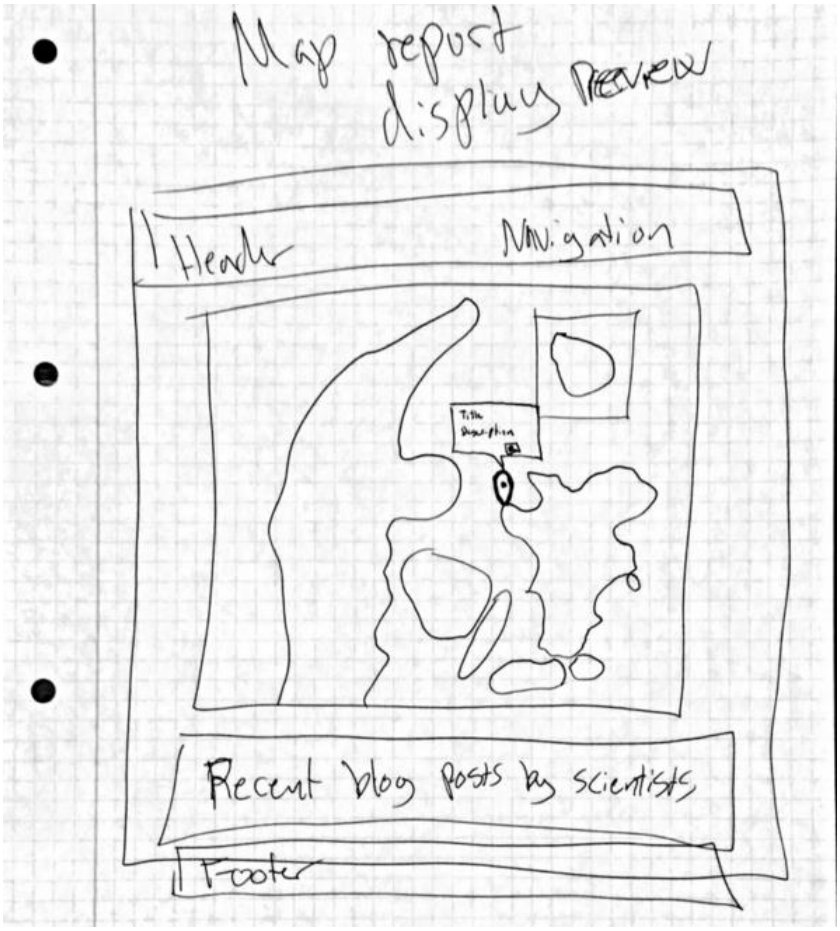


Figure L.7 - Design draft for the map page reports was made in collaboration during the workshop

As seen in figure L.7, the report will be previewed by a box displayed when clicked. This box will hold minor details about the type of report, the provided title and a description. In the bottom of the box a button with a link for a report page for the specific report will be linked to.

In connection to the previous draft and the button linking to a specific report, the design draft has been created for this page.

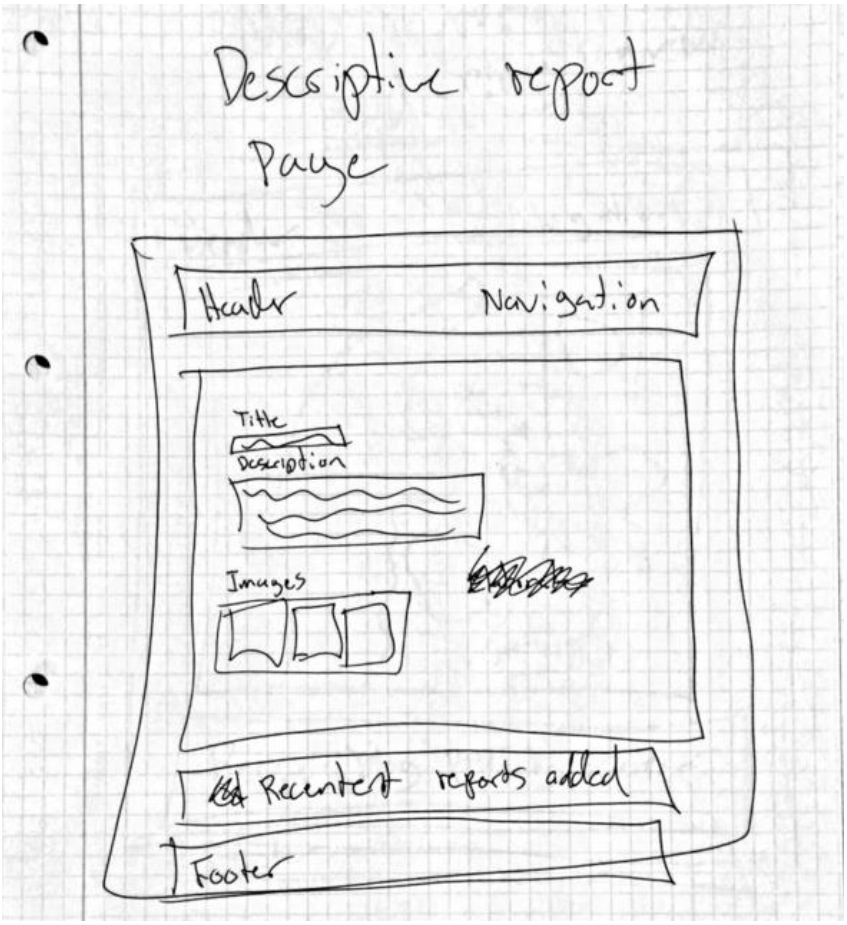


Figure L.8 - Design draft for the report page was made in collaboration during the workshop

Illustrated in figure L.8, the report page is structured and is designed in collaboration to contain the required data listed and agreed earlier within this working document.

Resolving open Issues

Engagement and motivation was the main open issue relevant for the participant. The participants suggested that the ability to share you contributed report on the most used social medias in Denmark would be the best feature of the system to serve their engagement and motivation.

Proceedings

The previous content concludes the working document which is distributed and valid until the final document has been distributed and signed by the participants.

22 Appendix M – JAD workshop final document

JAD FINAL DOCUMENT

Citizen Science: Enabling Danish Spearfishers To Contribute Marine Observations For Project Fiskeatlas

8th of November, 2015

Bianca Secher
David Rasmussen
Jesper Hansen
Mihail Gonatos

PREFACE

This document describes all decisions made in the JAD session held 8th of November 2015. When the participants approve this document, the project management can continue to the next phase of iterative design and build of the service.

JAD Workshop

The JAD workshop documented within this working document will be the foundation for the RAD iterations of design, development and experimentation of the service wanted.
The goal of this workshop is for the workshop facilitator to figure out what the users of the service being developed require for being interested in using it.
Through this workshop there has been discussed assumption, design and issues among other topics.

Workshop Agenda

The following topic on the schedule listed below has been completed together with four participants in the workshop. The following list is the topics which have been covered in the two-hour JAD workshop, the 8th of November 2015.

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13:05 - Design project process
13:15 - Design screens
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13:45 - Ending the Joint Application Development workshop
14:00 - The Joint Application Development workshop ends

Workshop Participants

Four volunteer participants joined the workshop. All four of them are active spearfishers in denmark and had an interested in sharing opinions and discussing the project issues. The list of participants is listed within table L.1.

Name	Role
Bianca Secher	Spearfisher/volunteer participant
David Rasmussen	Spearfisher/volunteer participant
Jesper Hansen	Spearfisher/volunteer participant
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Kim Nyegaard Andreasen	Facilitator

Table L.1 - Table of individuals attending the JAD workshop the 8th of November

The Final Document

The participants listed within table L.1 will receive the final document of this JAD workshop once it has been generated. Until the final document has been finished, this working document will function as the temporary document for reference.

Discussing Assumptions

The assumptions include the project decisions agreed so far which is based on theory and experience. The assumption has been discussed and a categorization of the assumption has been agreed on. The assumptions has been categorized as Stay as it is, Be revised or Become an open issue. The agreements are following listed.

- Spearfishers are interested in sharing knowledge.
  - Stay as it is
- The interests of Danish spearfishers and the scientists of Fiskeatlas can be joined into one scientific purpose
  - Stay as it is
- Spearfishing will use a web based service for contributing observations with.
  - Stay as it is
- Spearfishers can be motivated using motivational factors based on egoism.
  - Stay as it is
- Spearfishers is reliable enough to provide correct data into a database
  - Stay as it is

All assumptions were agreed upon and were not required to be revised or become an open issue.

Data Requirements

The data requirements established and provided by the scientists of Fiskeatlas were presented for the participants. The challenge is that none of the parameters can be removed since the provide the data quality required by the scientific community for being useful and valid. The data is listed as follows:

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The parameters suggested by the participants will be added to the required parameters of the report.

Designing project processes

The process of the service was the topic discussed. Suggested by one of the participants and agreed with the rest of the participants, the service needs to be simple and efficient. The process of providing a report of an observation into the database cannot take too much time.

The flowchart of the process when reporting an observation was made during the workshop and is illustrated within figure L.1

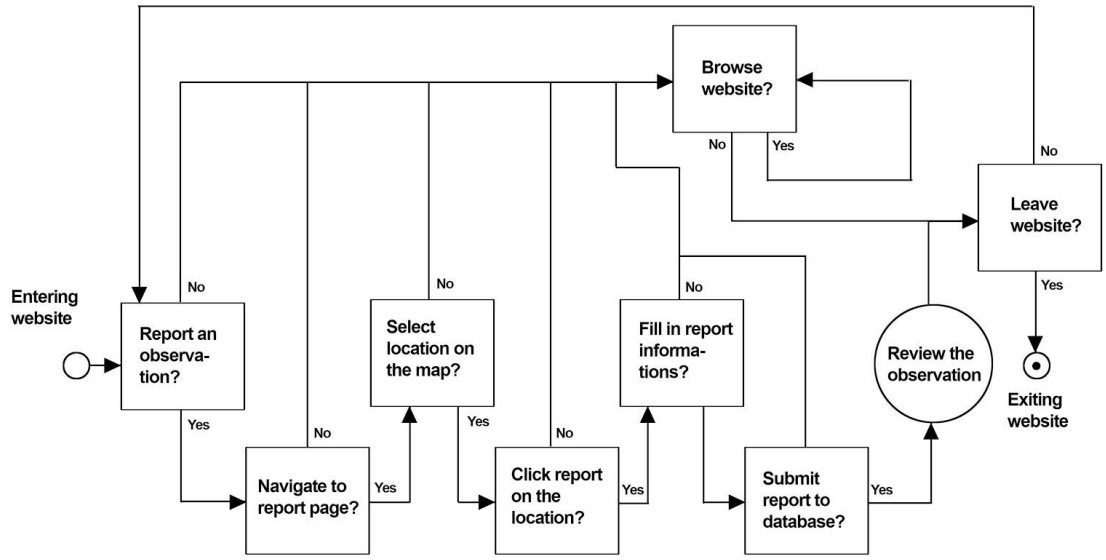


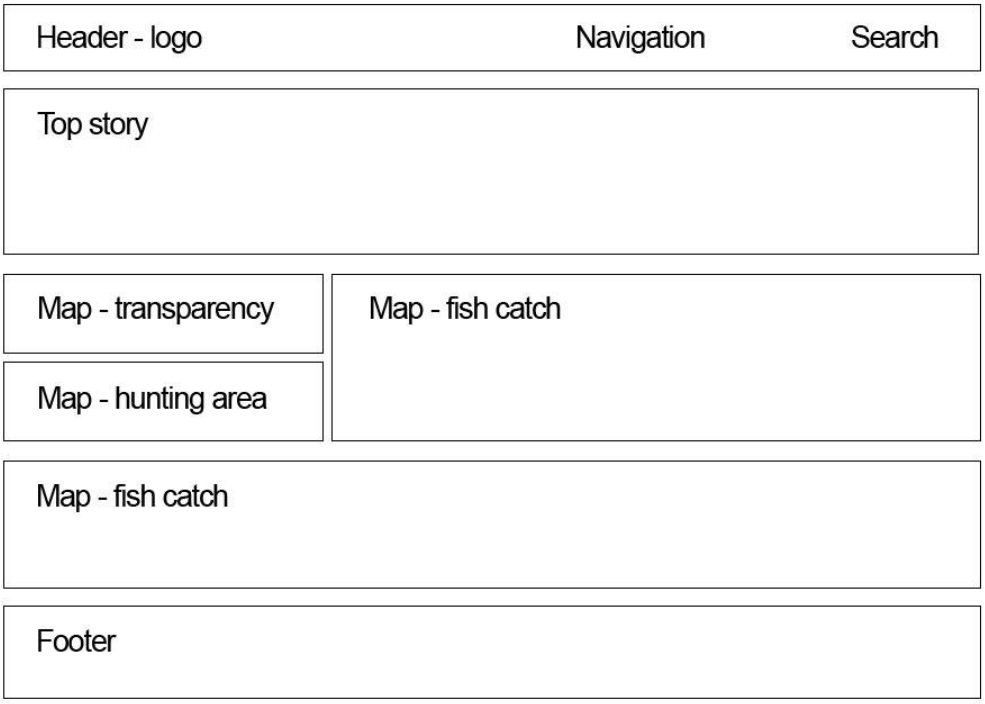
Figure L.1 - Flow chart for spearfishers using the service

The flowchart is a design draft for the process of contributing an observation. The final flowchart has been optimized and now presented to the participants within this final document.

Designing screens

The user interface was discussed during the workshop. The relevant pages connected and influencing the concept and service was discussed and design draft was made in collaboration.

The first page discussed and design was the home page. The draft is illustrated within figure L.2.



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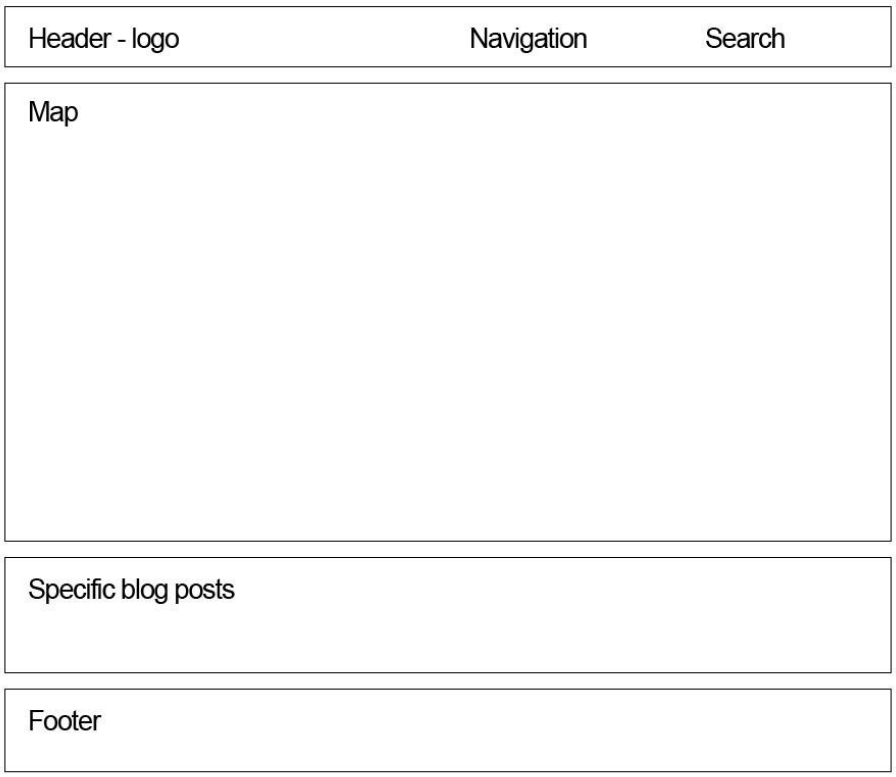

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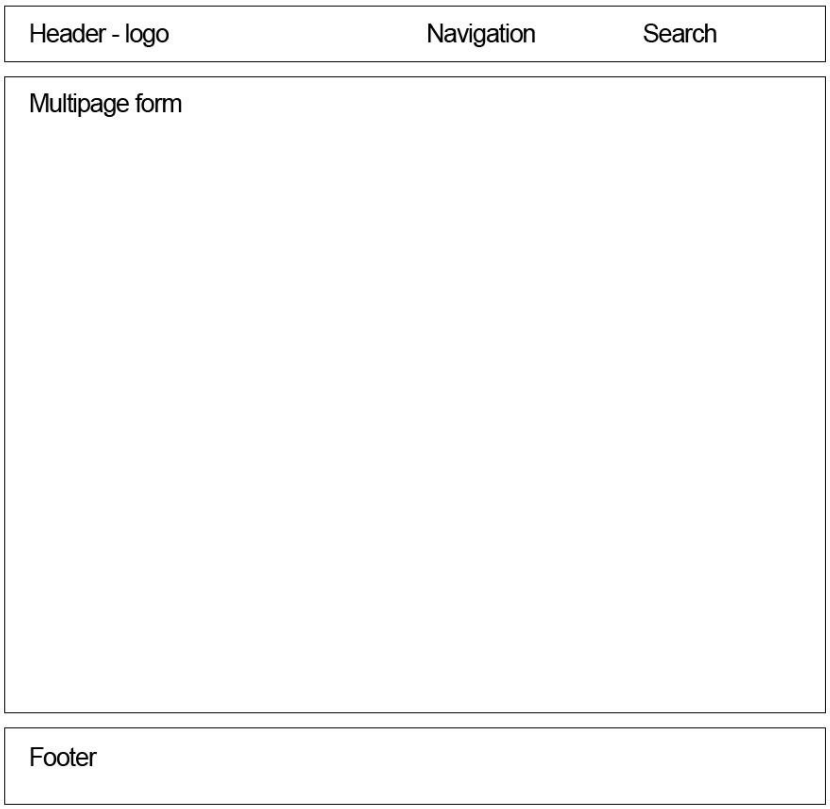

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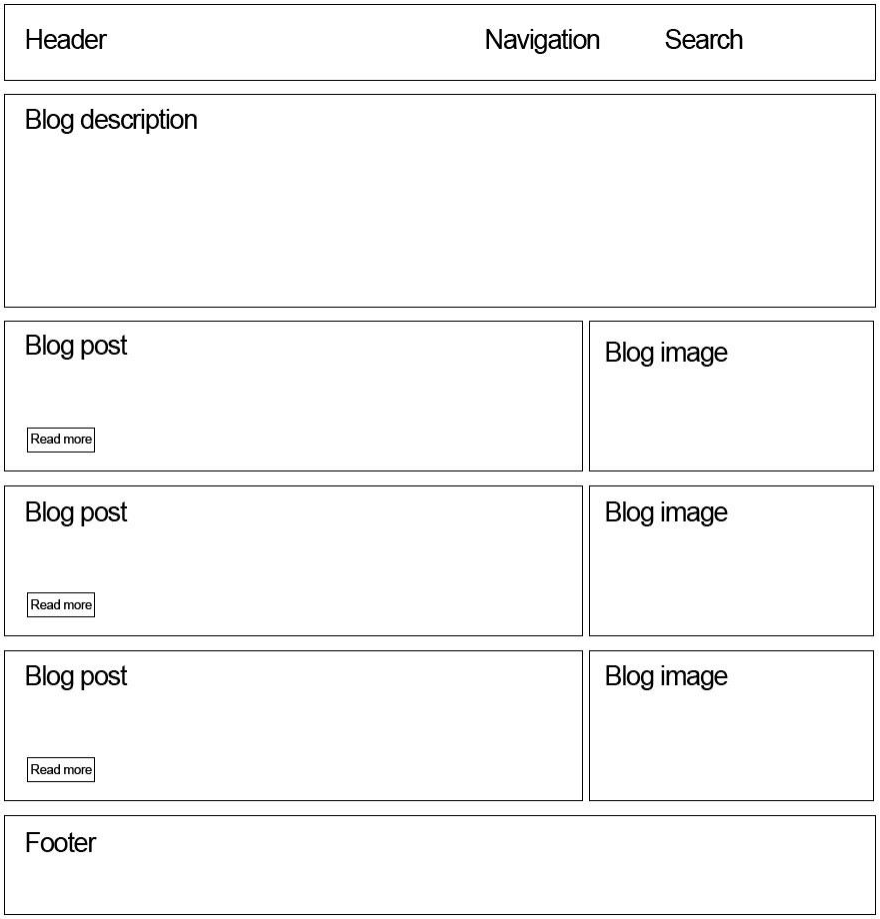

Figure L.6 - Design draft of the scientist's blog page was made in collaboration during the workshop

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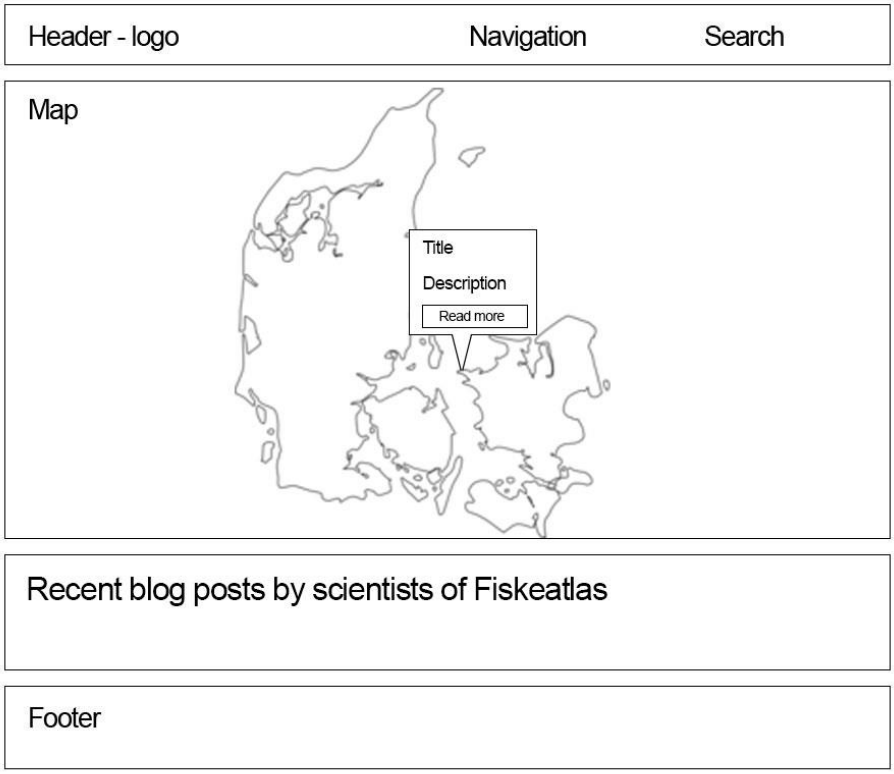

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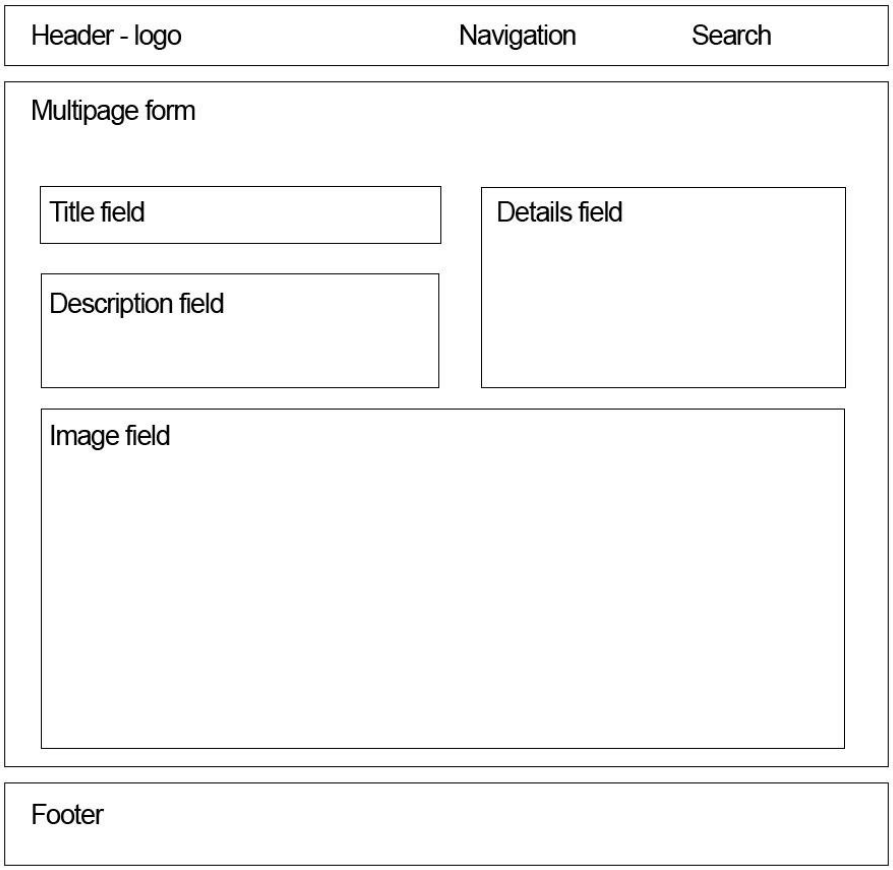
In figure



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Illustrated in figure L.8, the report page is structured and is designed in collaboration to contain the required data listed and agreed earlier within this working document.

Resolving open Issues

Engagement and motivation was the main open issue relevant for the participant. The participants suggested that the ability to share you contributed report on the most used social medias in denmark would be the best feature of the system to serve their engagement and motivation.

JAD Approval Form

JAD Project: CITIZEN SCIENCE: ENABLING DANISH SPEARFISHERS TO CONTRIBUTE MARINE OBSERVATIONS FOR PROJECT FISKEATLAS

Authorizing User Managers:

Participants #1: bianca Secher Date: 10/11/2015

Participants #2: Mihail Gonatay Date: 10/11/2015

Participants #3: Jesper Hansen Date: 10/11/2015

Participants #4: david rasmussen Date: 10/11/2015

Authorizing Project Facilitator:

Facilitator:  Date: 10/11/2015

23 Appendix N – Information & Knowledge survey

Spørgsmål om informations deling indenfor undervandsjagt

Spørgeskemaet er udsendt med et formålt om at samle data omkring informationsdelingen indenfor undervandsjagt.

Der bliver sat stor pris på ærlige svar og tiden, der bliver brugt på at besvare følgende 12 spørgsmål.

Resultatet af dette spørgeskema bliver anvendt til et specialeprojekt i computervidenskab på Aalborg universitet og dine svar vil blive behandlet med diskretion og respekt.

*Påkrævet

Køn *

- ○ Mand
- ○ Kvinde

Alder *

Dit svar

Landsdel *

- ○ København by og omegn
- ○ Nordsjælland
- ○ Østsjælland
- ○ Vest- og Sydsjælland
- ○ Bornholm
- ○ Fyn
- ○ Sydjylland
- ○ Østjylland
- ○ Vestjylland
- ○ Nordjylland
- ○ Andet:

Deler du information med andre, der også dyrker undervandsjagt?
Det kan eventuelt være information om tabt udstyr, sigtmelding, fangster eller lignende.

- ○ Ja
- ○ Nej

Hvis ja, hvilken information vil du gerne dele med andre, der dyrker undervandsjagt?
Nævn gerne så mange emner som muligt.

Dit svar

Hvad er din motivation for at dele eller ikke at dele information med andre, der dyrker undervandsjagt?

Dit svar

Hvilken information vil du IKKE dele med andre, der dyrker undervandsjagt?
Nævn gerne så mange emner som muligt.

Dit svar

Er der informationer som du gerne vil dele med andre undervandsjægere, men du er ikke i stand til det på grund af eventuelle begrænsninger i form af, at det er for besværligt?
Eventuelle begrænsninger inden for følgende områder; teknologiske, lovmæssige, geografiske og så videre.

Dit svar

Hvor meget praktisk forberedelse, gør du dig inden et dyk?
Et eksempel er eventuelt, at du tjekker fangst historikken over et området eller tjekker tidligere dages vind og vejr.

	1	2	3	4	5	6	7	
Lidt	○	○	○	○	○	○	○	Meget

Hvilke praktiske forberedelser gør du dig?
Nævn gerne så mange emner som muligt?

Dit svar

Hvor nemt synes du det er, for undervandsjægere, at dele generel information med hinanden?
Det kan eventuelt være erfaringer, diskussioner, spørgsmål og så videre.

	1	2	3	4	5	6	7	
Svært	○	○	○	○	○	○	○	Nemt

Hvor nemt synes du det er, for undervandsjægere, at dele geografisk information med hinanden?
Det kan eventuelt være konkret information om sigtmeldinger, jagtområder, dykkende undervandsjægere og så videre.

	1	2	3	4	5	6	7	
Svært	○	○	○	○	○	○	○	Nemt

SEND

100 %: Du er færdig.

Indsend aldrig adgangskoder via Google Analyse.