ANSSI MYLLYMÄKI
REDESIGN OF AN AIR QUALITY MONITORING WEBSITE FOR
CHINESE USERS

Master of Science thesis

ABSTRACT

ANSSI MYLLYMÄKI: Redesign of an air quality monitoring website for Chinese users
Tampere University of technology
Master of Science Thesis, 81 pages, 10 Appendix pages
May 2016
Master's Degree Programme in Information Technology
Major: User Experience
Examiner: Professor Kaisa Väänänen

Keywords: China, web design, user experience, cross-cultural, user-centered design, usability, Hofstede, air quality, paper prototype, guideline

China is one of the most populated countries in the world with a strong growing economy. These two among many other attributes makes China an interesting target for any company that wants to sell their products on a wide market. Getting products sold on the Chinese market is different from the western markets as the local companies want to build trust and ensure that the product and the relationship with the selling company is a worthwhile long term investment before making decisions about buying. Therefore, creating products that are reliable, efficient and satisfying is essential.

These type of product attributes are achievable through user-centered design (UCD) processes. The process includes the targeted users of the product as part of the design and development and through it improves the usability and user experiences of the product.

Approaching a foreign culture with UCD methods requires thorough knowledge about the target culture. In this thesis, the Chinese culture is approached through the culture dimensions of Hofstede which provide overall pictures of national cultures. These dimensions have been used to understand the target users in the foreign culture and to provide culture specific guidelines for product development.

The goal of this thesis was to redesign a Finnish air quality monitoring website to be more suitable for the Chinese users. It was expected that the research process also provides general design guidelines targeted for Chinese people, and for conducting UCD research in China.

The study consisted of three user research rounds, from which two were conducted in Finland and one in China. Total amount of participants in these studies were 7 Finnish and 14 Chinese. The used UCD methods include; task based user testing, interviews, competitive evaluation and paper prototyping.

The results of this thesis include the redesigned website which was optimized for the Chinese users group. The users of the original website that were part of the study, were pleased with the new design. The thesis proposes guidelines for designing products targeted for Chinese people and guidelines for conducting UCD research in China. The redesigned website is expected to be provided for the company customers in the near future.

TIIVISTELMÄ

ANSSI MYLLYMÄKI: Ilmanlaadun tarkkailuun käytettävän verkkosivun uudelleensuunnittelu kiinalaisille käyttäjille
Tampereen teknillinen yliopisto
Diplomityö, 81 sivua, 10 liitesivua
Toukokuu 2016
Tietotekniikan diplomi-insinöörin tutkinto-ohjelma
Pääaine: User Experience
Tarkastaja: professori Kaisa Väänänen

Avainsanat: Kiina, verkkosivusuunnittelu, käyttäjäkokemus, monikulttuuri, käyttäjäkeskeinen suunnittelu, käytettävyys, Hofstede, ilmanlaatu, paperiprototyyppi, ohjenuora

Kiina on yksi maailman väkirikkaimmista valtioista ja taloudellisesti vahvassa kasvussa. Nämä kaksi, monien muiden ominaisuuksien joukossa, tekevät Kiinasta kiinnostavan kohteen yrityksille, jotka haluavat myydä tuotteitaan laajoilla markkinoilla. Kauppojen tekeminen Kiinassa eroaa länsimaisesta kaupankäynnistä, sillä Kiinalaiset haluavat varmistua tuotteen ja kauppakumppanin luotettavuudesta sekä yhteistyön pitkäkestoisuudesta ennenkö tuotteista tehdään ostopäätös. Tämän vuoksi on tärkeää, että Kiinaan myytävät tuotteet ovat luotettavia, tehokkaita ja miellyttäviä käyttää.

Näitä ominaisuuksia voidaan lisätä tuotteeseen käyttäjäkeskeisen suunnittelun avulla. Käyttäjäkeskeisissä projekteissa tuotteen kohdekäyttäjä osallistuu tuotteen kehitykseen ja tämän kautta tuotteen käytettävyys ja sen tuottamat käyttäjäkokemukset parantuvat.

Käyttäjäkeskeisten metodien käyttäminen vieraassa kulttuurissa vaatii aiheeseen perehtymistä. Tässä työssä Kiinan kulttuuria lähestytään Hofsteden kulttuuriulottuvuuksien kautta, jotka antavat kokonaiskuvan kansalliskulttuureista. Näitä ulottuvuuksia on käytetty kohdekulttuurin käyttäjien ymmärtämiseen käyttäjäkeskeisiä metodeja käytettäessä sekä suunnitteluohjenuorina tuotekehityksessä.

Tämän työn tavoitteena oli uudelleensuunnitella suomalainen ilmanlaatumonitorointiin käytetty verkkosivu kiinalaisille käyttäjille sopivammaksi. Työn tavoitteen ohella oletettiin syntyvän ohjenuoria tuotteiden kehitykseen kiinalaisille sekä ohjenuoria käyttäjäkeskeisen tutkimuksen tekemiseen Kiinassa.

Tutkimus koostuu kolmesta käyttäjätutkimuskierroksesta. Kaksi kierrosta toteutettiin Suomessa ja yksi Kiinassa. Tutkimukseen osallistui yhteensä 7 suomalaista ja 14 kiinalaista. Tutkimuksessa käytettiin metodeina tehtäväpohjaista käyttäjätestausta, haastatteluja, kilpailijavertailua sekä paperi prototyyppejä.

Työn tuloksena syntyi uudelleensuunniteltu verkkosivu, joka optimoitiin kiinalaiselle kohderyhmälle. Tutkimukseen osallistuneet alkuperäisen verkkosivun käyttäjät olivat tyytyväisiä verkkosivun uuteen toteutukseen. Tuloksena saatiin myös lista ohjenuoria tuotteiden kehittämiseen kiinalaisille sekä ohjenuoria käyttäjäkeskeiseen tutkimukseen Kiinassa. Uusi verkkosivu annetaan asiakkaiden käyttöön oletettavasti lähitulevaisuudessa.

PREFACE

This thesis was done for Pegasor Oy between August 2015 and May 2016. I would like to sincerely thank the company and all of my colleagues for giving me the opportunity to make this thesis from such an interesting topic. User research in China and designing for the Chinese were both challenging tasks from which I learned a lot.

I would like to express my gratitude for my supervisor Prof. Kaisa Väänänen for giving me excellent advice during the project, especially with the parts related to user experience and user-centered design.

From the company side, I would like to give my extended thanks to my supervisor Yanan Mi for giving me advice on Chinese culture related matters and for discussing about the work and the results in different phases of the project. I would like to thank Markku Rajala for providing comments for the thesis and guiding the work to the right direction. I would also like to thank Lei Dong for helping me translate the parts of the user research to Chinese and interpreting the user tests conducted in China.

I would like to express my thanks to the company making the practical implementation work for the redesigned website and especially Jukka Suhonen for being a part of the design process and for delivering fast solutions to any urgent issues.

I thank all of the participants of the interviews and prototype testing. Your feedback made the redesigning of the website possible and it was a pleasure working with you.

To Mikko and Aleksi, I give my thanks for reading this through and giving me valuable feedback for improving the thesis and making the text more reader friendly.

Lastly, I would like to thank Eija for supporting me through the project and making me explain, also to myself, what I am actually doing during the various phases of the project.

Tampere, 28.4.2016

Anssi Myllymäki

"One does not inhabit a country; one inhabits a language. That is our country, our fatherland --and no other."

-Emil Cioran, Romanian philosopher

CONTENTS

LIST OF FIGURES

List of Symbols and abbreviations

AQI   Air Quality Index
MB   Megabyte
PM   Particulate matter
PPS-M   Pegasor Particle Sensor
Px   Pixel
QR-code   Quick Response Code
RFID   Radio frequency identification
UCD   User centered design
UI   User interface
UX   User experience
WTO   World Trade Organization
WVS   World Values Survey

1. INTRODUCTION

China is one of the most populated countries in the world with a strong growing economy. These two among many other attributes makes China an interesting target for any company that wants to sell their products on a wide market. Getting products sold on the Chinese market is different from the western markets as the local companies want to build trust and ensure that the product and the relationship with the selling company is a worthwhile long term investment before making decision about buying. Therefore, creating products that are reliable, efficient and satisfying is essential.

Fast growth invokes fast changes on many areas, also in the field of web page design. Chinese web pages have changed drastically during the last decade and the current trend of design is close to the most popular websites in the west. Because of the fast change and lack of research it is hard to determine Chinese design preferences and if they differ from the western preferences.

User-centered design (UCD) processes are used to improve usability and invoked user experience of products by learning the preferences and needs of the targeted user before the development of the product. To learn the preferences and needs, UCD methods include potential users of the product to the design process. The methods used in this study include; interviewing the users for feedback, testing the product user interface (UI) with a task list, comparing the product with another similar product, testing the product with a paper prototype and co-designing the product with the potential user while testing.

Approaching a foreign culture with UCD methods requires thorough knowledge about the target culture. In this thesis, the Chinese culture is approached through the culture dimensions of Geert Hofstede which provide overall pictures of national cultures. These dimensions have been used to understand the target users in the foreign culture and to provide culture specific guidelines for product development. Foreign language is another significant factor that affects the use of the UCD methods as well as the gained results from the methods. Therefore, the thesis discusses about the effects that interpretation and different languages have on the UCD methods.

In the research, a website that is designed by a Finnish company and used by Chinese users, was taken through a user-centered design process consisting of several methods. Methods were used over three round of development with total of 7 Finnish and 14 Chinese participants. Two rounds of user-centered design were conducted in Finland and one in China. The website was redesigned over the three iteration rounds based on the results of the processes.

The goal of this research was to improve the user experience of the website especially for Chinese users. Research was expected to yield a list of common practices and guidelines related to Chinese design preferences that could be later applied also to other projects targeted to China. As an additional result, the research aims to determine the differences between user-centered design processes conducted within China and Finland.

The thesis was done for a Finnish company Pegasor[1] which provides solutions for air quality measurement and has been active in China for several years. The targeted website is a monitoring page for one of the newest products of the company. The original website is developed by another Finnish company, Realin[2].

The structure of the thesis is as follows. Chapter 2 defines User Experience and discusses about the methods and processes of user experience research. It also lists the benefits that good user experience can provide. Chapter 3 covers culture and traditions of China and the ways they can affect the process and results of user experience evaluation. Chapter 4 describes the general web design principles and current situation of web sites in China, the history of usability and web design in China and the ways that the culture affects the web design. Chapter 5 goes through the research process of the study and covers the used methods and reasoning for their use. Chapter 6 lists the results of the UCD processes. Chapter 7 presents the new website that was implemented during the creation of the thesis. Chapter 8 combines the Chinese preferences to a set of guidelines that can be used for other projects that are targeted to China. Chapter 9 gives a conclusion and discussion about the issues covered in the thesis as well as suggestions for future work.

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[1] www.pegasor.fi
[2] www.realin.fi

2. USER EXPERIENCE

Purpose of this chapter is to explain the concept of user experience (UX) and to clarify why it is important. This chapter also describes the differences and relation to more commonly known usability. The company, for which the thesis is done, has not used user experience or usability methods in their projects before. Therefore, this chapter describes how they benefit from considering UX related issues as a part of their product development processes. As the goal for this project is to improve the provided user experiences of a web page this chapter explains what has caused the need for web UX research in the time that we live in.

2.1 Definition

The scope of user experience is wide and there is no unambiguous definition for it available. One of the earliest definitions for user experience is from 1996 (Alben, 1996, p. 12) *"All the aspects of how people use an interactive product: the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it."*. According to ISO standard UX is defined in ISO 9241-210 as *"a person's perceptions and responses that result from the use or anticipated use of a product, system or service."* (ISO 9241-210, 2010). This definition is from a chapter of ISO-9241 "Ergonomics of Human-System Interaction" which is divided to software and interface design guidelines and also to workspace and environment ergonomic requirements. Recent definition of UX by (Olsson, 2012, p. 9) summarizes the UX as follows: *"User experience refers to the end users' subjective experience (e.g., emotional, physical or behavioral reactions) that is formed in interacting with an interactive technological artifact"* which is still very similar to the earlier definitions. What these three have in common is that they all mention a person who is using a system, artifact or a product. In (Roto, 2007), it is pointed out that many definitions of UX do not mention the fundamental fact that user experience happens inside the person and is a subjective and personal.

UX is closely related to usability which is defined as *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."* (ISO 9241-11, 1998). Even though UX is closely related to usability all definitions agree that UX is more than just products usefulness and usability (Väänänen-Vainio-Mattila, et al., 2008). Effectiveness, efficiency and satisfaction, the cornerstones of usability, are still important aspects of UX but the aim is to be less task- and work-oriented than in usability and to focus more on the subjective experiences of the user in different contexts. UX consists of the inner state of the user (expectations, mood, needs, motivation etc.), context of use and system that they are using

and how it works with the inner state of the user. Taking this many aspects into consideration UX is a very complex phenomenon which also raises critique towards it for being too vague, elusive and ephemeral. (Hassenzahl & Tractinsky, 2006)

It should be noted that not all experiences are user experiences because UX is only a subset of any given experience (Roto, 2007). An object and intended use of that object is required to form UX. When you are walking outside and come across a beautiful view an experience will probably occur but that is not a UX. If you see that your neighbor has a cake or you can smell the cake, you have an experience but it is not a UX but if you are invited to eat the cake you get to interact with the object, that is a UX (Roto, 2007).

There are several reasons why summarizing UX under one definition is so hard. One of the reasons is that UX deals with concepts that are hard to completely understand such as emotion or experience and values that are hard to measure such as fun, pride, pleasure or surprise. Secondly the measured unit for analysis can vary too much. Focus of a UX research can be on a single aspect of a single end user or the whole system can be measured with multiple aspects taken into account with the help of multiple end users. Also the field of UX has divided to several groups of theoretical models which each one of them has their own focus, such as experience, emotion or beauty. (Vermeere, et al., 2008)

2.2 Stages of UX

As UX is a temporary experience or feeling, a state of mind, that the user has during and after interacting with an object, how to determine the duration of UX? Figure 2-1 (Roto, 2007) describes the generation of UX from initial expectations to after use evaluation. Before a user has an experience from any given object, they have some kind of expectations about it first. This is not yet user experience but it is an essential part of UX as the expectations will be compared to the felt experience when the object is used. After the user has used the object and had the initial UX the experience begins to change over time depending on various factors. E.g., users experience about a shirt can change over time if they find out that the shirt was made using child labor. (Roto, 2007)
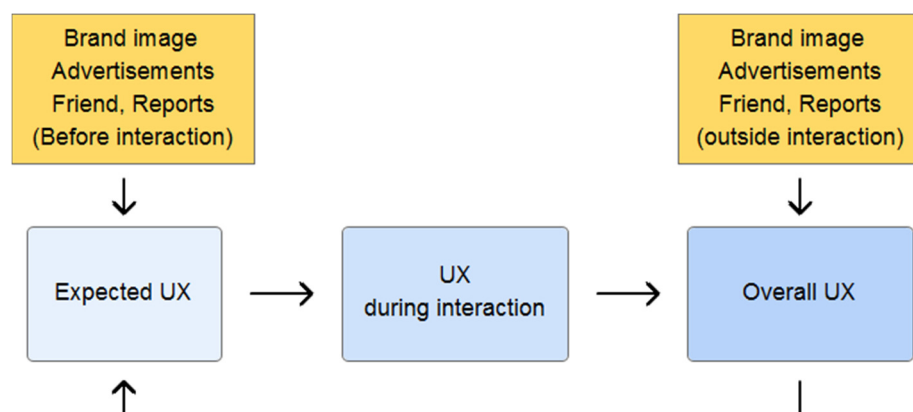
Figure 2-1: Stages of UX (Roto, 2007)

According to (Hassenzahl, 2008), the UX that occurs during the use of the object is the most important phase of UX. This is a good phase for finding out which features in the object provide good UX and which ones provide bad UX (Roto, 2007).

2.3 Process

Measuring or designing especially for UX is rare and is still lacking for agreed methods. UX can be improved through user-centered design (UCD) by understanding the needs and values of the users before designing for solutions (Väänänen-Vainio-Mattila, et al., 2008). Chapter 5.5 describes the UCD methods that were used during this thesis.

UCD consist of a few phases which are iteratively repeated until the designed product satisfies the set requirements. Some of the requirements such as marketing or hardware requirements should be defined very early on in the project. The requirements that come from the users are found out during the UCD process. Feedback and requirements that comes to the marketing team is usually from the decision makers who have different goals than the end users of the device and they should not be confused with each other (Courage & Baxter, 2005). It is essential that the before the product is complete, the solution is reviewed with the end users to ensure it fulfils their requirements (Courage & Baxter, 2005).

UCD starts and ends with the user but it also keeps the user involved for the whole duration of the process. A general UCD process is displayed in Figure 2-2 (Courage & Baxter, 2005). The process should begin by getting familiar with the background of the user. What are the tasks that the user does, in what kind of environment do they work, what values they have, what kind of expectations do they have and what needs do they have concerning the product. It is beneficial if it is possible to get direct contact with the users at the early phase of the development. Once the target user is defined, the developed product is measured and improved with representatives of the target group. The measurement is done with a method from the field of usability or user experience such as interviews or paper prototyping. Based on the results of the measurement the product is redesigned and measured again. (Rubin & Chisnell, 1994)
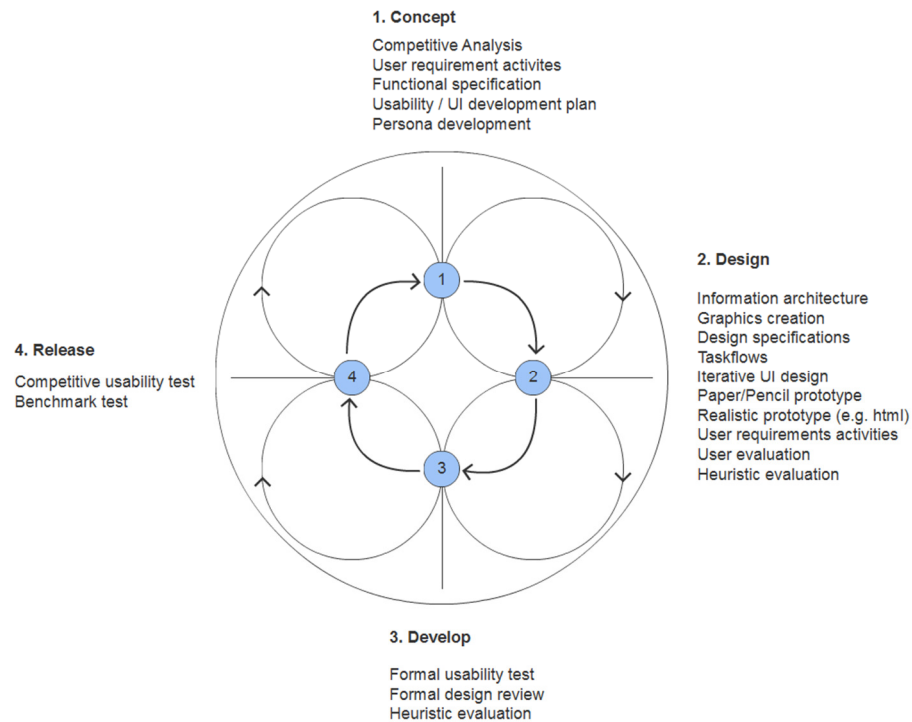
Figure 2-2: UCD process (Courage & Baxter, 2005)

Participants of the user studies during the UCD process are rarely fully representative of the target population. According to (Rubin & Chisnell, 1994) "*Participants are only as representative as your ability to understand and classify your target audience. Market research is not an infallible science, and the actual end user is often hard to identify and describe.*"

2.4 Benefits

Even though the concepts of UX and usability are close, the aimed improvements are to some extent different. When the goal is to improve a products usability, the product is made more optimal to use and through that, the work of the users is made more effective (Bevan, 2009). When improving UX the goal is user satisfaction and achieving both pragmatic and hedonic goals of the user (Bevan, 2009). By definition satisfaction is also a part of usability and which is usually improved during the usability improving process. It is satisfying that you can be effective in your work. Then again, great usability does not necessarily guarantee exceptional user experience and vice versa.

For example the bus transportation system in Tampere Finland uses radio frequency identification-cards (RFID) that are used for paying for the traveling. Money is loaded to the card before entering the bus. When entering the bus, the back of the card is shown to a RFID-reader and the card is read. The reader will either charge the card for the bus ticket price or tell the passenger to pay to the driver if the card balance is insufficient. The device interacts with the user about the payment with both text and with different sound beeps.

After this, the user transaction with the device is over. This system covers two corner-stones of usability, effectiveness and efficiency, as the card does what it is supposed to and it does it with very little effort. As using of this system is simple and usually done without much thought, the UX is not the main aspect that makes this solution great. It is also subjective if the good usability of this system is satisfying.

Different solution, where UX does not affect usability could be a solution that has random elements in it. Unless the solution is entirely designed to provide random results, such as dice, randomness does not usually bring the user closer to the desired goal in the most efficient way. In the other hand, randomness can provide user experiences that usability-oriented approaches could never achieve (Hassenzahl, 2008). Randomness is commonly used in games to make the experience different and unpredictable. This makes the experience itself more thrilling even though reaching the goal and finishing the game more time consuming. If randomness would be added to the bus payment system of the previous example in a way that the system uses additional time to enter the passenger in to a draw which gives the user a chance to travel that trip for free, it could be a good user experience of suspense for some passengers. Yet, this kind of solution would require different type of paying system where the driver does not wait for each passenger to enter and pay separately. With the existing solution each passenger would increase those additional seconds of the draw to the total traveling time of the bus which would ruin the usability of the system.

Even though usability and UX are not always improved simultaneously the results may be indistinguishable as the benefit for including usability or user experience practices in the processes of a company are similar. According to Gartner research (Gartner 2007a, according to Ketola & Roto, 2008) the success of UX can be measured in hard metrics and as intangible benefits:

- Increased Revenue: More orders per customer, more repeat engagements, more products per order.
- Reduced cost: Fewer support calls, fewer returns due to mistake or misperceptions, more efficient server use
- Faster time to market due to accelerated development: Increased customer satisfaction, improved brand image, positive word of mouth.

In (Weinschenk, 2005) the benefits on usability are listed in several categories:

- Increased sales and customer satisfaction
- Advertising advantages
- Reduced costs: development and maintenance, training, support, documentation
- Improved productivity and operational efficiency
- Litigation deterrence

Users are more satisfied which increases the sales frequency and volume. The product is easier to use which reduces the amount of support and training needed for each unit of the product. Product gives the customers what they want which reduces the chance for demanded refunds or legal issues.

2.5 Need for UX improvement in web design

Currently there exists close to one billion websites in the Internet (Worldometers, 2015). Among all these web sites there are usually thousands of web sites that can satisfy the need of the web user for certain kind of information. Because the users could get the same information from many other websites, it is often usability that makes the user stay or leave. (Nielsen, 1999). As the Internet has evolved from slow loading pages and bad page structures the need of the users has increased from usable web sites to web sites that provide great user experiences.

The Internet can currently be browsed through various devices such as desktop computer, laptops, smartphones and tablets. All of these have different screen sizes and are used in different ways. Desktop computer is usually used with mouse and keyboard whereas laptops have keyboard and touchpad. Smart phones and tablets are both used with a touch screen but the way of using the screen might be different e.g., smartphone could be used with both thumbs on the screen when tablet requires one hand holding the device and the other clicking the screen. Using touch screens also completely disables some functionalities in web sites such as mouse hovering, where you hold the mouse cursor on top of an object to interact with it. Some actions are performed differently with each device e.g., zooming. Mouse zooming can typically be performed with the scroll wheel of the mouse, most phones and tablets use pinching gesture to zoom and laptop touch pads might also have a gesture for zooming depending on the manufacturer and operating system. Creating a web site that provides good UX on each of the devices that it is meant to be used on, is not a simple task and is rarely successful without any emphasis on it.

The amount of internet users has increased from 400 million users in 2000 to 3.2 billion users in 2015 (ICT, 2015). If the user amount grows equally in the upcoming years, Internet will soon be used by half of the world's population. As Internet connections are becoming more common, new cultures gain access to the web. These cultures might have completely different requirements and preferences for websites in terms of cultural aspects such as language, symbols and colors. Chapter 3 describes how Chinese culture was taken into consideration in the UX improvements that were made as part of this thesis.

The requirement for improved UX does not limit to web design. According to (Olsson, 2012), people are constantly looking for more pleasurable experiences that exceed their expectations and support the feeling of fulfilment. Also (Walsh, et al., 2010) states that customers are globally expecting more from their products and services than mere utility and usability. Web design in discussed in greater detail on Chapter 4.1

3. CULTURE OF CHINA

Culture effects the way user studies can be conducted (Herman, 1996) and different national cultures lead to different kind of answers within user studies (Walsh, et al., 2010) (Brejcha, et al., 2013). Therefore, this chapter focuses on the national culture of People's Republic of China. Many researches take culture into consideration in form of the dimensions introduced by Hofstede (Hofstede, et al., 2010). These dimensions, which are also used in this thesis, provide a general idea about the preferences and values within a national culture. In addition to the general idea, this chapter also describes some Chinese traditions and values and their possible origins.

3.1 Definition of culture

Culture is a term that is hard to define and can be interpreted in many ways. Culture can be considered as the way that people behave in a country i.e., national culture, but it can also be considered as the way employees interact with each other within a company. (Hofstede, et al., 2010). In 1952, American anthropologists, Kroeber and Kluckhorn, reviewed and listed 164 different definitions for culture (Spencer-Oatey, 2012). In the early 1990s there was still no unambiguous definition for culture among anthropologists (Apte, 1994: 2001, according to Spencer-Oatey, 2012).

Hofstede (2010) defines culture as *"the collective programming of the mind that distinguishes the member of one group or category of people from others"*. Compared to the definition by Matsumoto (1996 according to Spencer-Oatey, 2012), *"the set of attitudes, values, beliefs and behaviors shared by a group of people, but different for each individual, communicated from one generation to the next"*, the definition by Hofstede does not bring up the individual differences inside the culture. The definition by Matsumoto includes the way that the culture is inherited which is not included in the definition of Hofstede. According to culture onion model of Hofstede displayed in Figure 3-1 (Hofstede, et al., 2010) culture is inherited only partially.

Hofstede et al. (2010) see that culture manifests through symbols, heroes, rituals and values. Symbols being the characters that are used in the culture for writing as well as meaningful pictures, objects, words and even dressing- or hairstyles. Heroes are the key persons that have affected or are affecting the culture and persons that strongly represent the nature of the culture. Rituals are routines that are carried out within the culture, including behavior such as conversation flow and greetings and also arranging of specific events. Values are basic concept that have two sides e.g., good versus evil or beautiful versus ugly.
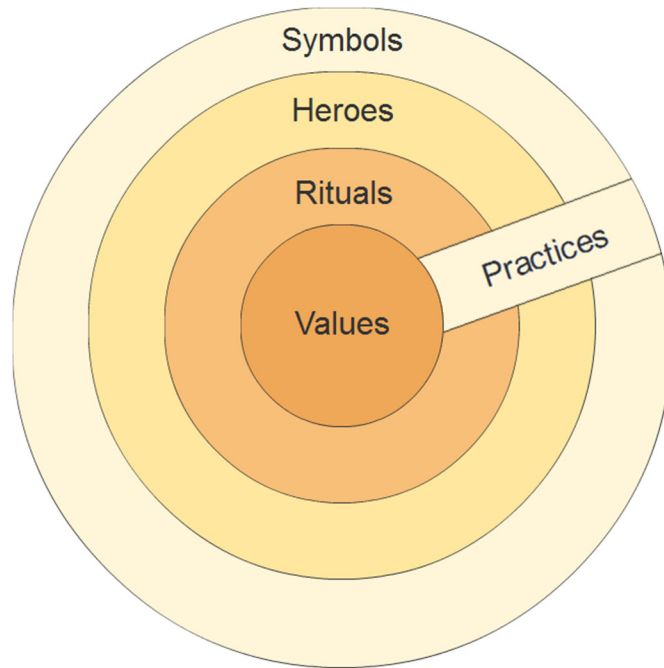
Figure 3-1: Culture onion model (Hofstede, et al., 2010)

Figure 3-1 presents culture as four layered onion model by Hofstede where each layer consists of different type of elements that the culture is made of. The outer layers are more prone to change in time whereas the inner layers consist of elements that can stay the same for centuries or even millenniums. The three outer layers are taught and learned through practice.

3.2 History and tradition

This chapter focuses on some of the historical events that have shaped the Chinese culture and traditions to the way that they currently are.

One of the most important contributors for Chinese tradition and value system is Confucianism. This school of thought, alongside with Daoism, Mohism and Legalism, were the ones that flourished during the Spring and Autumn period (770-476 BC). In the Han dynasty (206-280 AD) the emperor Wu Han banned the other three school of thoughts and from that moment on Confucianism was the state religion and base for values for the Chinese. (Zhu, 2008)

During the Han dynasty Confucian writings became part of the political rule and they served as legal documents solving issues such as criminal justice (Chun, 2012). Even though other schools of thought were banned during the Han dynasty they continued to effect the Confucian ways throughout the dynasty (Zhu, 2008) (Chun, 2012).

In the later dynasties Daoism and Indian Buddhism took part of the support from Confucianism and the three ideologies formed the base of religion and governance for the Chinese culture (Zhu, 2008). The relationship between these ideologies was supporting rather

than competing (Huotari & Seppälä, 1999). The governance of China was understood through Confucianism whereas Buddhism and Daoism answered to more religious questions. The longevity of these ideologies and religions can be seen during the time of Chinese Cultural Revolution (1966-1976) when the Chairman of communist party of China, Mao Zedong tried to wipe out Confucianism even though his own rule continued to consist of many Confucian elements (Huotari & Seppälä, 1999). Even after the Cultural Revolution, Confucianism is still an important part of the Chinese culture (Huotari & Seppälä, 1999) and Daoism as well as Buddhism are still common religions in China (Wenzel-Teuber, 2011).

The situation for the culture of China has been complicated after the death of Mao. The cultural revolution of Mao reformed China into a communistic country but after his death the form of governing was questioned and debate about capitalism, socialism, democracy and foreigners has been ongoing (Huotari & Seppälä, 1999). In 2012 former president of China, Hu Jintao, warned about the potential cultural influence of the culturally strong international western countries (Simpson, 2012). Other acts of protecting the national culture can be seen through the internet and media censorship conducted by Chinese government (Xu, 2015). The Chinese censorship is discussed in Chapter 4.

One of the traditional concept originating from the historical ideologies is the "Mandate of Heaven" (tianming). The concept describes the relationship between heaven and political rule. It is a general belief that the ruler of China rules from behalf of heaven and heaven judges the decision of the leader, blesses rightful ones and punishes the unwise (Zhu, 2008). As the ruler did not always have time to make all the important decision the respect that was earned through the Mandate was partly directed to the institutes that helped the ruler through their work (Huotari & Seppälä, 1999). This is likely one of the reasons for Chinese to accept great power distances between different social statuses. Power distance is discussed later in this chapter.

The Chinese culture is collective which mean that individuals feel tight belonging in the cultural group and their aim is to improve the group and be loyal to the group instead of being independent (Hofstede, et al., 2010). Collectivism originates from the schools of thoughts from Spring and Autumn period especially from Legalism and Mohism. These school of thought emphasized that one should dedicate their effort for good of a group (Zhu, 2008). Confucianism used to support both individualistic and collective ways but eventually categorized in to the later after absorbing some of the ways of other schools of thought (Huotari & Seppälä, 1999). The rise of communism in the 20th century both fit the collective culture and also empowered it. Collectivism is discussed later in this chapter.

There are several cultural aspects that originate from Confucianism. Based on the ideology, Chinese believe that humans are virtue-oriented, they should have harmonious relationship with nature and people, they seek harmony and altruism, they want to develop

under stabile circumstances, they value the past and the ancestors (Zhu, 2008). One of the main principles in Confucianism is that one should treat their elders and superiors with respect but also that the elders and superiors should treat their counterparts with kindness and wisdom (Huotari & Seppälä, 1999).

If the current situation of China is reflected to these aspects, it can be said that following some of these values has not been the greatest priority during the last century. Aspects conflicting mostly with the current situation are harmony with nature compared with the air quality problem and overall harmony with the rapid development.

Even though the culture of China has been in turmoil since the beginning of 20th century, Kumar & Worm (2011, p. 82) argue that China has a strong and tight culture and therefor they usually want to use the Chinese customs when interacting with foreigners. In this statement "culture" refers to a certain part of culture, rituals. It is possible that the core culture of China, rituals and values, have remained strong and tight during the various historical events even though the other layers of culture, heroes and symbols, have wavered like the culture onion model in Figure 3-1 suggests.

3.3 Hofstede's dimensions

Cultural dimensions which were first introduced in 1980 (Hofstede, et al., 2010) are the most often quoted theories in relation to cross-cultural usability (Smith, 2011). The dimensions are based on research that Hofstede did for IBM where he surveyed IBM employees in over fifty countries. Based on the results the countries where put under an indexed order in four cultural dimensions: Power distance, collectivism versus individualism, femininity versus masculinity and uncertainty avoidance. The tests done at IBM have been replicated multiple times in different companies, languages and social statuses and the results have been similar. (Hofstede, et al., 2010)

One of the replication tests was done in China where Michael Minkov asked his Chinese colleagues to compose a survey about basic values for the Chinese people. That survey was distributed to 23 countries and in each 50 male and 50 female students were asked to answer the survey. As a result from these surveys a new cultural dimension was found: long-term versus short-term orientation. (Hofstede, et al., 2010)

The newest of the Hofstede's culture dimensions was found in data research of World Values Survey (WVS) done by Misho Minkov. Minkov extracted three dimensions from the data of the surveys which he labeled as: Exclusionism versus universalism, indulgence versus restraint and monumentalism versus flex-humility. In further analysis it was found out that exclusionism versus universalism correlated highly with Hofstede's collectivism versus individualism and monumentalism versus flex-humility correlated with long- versus short-term orientation. Indulgence versus restraint was added as a new dimension to

Hofstede's culture dimensions. Table 1 presents the current six culture dimensions and their descriptions. (Hofstede, et al., 2010)

Table 1: Culture dimensions by Hofstede (Hofstede, et al., 2010)

Culture dimensions	Definition
Power Distance	The extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally
Collectivism versus individualism	Belonging into a strong cohesive in-group which protects the people throughout their life in exchange for loyalty, versus being independent, looking after oneself and ones immediate family only
Femininity versus masculinity	Society where emotional gender roles overlap and both men and women are supposed to be modest, tender and concerned with quality of life, versus society where emotional gender roles are clearly distinct. Men are supposed to be assertive and tough and women are supposed to be modest and tender.
Uncertainty avoidance	The extent to which the members of a culture feel threatened by ambiguous or unknown situations.
Long-term versus short-term orientation	Fostering pragmatic virtues oriented toward future rewards in particular perseverance, thrift and adapting to changing circumstances, versus fostering of virtues related to the past and present, such as national pride, respect for tradition, preservation of face and fulfilling social obligations
Indulgence versus restraint	Society where relatively free gratification of basic and natural human needs related to enjoying life and having fun are allowed, versus society which suppresses the gratification of needs and regulates it by strict norms.

For each country that has been part of the research of Hofstede, indexes for these dimensions are available. The index value determines the intensity of any culture dimension within a country compared to other countries and is usually limited between 0 and 100. Indexes for over 100 countries and areas are available for comparison (itim International, 2012).
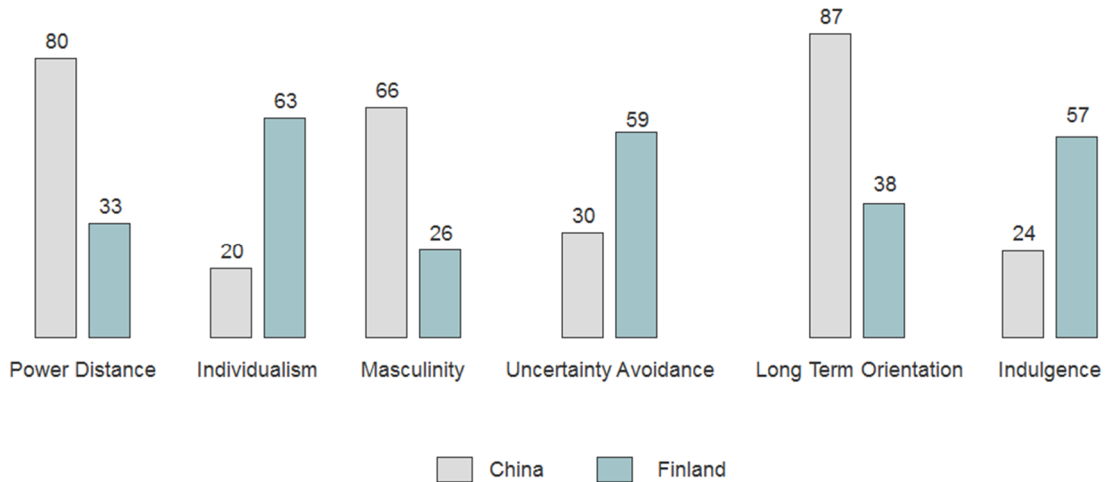
Figure 3-2: Culture index values for different dimensions in China and in Finland (itim International, 2012)

Figure 3-2 shows the culture dimension indexes for both China and Finland. The indexes between these two countries vary greatly. Chinese Long Term Orientation is highest index of the six which is expectable as this dimension originates from China. Power distance is another high index and the most significant dimension for this thesis. Second dimension that had a high impact on this thesis was the collectivism versus individualism. Chapter 4.3.1 describes the use of these indexes for design in greater detail.

It can be argued that summarizing whole national culture under single definition or set of values is misleading as there are other cultures within the national culture that could have very different values e.g., religious societies. Even so, replications made from the tests of Hofstede, have yielded similar results for different cultures within the national culture (Hofstede, et al., 2010). Yet, (Hofstede, et al., 2010) states that one should never base their opinion of a person on a national stereotype.

3.4 Chinese culture relation to the thesis

This chapter describes the cultural phenomena that have been taking into consideration during thesis while making the user research and the redesign of the new website.

3.4.1 Concept of face

"Investigations by anthropologists and psychologists have shown that I while the desire for prestige exists in every human society, the value placed upon it and the means for attaining it vary considerably." (Hu, 2009, p. 1). The concept of face is a highly valued and honored prestige system in the Chinese culture.

The concept of face guides the Chinese to never experience a shameful situation which would cause them to "lose face". It is not unusual to protect ones face by hiding shameful or negative information, even though it would make it easier for the other party to understand the situation. In more rare cases the Chinese might consciously alter results of their work to be in a better position and therefor gain face and at the same time protect their face from bad results. (Saraste & Lehberger, 2010)

Chinese do not wish others to lose face either, which makes them reluctant to refuse anything openly and indirect communication is common (Kumar & Worm, 2011). This also applies to user testing as the Chinese participants might not want to criticize a product because they are scared of causing the designer to lose face (Herman, 1996). One possible occurrence of this in practice is described in (Walsh, et al., 2010), where people from five different national cultures were participating in a user research. The results show that the Indians and Chinese were the ones to give least negative answers.

According to (Ting-Toomey & Kurogi, 1998), "face" exists in every culture. The way the face is interpreted within the culture depends on whether the culture is collective or individualistic. In cultures that are supporting individualism, the concept of face is less important as protecting and gaining face is mostly focused on oneself. In collective cultures, such as Chinese, face needs to be considered on a larger extent. Collectivism requires consideration of face on behalf of the group that one represents. Face loss of a group caused by one, brings shame to everyone within the group. In addition, protecting and giving face for others is more common in collective cultures than in individualistic cultures. (Ting-Toomey & Kurogi, 1998)

In China the significance of the concept of face can also be seen related to Confucianism. Confucianism respects harmony and kindness which are both related to protecting the face of others and in the attempt of avoiding conflicts.

Concept of face was expected to affect the user studies of this research. The answers given by both Finnish and Chinese users were analyzed keeping this concept in mind. The user study situation was also studied in relation to this aspect. The estimated effects of the concept of face to this research are discussed in Chapter 9.

3.4.2 Colors

Different cultures have different meanings for colors. This chapter describes some of the most meaningful color interpretation differences between China and the western cultures.

In some cultures, a specific color can hold a much stronger meaning than the others, like the color red in China. Red is the color that is most often associated with China. It is generally considered as a good color and it symbols prosperity and happiness compared to western cultures where red is seen as danger or destruction. Red is a festive color and therefor over using it should be avoided. The Communistic party of China uses red as their main color but the original meaning and importance of the color has far deeper roots in the history of China. (Gao, 2011)

White is associated with death or funeral in China and should not therefor be used with anything festive (Gao, 2011). On the other hand, white is commonly used for products that represent cleanliness and aesthetics (Olivier, 2014).

Qing (青）is a commonly used color in China that is between green and blue and which is not often recognized as a separate color in western cultures. Using Qing might be associated with traditional Chinese culture. (Gao, 2011)

Yellow is a problematic color in China as it is related to pornography. Any product or media that has the term "yellow" strongly associated with it, such as magazine or video, is considered to consist of pornographic elements. The use of yellow should be avoided but it is not necessary to avoid it altogether. (Gao, 2011)

The usage of colors for Chinese web page design is discussed in Chapter 4.3.2 and color usage for the web site that was developed as part of this thesis is discussed in Chapter 7.2

3.4.3 Language

Mandarin Chinese is the most spoken first language with approximately 897 million speakers. In addition to China, it is spoken as first language in ten other countries. (Lewis, et al., 2016)

Chinese is the only used Language that has a writing system which is purely non-alphabetic (Huotari & Seppälä, 1999). Every character is separated to levels of pronunciation, form and meaning which means that one of these levels cannot be figured out through the other. This means that almost every character must be learned individually. (Huotari & Seppälä, 1999) Chinese written language consists of approximately 20 000 glyphs for both traditional and simplified characters (Schaefer, 2015b). The wide popularity of Mandarin Chinese combined with the complexity and effort to learn the language are likely to make the language culturally significant for the Chinese.

The term calligraphy means either beautiful writing or the way of writing, which is an important form of art for the Chinese. (Huotari & Seppälä, 1999) Chinese calligraphy can be seen in various places in China such as commercial posters, restaurant name signs or at homes on the walls. The importance of calligraphy has probably increased the Chinese affection towards their character system and using calligraphy on products could prove to be pleasant for the Chinese.

Currently China has a great emphasis in teaching of English. English is taught from primary school to university and those who study for their bachelor's degree in English have 11,5 hours of studies in English weekly (Qiufang, 2012). English has enabled the possibility to interact with native English speakers and with those who speak English as their second language without the help of an interpreter. Increasing emphasis on English has reduced the amount of other languages taught in China (Lidi, 2008). Even though English is the main focus of foreign language studies in China, learning the language is still hindered by several issues. English is not commonly used in China outside classrooms and media publication in English are rare (Lidi, 2008). Majority of originally English movies are dubbed to Chinese. According to (Lidi, 2008) and (Qiufang, 2012, p. 80) the English lessons in China are heavily crowded and the teachers are not always professionally qualified for teaching English. At 2012 the ratio of English teachers to students was 1 to 160 in the primary schools and 1 to 120 on secondary schools (Qiufang, 2012, p. 80). Even though China is focused on teaching English, the communication in English might be challenging for those who rarely use it in practice.

While making research in China or designing products for the Chinese, language should be taken into consideration. Chapter 4.3.3 discusses website translation from English to Chinese and 5.6 discusses the implementation of user tests with Chinese interpreter.

3.4.4 Smartphones

Smartphones are becoming a standard equipment for almost everyone living in urban areas of the developed economies e.g., Finland. Even though China is not amongst the countries that have the most mobile users with respect to the total population, mobile usage in China cannot be ignored while studying the current culture as the percentage of urban population owning a smartphone is still at significant 89%. (Nielsen, 2013)

The amount of mobile users is not the only thing making the Chinese phone usage worth the interest, but the way that the smartphones are used (Schaefer, 2015a). The Chinese use smart phones for various tasks that are not as common in other cultures. Some of these tasks include: mobile paying and banking, mobile shopping and regular use of Quick Response (QR)-codes or barcodes. (Nielsen, 2013)

Collectivism has a significant effect in the way that mobile phones are used within a culture (Strikes, et al., 2009). In collective cultures the importance of being able to communicate within ones culture is essential and having a mobile phone empowers the belonging to the group (Strikes, et al., 2009). Having the need to communicate with a group reflects to features used especially in social media called "sharing". Sharing features and the way mobile usage should be taken into consideration are discussed in Chapter 8.

3.5 Summary

Chinese culture has a long history and some of the cultural values originate from over 2000 years ago. The culture has gone through great changes during the latest centuries but some of the old cultural values still persist.

Chinese culture is very different from the Finnish culture and the culture should be considered while designing for and working in China. The differences can be understood through the culture dimensions of Hofstede from which this thesis focuses mostly on power distance and collectivism.

One of the most meaningful cultural aspects in China related to this work is the concept of face. The concept of face guides the Chinese to never experience a situation that would lead them or others to a shameful situation where they would "lose face". The concept originates from Chinese desire for harmony and respect as well as from the collective and high power distance culture.

Certain colors have strong meanings in the Chinese culture. It is appropriate to familiarize with the Chinese color meanings before designing for them. Mandarin Chinese is the most spoken first language in the world and the use of Chinese is respected in China. Chinese language should be used in products that are targeted to China when possible, even though Chinese are constantly getting more used to English.

4. WEB DESIGN FOR THE CHINESE USERS

This chapter describes the general website design principles and Chinese web design preferences. Chinese web page design is evaluated through the history of Chinese usability and current web page design trends. Fast and drastic changes on Chinese web pages during the last century are continuously changing the valid guidelines for Chinese website design. This chapter presents some of the guidelines that have been suggested for Chinese websites during the latest centuries.

4.1 Web design principles

A lot of content exists concerning the web design principles and the scope is so vast that it could be a single topic of a thesis. Many books such as (Nielsen, 1999), describe the requirements and appreciated practices of web usability. There are websites such as *Northwest Alliance for Computational Science & Engineering* (NACSE, 2002) that provide summarized guidelines for website designing. More recent sources focus on the current trends of web design that improve UX (Cao, 2015).

The way websites should be designed has changed a lot during the short history of the World Wide Web. Fifteen years ago the most important requirement for a good website was that it had short loading times (Nielsen, 1999). Excessive use of pictures or animations made the loading times rise and ultimately ruined the usability of the website. Nielsen (1999) stated that Internet users are not looking for experiences and are instead only interested about the content. Yet, after fifteen years from the publishing, UX is a term that is used parallel to usability and considered important for web design.

Many web site principles originate from usability. One of the main concerns, the loading times, are related to efficiency. According to (NACSE, 2002) website response time should be within a second to retain the focus of the user and under 10 seconds to keep the user interested about the website. By having the response time within 0.1 seconds the UI element can be considered interactive (NACSE, 2002). Cao (2015) states that interactivity is required for light elements and actions to make the user feel like they are in control of the system. As connection speeds have increased worldwide the problem of slow loading pages is fading away. Yet, many countries, including China, still have slow connection speeds compared to most western countries (Akamai, 2015). According to (Akamai, 2015), China has average connection speed of 3,7 MB/s whereas average in Finland is 14,8 MB/s. As new countries gain access to the Internet, with slow connections at first, the problem of page loading times is still going to persist for decades for some web users.

Both (NACSE, 2002) and (Nielsen, 1999) stress the importance of written content within the website which is according to them, the most important part of any website. This is

related to the effectiveness in usability. Since the website that is redesigned as part of this thesis is not a written content driven website, this principle is not discussed in greater detail. Websites were also likely to be more written content driven fifteen year ago.

Search function is common element in many websites. According to (Nielsen, 1999) search function should be added to pages that consists of over 200 pages whereas (NACSE, 2002) sees 100 pages as the threshold for the feature. As old websites used to consist mostly of pages, it is assumable that currently the search threshold could also be measured with objects such as devices. Browsing through almost 100 devices without a search function would be a tedious task and therefor the limit for adding search function could be even lower.

Scrolling is another typical feature for websites. Scrolling allows large amounts of data displayed on a single page. It also makes resizing of the browser window less challenging. Yet, (NACSE, 2002) states that horizontal scrolling should not be required, as it is not familiar for the users. Also, it is rare that a computer mouse would support horizontal scrolling with a scroll wheel. Nielsen (1999) argues that scrolling should be avoided altogether on navigational pages as users less likely to choose the elements outside of the screen.

NACSE (2002) proposes many guidelines for website development. General guidelines that were considered most relevant for this thesis are displayed in Table 2. Other guidelines focused on either how written content should be displayed on the website or on small tips for websites such as, not to use a welcome text, not to include copyright notice or avoiding statement "this site is under construction". Some of the guidelines in Table 2, such as the support for multiple browsers, might be even more significant now as the amount of commonly used browsers have increased greatly since these guidelines were first presented.

Table 2: Web design guidelines (NACSE, 2002)

Guideline	Description
Consistency	Use similar design and elements throughout the whole website. Includes various elements of a website such as layout, fonts, color palette, icons, navigation, wording of text and naming of elements.
Support browser resizing	Browser size can vary greatly between different users depending on screen size or user preference. Website should be designed so that the element alignment is controlled when the browser is resized.
Show the user where they are on the site	Users are not as familiar with the website structure as the developers are. The website should always tell the user where they currently are and how they can navigate back to where they came from. This can be done with e.g. bread crumb trails or navigation bars.
Show the user where they can find what they are looking for	Users are not familiar with the content of the website and they do not know where to find it. Use visual cues such as color, font size or highlighting to encourage the users to find the elements that they are looking for
Tell the user where they can contact you and where to find more information about you	Users expect to find this type of elements from a website. This way of contacting should not be limited to matters related to the website. The user might also be interested to find more information about the company through other websites which might also answer their reason for contacting.
Support multiple browsers	It can be expected that a website is going to be used with various browsers and different versions of those browsers. Using a browser that the website was not designed for might lead to unexpected results.

More general interaction design principles, which are not limited to web design, are proposed by (Nielsen, 1995). These are ones of the most commonly referred usability heuristics. The heuristics are displayed in Table 3.

Table 3: Usability heuristics (Nielsen, 1995)

Heuristic	Description
Visibility of system status	The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
Match between system and the real world	The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
User control and freedom	Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
Error prevention	Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
Recognition rather than recall	Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
Flexibility and efficiency of use	Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
Aesthetic and minimalistic design	Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
Help users recognize, diagnose and recover from errors	Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
Help and documentation	Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

The guidelines in Table 2 and heuristics in Table 3 have many similarities but the guidelines are more detailed about the way that they can be implemented for websites. Even though the heuristics of Nielsen are over twenty years old, they still provide a solid base for website design and guidelines.

4.2 History of usability in China

Usability is still a fairly new concept in China. Chinese equivalent for the word "usability" could be found from the Chinese academic databases starting from 1994. Lei et al. (2014) conducted a quantitative analysis about usability in China, in which they found 647 publication about Chinese usability from three Chinese databases and from one English database. The publication distribution over the years is displayed in Figure 4-1 (Lei, et al., 2014).
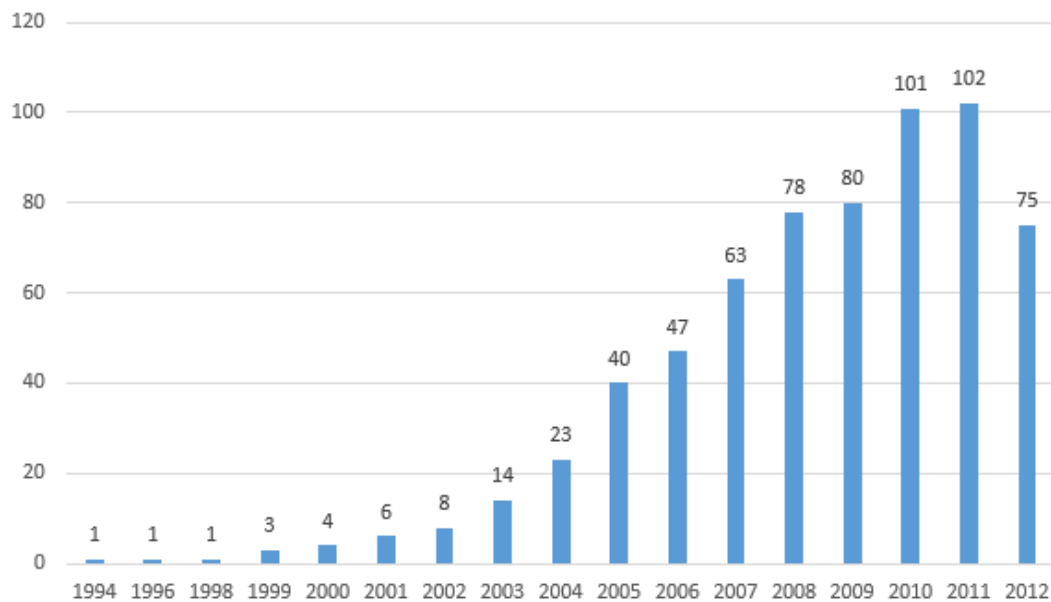
Figure 4-1: Distribution of usability publication by year in China (Lei, et al., 2014)

In the articles, usability was defined most often (151 times) with ISO9241-11 (ISO 9241-11, 1998) standard "Ergonomic requirements for office work with display terminals". Second most quoted definition for usability was from Nielsen (120 times) in 1993 where usability is seen to be consisting of efficiency, satisfaction, learnability, memorability and errors. Most used keywords were "usefulness" (140 times) and "user experience" (84 times). Usability was used as a keyword for only 21 times which can be explained by similarity of the other used terms and the direct Chinese interpretation of the term. (Lei, et al., 2014)

Liu et al. (2011) see that customer orientation has become increasingly important for many Chinese companies during the years of the increasing publication. Companies are changing the focus from product to service and the change is happening fast compared to the previous centuries. Some of the pioneer companies for Chinese usability and UX include Lenovo, Huawei and Haier which begun to utilize usability methods in their practices in 2003-2004. Some of the companies still employ over 100 people from the field of usability. (Liu, et al., 2011)

One of the reasons for sudden interest in usability originates from 2001 when China joined World Trade Organization (WTO). Joining the organization opened new markets for China which increased the competition and therefor the requirements for products. WTO exposed China to greater foreign influence which introduced new aspects of usability for the Chinese. (Liu, et al., 2011)

The usability studies in Chinese publications are mostly targeted in web applications (Lei, et al., 2014). Despite the constant increase in Chinese mobile usage, only four publications concerned mobile technology in 2012, compared to the fourteen in web applications. Due to the limited resources for translation, publication about the Chinese website usability in Chinese, could not be addressed in this thesis.

Lei et al. (2014) note that, according to the publications that they found during the research, Chinese do not have an author or a journal that focuses especially in usability or UX. The situation is different in the western countries, in which several usability and UX journals are constantly being published with articles from familiar authors. Not having a regularly publishing media for usability in Chinese might hinder the development of the field in China.

One of the most visible current trends in Chinese web development is mimicking the successful websites of the west (Maruma, 2014). Most of the popular western websites are blocked in China by the government (Schaefer, 2014). Chinese companies have produced similar websites to replace the blocked ones. One of the most used website, Google, is replaced by Baidu in China.
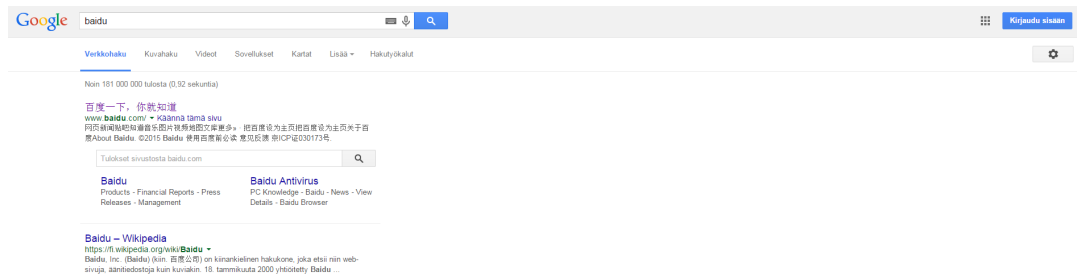
Figure 4-2 Google website

Figure 4-3 Baidu website

The Figure 4-2 and Figure 4-3 show that the layout of these websites don't differ much. On many other mimicked websites, the copying is not as obvious even though the designs are close to each other. According to (Schaefer, 2014) Chinese copy the designs of their competitors within China too, which means that the phenomenon is not limited to mimicking western designs. This is one of the reasons for the persisting of the old designs that lack usability. Schaefer (2014) argues that because of the copying and low awareness of web usability, some of the Chinese websites are still crowded with content and therefor hard to use.

4.3 Chinese web design

Discovering the Chinese web design preferences is difficult as the changes have been fast and guidelines for the design are often outdated. In addition, as China is one of the most populated countries, countless different variations for these preferences exist combined from many elements such as, language, color and user interface (UI) crowdedness.

While doing research on the Chinese web design, it is almost impossible to avoid the conversation about crowdedness or busy UIs. Some say that the UI designs are plain bad (Treehouse, 2011). Some argue that there are too many Chinese websites that are crowded, and Chinese actually prefer simple and delightful UI designs (Hu, 2012). According to some, the pages are not crowded and the feeling of crowdedness originates

from the way Chinese characters are perceived by those who cannot read the language (Tan, 2011). Some state that Chinese prefer information heavy web pages and that somewhat crowded UIs should be provided for the Chinese users (Su, et al., 2013). Clearly, there is no simple answer for this issue. Based on the results of this thesis, Chinese prefer more crowded UIs than the Finnish. As a reference to a website that could be considered crowded, Figure 4-4 presents one of the most popular news websites in China.

Figure 4-4: Sina.com.cn - popular Chinese news website

Brejcha et al. (2013) studied the differences between the Chinese and Czech website preferences. In addition to the language and color preference differences that are covered in Chapters 4.3.2 and 4.3.3, they found several layout preferences that differ between the two nationalities. The study suggest that the Chinese prefer the most important information in the middle of the screen. They prefer golden-section layouts such as 16:9 or 4:3 over square or double square layouts. The most useful media for Chinese was considered to be images and videos whereas for Czech preferred text and images. The study also claims that Chinese would prefer round corners in icons and windows. Yet, the founding is in conflict with the most used Chinese websites. On these websites (Written Chinese, 2014), most of the UI elements have sharp edges (see Figure 4-4). Brejcha et al. (2013) emphasize that the most important factors in UIs for both Chinese and Czech users is that the website works fluently and is aesthetic.

4.3.1 Culture dimensions

Some of the web design differences between China and the west are explainable by cultural models. This chapter reviews how Hofstede's power distance, collectivism and long-term orientation dimensions are considerable in web design.

Ahmed et al. (2009) propose several guidelines for designing web pages for high power distance cultures. These guidelines include hierarchical structure, honorific titles and the use official certificates and logos. Ahmed et al. (2009) see that hierarchical structure is implemented through including photographs of powerful members of the company that represent the content of the website. In addition, (Marcus & Gould, 2000) consider that website structure is part of the hierarchical structure. In high power distance websites the layout should be symmetric whereas with low power distance websites the symmetricity is not necessary. Hierarchy should also be empowered by including features that are visible for everyone but only usable by those who are high in rank (Marcus & Gould, 2000).

The use of honorific titles and symbols are emphasized by both (Ahmed, et al., 2009) and (Marcus & Gould, 2000). Using logos, certificates and titles is important for the Chinese web design. According to (Marcus & Gould, 2000), power distance determines the emphasis on nationalism on the websites, high power distance having greater focus on it.

According to (Smith, et al., 2005) collectivism is not relevant for the Chinese users as they prefer individualistic websites. This does not correlate to the findings of this thesis. Compared to the Finnish participants the Chinese tended to be more interested in features that were aimed to benefit others such as, sharing or the report feature. The interest in collectivism might have increased greatly since the smartphones have started to become popular which enabled easier communication and sharing of information compared to desktop web usage.

In long-term oriented cultures it is desired that the navigation requires learning (Marcus & Gould, 2000). In comparison, short-term orientation cultures prefer websites where the concise idea of the site can be understood quickly and the elements attract the interest of the user (Hofstede, et al., 2010). Long-term cultures are less concerned if all of the content of the website does not represent the area that the user is interested in (Marcus & Alexander, 2007).

According to (Smith, et al., 2005) power distance is the most significant dimension that effected the way Chinese experience web pages. Yet, (Smith, et al., 2005) underline that the cultural dimensions are old and were not initially designed to be used as guidelines for web development. Even though the cultural values have remained the same for centuries the web pages have changed greatly during their existence.

4.3.2 Colors in web design

There are several colors that hold a strong meaning in the Chinese culture and some colors get used more than others. The color palette used in popular Chinese website design is slightly different from the palette that is typical for the Chinese culture.

Ten of the most used web sites in China during 2014 (Written Chinese, 2014) were ana-lyzed for a color pattern. These web pages were analyzed with *Web Colour Data* tool (Liu, 2016) and the results were confirmed by inspecting the websites by eye. 9 out of 10 websites had a white or partially white background and 1 having light purple back-ground. Most used colors for the foreground elements such as links and buttons were red, orange and blue with varying saturation and hue. Plain text was usually black or grey. There was also a little use for green, yellow and qing.

Color scheme using mainly the colors that are in opposite directions of the color circle is called complementary color scheme. (Cousins, 2012) Some of the most used Chinese websites used complementary color designs by using shades of orange and blue together which are opposite colors on the color circle displayed in Figure 4-5 (Sakurambo, 2007). According to (Cousins, 2012) complementary schemes are good for drawing attention but should be used with caution and never as a basis of websites. Analogous color schemes use colors that are next to each on the colors wheel with a similar hue (Cousins, 2012). These color schemes are visually pleasing and calming and are generally advisable to use. In popular Chinese website designs, the combination of red and orange usually forms an analogous color scheme.

Figure 4-5: The color circle (Sakurambo, 2007)

Based on the research conducted by (Brejcha, et al., 2013), Chinese prefer lighter colors and white or lime background. For foreground colors, (Brejcha, et al., 2013) found out that favorite color for the Chinese would be blue. Black and white was the most preferred color combination. Yet, black and white pictures should not be used as Chinese associate it with death (Schaefer, 2014). Even though red with yellow or golden text is a commonly

used color combination in Chinese culture, it should be generally avoided on websites as it is too festive and represents special occasions (Brejcha, et al., 2013).

Ge et al. (2007) studied Chinese color preferences for colorful software interfaces. According to the study, Chinese prefer blue, purple or cyan backgrounds. White and black were excluded from this background preference research. For the foreground blue was the most preferred color followed up by white. The study was not conducted by researching working software but with comparing colors against each other outside the context of use which may cause bias in the answers.

Neither (Brejcha, et al., 2013) nor (Ge, et al., 2007) mention color orange, even though they cover most of the familiar colors in the studies. Orange does not have a strong meaning in the Chinese culture either. Still, the color is used in many of the most popular websites of China even though it is the complementary color to also commonly used blue.

For regular websites, white background is generally a safe choice and for colorful websites use of either light blue, cyan, purple or lime backgrounds are advisable. Foreground colors depend on the color that it is used on but generally orange, red and especially blue are generally good choices for Chinese websites. Excessive combined use of orange and blue or other complementary colors should be avoided.

4.3.3 Translation

Since the Chinese language is an important part of the culture, translation of websites is recommended in order to satisfy the Chinese users. As there are over 20 000 glyphs on both traditional and simplified Chinese, usage of different fonts is complicated. There are also some cultural aspects in the Chinese language that should be considered in the translation.

Translation to Chinese can be done to either traditional or simplified Chinese. Simplified Chinese was implemented during the rule of Mao Zedong and is used mainly on mainland China whereas the traditional Chinese is used in e.g. Taiwan and Hong Kong (Schaefer, 2015b). Because the website that is redesigned as a part of this thesis is targeted to mainland China, the site is translated into simplified Chinese.

The Chinese font size range from 3 to 7 megabytes (MB) (Schaefer, 2015b) which makes using of custom fonts difficult as the user would be required to download the large font set before using the website. For this reason Chinese companies, such as Logic Design, use pictures for the text for special fonts and standard web fonts for dynamic text (Schaefer, 2015a). On the other hand, using pictures for unusual fonts or calligraphy instead of text, complicates the translation process as the text fields of the web pages need to be converted to image elements. The image elements take longer time to load and are not helpful for the visually impaired unless the written text in the image is included in the

metadata of the element. Standard simplified Chinese web fonts for both Windows and OS X are displayed in (Schaefer, 2012).

Font size should also be considered as the Chinese characters are more detailed than the characters in Roman alphabet. In the study performed by (Su, et al., 2013), Chinese participants preferred the larges font size that was suggested for titles, 20 pixels (px). The only size provided for text on the pages with 20px titles was 13px.

Brejcha et al. (2013) noticed in their research that Chinese consider verb based menus more natural than those that are noun based. Although a noun and verb menu were regarded equally easy to understand, a verb driven menu was preferred since it showed a clear purpose to the user. In contrast, the Czech sample expressed a strong preference towards nouns as these felt the most intelligible. When translating to Chinese the descriptions of buttons and menu items should be converted to verb form for the translation if suitable.

Chinese have their own characters for numbers but they also use the Arabic numerals which means that translating the numbers is not necessary. Some of the Chinese numbers have strong cultural meanings which are also conveyed to the Arabic numerals. Chinese dislike using number four on any occasion as the pronunciation of the letter of the number 四 (Pinyin. sì) is close in pronunciation to 死 (Pinyin. sǐ) which refers to death. Chinese number eight 八 (Pinyin. bā) is the most used number because the pronunciation is similar to 发 (Pinyin. fā) which means fortune. Also number six 六 (Pinyin. liù) is considered to be a good number in China as it means that matters are proceeding smoothly. (Travel China Guide, 2016)

It is not necessary to remove every occasion of number four from the website during translation. Still, object groups that clearly have four objects, layouts that are divided to four equal parts or a clock icon that is set to four, should be redesigned to respect the meanings of the Chinese numbers. Also, in some research methods such as the questionnaire with one to five answering scale, the use of number four could be avoided by replacing the numbers with written forms such as agree or strongly agree.

4.3.4 Mobile web usage

Smartphones are currently one of the most popular way of using the web in China. The popularity is increasing at such speed that (Schaefer, 2015a) predict that China might be heading for mostly mobile web usage in the future, abandoning desktop designs.

Most of the websites in China use mobile phone number as the primary identifier for their authentication information (Schaefer, 2015a). In the west, email is usually used for the same purpose. Smartphones are used for paying in the web. The transaction is done by

scanning a QR code on the website which pays up to 30$ (USD) purchases without verification. QR codes are also used for several other purposes such as downloading applications or loading and signing in to web pages,

QR codes are used on desktop web pages to improve integration to the mobile variant of the web page (Maruma, 2014). Yet, according to (Schaefer, 2015a), it is not necessary for the Chinese to have websites that work for both desktop and mobile. However, if the desktop website can be used with mobile, Chinese prefer to have it redesigned as a mobile application, instead of rescaled version of the website (Schaefer, 2015a).

In the redesign of a website that was done during this thesis, smartphone usage was not one of the main focuses for several reasons. The initial requirement for the thesis was to improve the usability and UX of the website for desktop and for large screens, the importance of smartphones in China was discussed later during the project. The original website requires authentication which is harder to input on a mobile device than on a desktop computer. It is mainly targeted for work usage where employees are expected to use desktop or laptop computer. Creating a UI on several platforms for a foreign culture would have exceeded the scope of the thesis. Should the website be implemented for smartphone later, it should be made as an application, distinguishable from the website and with support for QR codes e.g., for logging in to the website.

4.4 Summary

Web design should be approached by following basic principles and guidelines such as, keeping the site consistent and guiding the user to their goals. Some common problems like website loading times are vanishing from the western countries as a result of high connection speeds, but the problem is still present in countries like China.

Usability and UX are fairly new concepts in China and the interest for them have constantly increased during the last twenty years. Usability and UX development has been impaired by website mimicking which is common in China. By designing similar websites, Chinese have had less chances to implement UCD methods or website guidelines for their websites. Chinese UCD development is also hindered by lack of Chinese authors or journals that promote usability, UX theory or methodology.

Even though lot of information about Chinese web design exist, finding a consensus is hard as discoveries from different sources might conflict with each other, some researches refer to websites that are over ten years old and the most of the popular websites in China are currently affected by western web design through mimicking. To counter these problems (Marcus & Alexander, 2007) recommend using user studies in addition to research on cultural background and local interface design to understand the needs of the targeted user group.

5. RESEARCH PROCESS AND METHODS

A website was redesigned as a part of this thesis based on feedback gained through a UCD process. This chapter describes the original website as well as the research process, background, goals and the used methods of this process. The process is divided into three sets of user tests, two of which were conducted and Finland and one in China. The test in China were done in Chinese with an interpreter and therefor this chapter also considers any potential effects an interpreter may have on the process and results of user test.

5.1 Research background

Pegasor Oy (Ltd) is a Finnish company that was founded in 2008. The company provides solutions and devices for aerosol measurement and specializes on ultrafine particles. Products of Pegasor are used for stack and engine emission measurement as well as for outdoor and indoor air quality measurement.   The company has operated in China for a few years and has established connections with some local companies and universities. The outdoor air monitoring device of Pegasor, Pegasor AQ^{tm} Urban (See Figure 5-1), is one of the main products of the company. The product is equipped with a modified version of Pegasor Particle Sensor (PPS-M) and it is designed to measure outdoor air quality and require minimal maintenance. The device sends sensor data to a cloud service which can be monitored through a website.

Figure 5-1: AQ^{tm} Urban – One of the main products of Pegasor

The website is provided to the company by another Finnish company, Realin, which was founded in 2013. Realin develops cloud websites for sensor data monitoring and provides solutions for connecting the monitoring devices to their services. This thesis focuses on the website that enables monitoring of AQ^{tm} Urban devices, provided by Realin.

5.1.1 Original website

The original website consists of few pages and features. Figure 5-2 displays the main page of the website with three station areas of the AQ^{tm} Urban devices and four of the device sensors represented with the green or gray icons within the areas. The value displayed next to the icons is particulate matter (PM) measured by the devices. Particulate matter is commonly referred value for evaluating outdoor air quality, especially in China (AQICN, 2016).

Figure 5-2: Main page with three measurement areas

By clicking one of the three rectangle areas in the main page leads the user to the area page seen in Figure 5-3. This page consists of information about the measurement area, a picture of the measuring site and values from selected sensors of AQ^{tm} Urban devices. By clicking one of the sensor value bars on the left, the website provides the core element of the website, the graph, which can be seen in Figure 5-4.
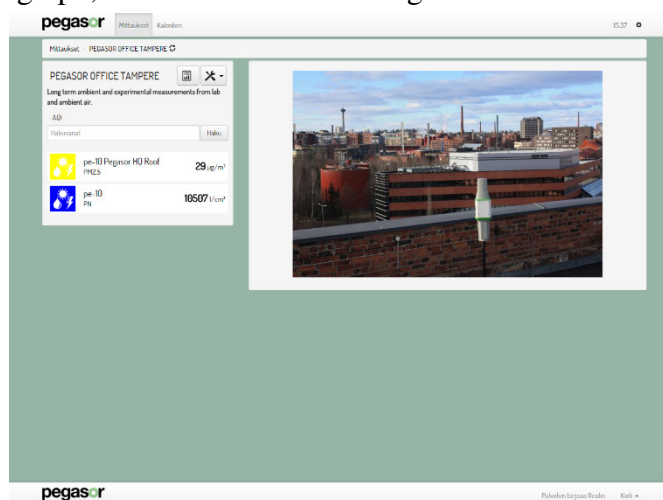
Figure 5-3: Area page with two sensors
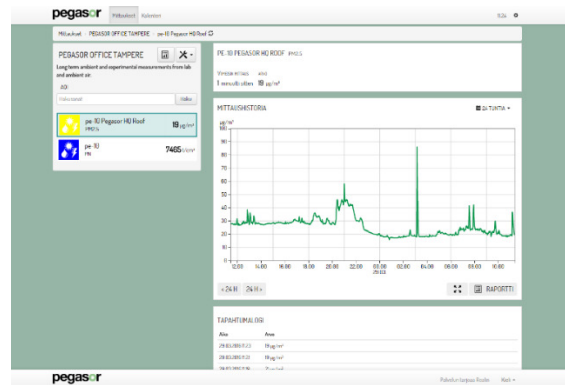
Figure 5-4: Graph view of Pegasor HQ Roof PM2.5 sensor

The graph shows measurement data from the sensors of the device. Other than the graph feature there are a few tools for handling the data such as reports and alarms. Report feature displays a premade template for a selected measurement period. The report includes graphs for each measured value in the selected area, also displaying the minimum and maximum for each value during the measurement period. The alarm feature is used to inform the user via SMS or Email if the sensor values exceed any set thresholds. Navigational model of the website is displayed in Figure 5-5.
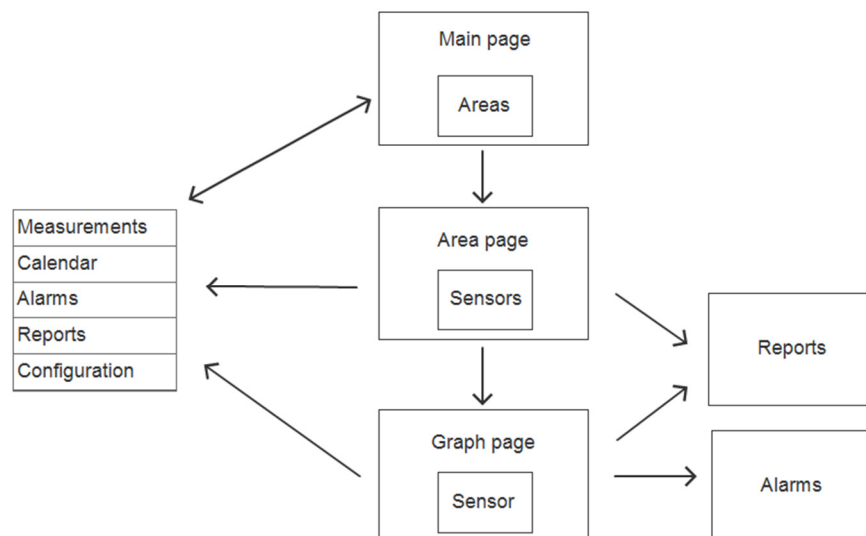
Figure 5-5: Navigational model of the original website

The website follows a hierarchical navigation path. The main page consists of areas and each area displays up to two current values of the sensors within the area, the area page consists of all sensors that are added to that area. Graph page opens next to the area page, which means that the area page is always visible when the graph page is visible. The page consist of a graph including the data of one or multiple sensors. Reports can be added for all devices on the area page or for single device on the graph page. Alarms can be added to sensors from the graph page when only one sensor is selected. For all pages, there is a

navigation bar that can be seen in the left on Figure 5-5. Measurement option of the bar navigates back to the main page. To aid navigation, breadcrumb list provides a way to navigate between the three main pages.

5.1.2 Goals

The goal of this research was to improve the user experience of the website especially for Chinese users. In addition, the Research was expected to yield a list of common practices and guidelines related to Chinese design preferences that could be later applied also to other projects targeted to China. As an additional result, the research aims to determine the differences between UCD processes conducted within China and Finland. The research questions of this thesis are as follows:

RQ1: *What type of web site for Pegasor AQ^{TM} Urban supports the needs and values of Chinese users of the device?*

RQ2: *What kind of guidelines can be given for creating a product for Chinese users?*

RQ3: *What needs to be taken into consideration when conducting user experience research in China or with Chinese participants as a foreigner?*

5.2 Research process

The research process was done over a nine month period between August 2015 and April 2016. The research was a UCD process with additional emphasis on cultural background research of China. The original website was already completely functional at the beginning of the process and it had not been improved with UCD methods before this project. The website was in use with a few AQ^{tm} Urban devices in Finland and with several devices in China. Figure 5-6 displays the progression of the research process.
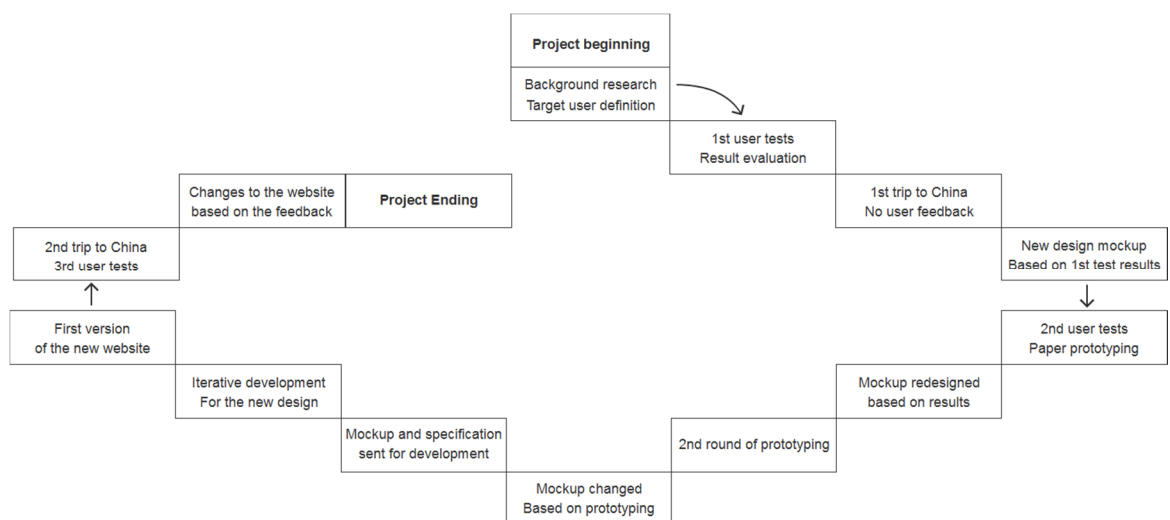
Figure 5-6: The stages of the research process

Before including users to the evaluation process of the website, the target group was defined to gain a better understanding about the preferences and needs that the potential users of the website could have. The target user was defined as a daily Internet user with some expertise in the field of air quality measurement and living in an urban area of Mainland China. The target user would be either student, scientist, real estate agent or a city official. Chinese cultural and traditional background was researched in order to discover how the user experience evaluation could be conducted respecting the Chinese ways and how the culture might affect the website related needs of the user.

5.2.1 First user tests – Task testing and interview in Finland

The first user tests were conducted in Finland with ten users, five of which were Finnish and other five Chinese. In addition, one prototype test was held before the actual tests. Used languages in tests were Finnish and English. It was required that the users were over 18 years old, spoke and understood English and that they used the Internet frequently. The recruited testers were familiar with Pegasor but did not have previous contact to the facilitator of the tests except for one participant. Test participants had varying expertise on the field of air quality measurement. Each participant was encouraged to prepare for the test by reading through (Air info now, 2015) which gave a brief explanation about the terms used for measuring particle mass in the air. Purposes of the first user tests were to find usability problems in the current system, determine the features users preferred, discover featur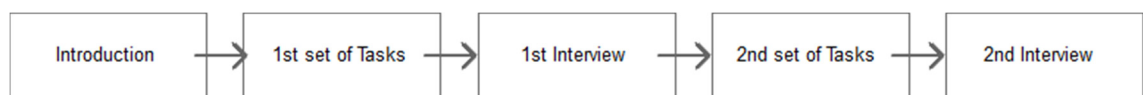es that needed to be changed in or added to the system and to see if there were differences in the way Chinese and Finnish users perform or think in user tests. The tests were done in two consecutive weeks. First week the tests were done at Pegasor office Tampere and Second at Pegasor office Pasila.

Figure 5-7: The structure of the first user tests

The user test process flow is described in the Figure 5-7. The tasks and the interview questions are displayed in Appendix A and B. Time reserved for each user test session was one hour. The introduction took from 15 to 20 minutes depending on the previous knowledge of the participant about UX, the company, company products and air quality measuring. Agreement for test participation and for the use of video camera to record the user test was signed at the end of the introduction part. The first part of the tasks, combined with the interview, took from 25 minutes to 45 minutes. Because the first part of the test usually took most of the time of the hour interview, the second tasks, in most of the test cases, were reduced to comparing aqicn.org (AQICN, 2016) website to the original website and discussing which features are the most important in both sites. In two user tests there was no time to use the other website at all. In the end of the user tests the

users were given a short questionnaire about the satisfaction for the website and the over-all visit to Pegasor. The participants were given a movie ticket as a gift for participating on the project.

After the interviews, the videos of the test situations were reviewed. All of the problems, suggestions and pleasant experiences were written in a single chart so that each row had the description of the feedback and each column represented an interview session. If two tests provided similar feedback, it was marked on the same row. For some instances the exact quote of the user was added to the cell as a comment. Figure 5-8 displays a part of the test findings chart of the first user tests.

Description	Test 1	Test 2	Test 3
Confusion with green and grey sensors	x	x	x
Tries to navigate to main page by clicking the logo		x	
Confused with raindrop/sun/lightning icon	x	x	
Cannot find time changer in the graph	x		

"Promises weather information"

Figure 5-8: Example rows of the test findings chart in the first user test with a comment in one cell

After going through all of the videos the chart was divided into several categories de-pending on the nature of the data. The categories were then reviewed once more and some similar instances were combined into single rows (See Figure 5-9). The chart was then reviewed inside the company to inform about the problems and suggestions that the in-terviews provided for the website. The greatest needs for improvement were agreed on this session and some of the change suggestions were discarded as they did not feel rele-vant for the website improvement. The results of these tests were supposed to be tested in China after the first iteration round but due to several arrangement- and website-issues the testing was postponed and later conducted in Finland.

Description	Test 1	Test 2	Test 3
Could not find the graph on the 2nd page	x		
Used the report function instead of graph for browsing data		x	
Did not realize that the sensor at 2nd page is clickable			x

Description	Test 1	Test 2	Test 3
Problems with navigation on the second page	x	x	x

Figure 5-9: Combining similar feedback on the feedback chart

Because the users could not be reached in China at this phase of the project, a short list of open questions were sent to the users (See Appendix E). These questions were almost the same with the ones that were asked on the first interviews adding two questions concerning the usage amount and satisfaction. The purpose was to see if the current users think about the website in the same way as the interview participants. These surveys yielded hardly any data with only two answers and the results are not discussed in the study.

Based on the background research, feedback from the interviews, Pegasor developers and marketing, a mockup for the new website was formed. The mockup was reviewed inside Pegasor and with the developing company of the website over several iteration round before it was taken into paper prototype tests.

5.2.2 Second users tests – Paper prototyping

Delivery of the mockup and specification for the website developing company, was already behind schedule at this point due to the issues in China. Because of the problems, recruitment for the Paper prototype testing had to be done fast. The group for these tests were formed from university students and recently graduated who spoke and understood English. The testing was done in two iteration rounds. First round consisted of three users one Finnish and two Chinese. And second round of one Finnish and one Chinese participant. The prototype test was done with a company co-worker. Participants looked through (Air info now, 2015) before doing the test. Each of these tests took one hour.

The tests were supposed to be done with a single prototype but as many changes were made during the first three tests, the prototype was redesigned for the last two testers. Most of the usability problems were removed in the redesign and the last two testers were generally pleased with the new design so most of that design was used in the final mockup.

The new website specification was made based on the final mockup and the changes that were negotiated during the paper prototyping sessions. The new version of the website was developed over several iteration rounds. Some of the initial specification changed during the process as a result of internal UI testing and evaluation. The new version was nearly complete when the website was user tested for the third time.

5.2.3 Third user tests – Task testing and interview in China

Third round of user testing was conducted in China with six participants. Four of the participants were university students and two of participants were customers of Pegasor. One of the students and both of the customers had used the original website before. During the time of the tests, all of the devices that were previously sending the data to the website server in China were offline, caused by a recent unsolved issue and therefore the

Chinese data could not be used in the tests. Data from the Finnish devices was sent to the Chinese server to provide a working testing sample for the participants of the user tests. This caused some problems in the user tests as the air quality numbers were very low compared to the numbers that the Chinese were used to. The third round used similar setup to the first round of testing displayed in Figure 5-7, yet the round only had one set of tasks and interviews. The tests were done with an interpreter for question and task translation and also for translating the website elements if necessary as the site did not have Chinese translation during the time of the tests. The tasks and questions of the third user tests are displayed in Appendix C and D.

5.3 Selecting research methods for user tests in Finland

Because the user groups in Finland consisted of both Finnish and Chinese users and the used language was different depending on the participant, simple methods were selected for these user tests. The website was supposed be changed based on the feedback so qualitative data was preferred over quantitative data as the open answers reveal more concrete needs within the system, which was preferred in this study. It would have been hard to find enough target group representatives from Finland to gain relevant amount of quantitative data.

In the first user tests the used methods were interviewing and task based user UI testing and competitive evaluation. Paper prototyping was chosen as the prototyping method in the second user tests because the new design of the user interface was changing the visual and navigational model of the website drastically. Implementing a working prototype on a computer with this type of changes would have resulted either in a low-fidelity prototype or in lot of work as every instance of navigation should have been programmed beforehand. On paper prototype every navigational task can be performed with the moderator being the programmed computer.

5.4 Selecting research method for user tests in China

Smith (2011) suggest that for Chinese users the preferred method would be one of the following

- Task based think aloud
- Scenario based think aloud
- Record and think aloud
- User/moderator co-discovery

These user tests used task based method but think aloud method, where the user constantly informs the moderator about what they are doing and why, was not used as the moderator of the tests was not familiar with Chinese language, and continuous translation of the

method was considered to make the use unnatural. Interviewing was used instead of the think aloud after the task based tests to gain similar type of data from the users.

The first round of user tests was task based and therefor it was convenient to use similar type of tests for the third tests to improve comparability for preference differences between Chinese, Finnish and Chinese living in Finland.

5.5 Research method descriptions

The research methods that are used in this work are described here. The more commonly used methods; Task based testing and interviews are described briefly. Competitive evaluation and paper prototyping are introduced in greater detail.

5.5.1 Task based testing and interviews

In task based testing the user was given a set of tasks (See Appendix A). The participant would go through the tasks one by one, usually stopping for a short discussion with the facilitator between the tasks. The goal of using this method was to see if the users have problems using the UI and to introduce the website to the users before asking questions about it. One problem in task based testing is that it requires a clear vision about the way that the typical users use the tested product in order to make tests that provide feedback about most critical features.

In the interview part, the participant went through a list of questions with the facilitator (See Appendix B). The issues in the task phase were also discussed during the interview. Goal of the interviews was to gain information about the subjective view of the users about the website and also to verify the problems that were discovered during the task based tests.

5.5.2 Competitive evaluation

First round of user testing used competitive evaluation as one of the methods. The evaluation was done with another website (AQICN, 2016). In competitive evaluation two or more products are compared with each other to find out what are the strengths and weaknesses of each one (Schade, 2013). The compared website was tested by the users with similar tasks to the ones that they tested the original site with (See Appendix A) and after the tasks the users had similar interview (See Appendix B).

The order of the websites that are compared with competitive evaluation should be altered as it might change the way that users feel about the website (Schade, 2013). As the first user tests used several methods and the main goal was to test the original website, the order could not be altered in these tests in order to avoid missing any critical tests for the original website because of the one hour time limit.

The two websites compared during these user tests were not actual competitors but closely related. According to (Schade, 2013), it is more important to test websites that have different approach for the similar problem than to compare it with a site that is a direct competitor.

5.5.3 Paper prototyping

Second part of this study was done with paper prototyping. Paper prototyping is an iterative, cost efficient and robust way of co-designing a system with a user. In (Holtzblatt, et al., 2005) paper prototype interview is defined as two on one interview on the users working environment where one of the interviewers is a facilitator and the other is a silent note taker. The definition of (Snyder, 2004a) focuses more on the process of paper prototyping "Paper prototyping is a variation of usability testing where representative users perform realistic tasks by interacting with a paper version of the interface that is manipulated by a person "playing computer," who does not explain how the interface is intended to work". Both of these agree that paper prototyping is a co-design process with the user and not only a way for validating ones design.

An observer is usually used in the paper prototyping sessions for note taking (Snyder, 2004a). For these test sessions there were no observers available so a camera was used instead for capturing the usage of the prototype. The camera was aimed to the user interface from a side so that neither of the participants were shown on the camera. Camera worked well in place of the observer and there were no detected situations where the actions of the user for using the interface could not be detected from the video.

Benefits of the paper prototyping is that it gives feedback about the system before investments and that it is an iterative process where making changes is flexible (Snyder, 2004a). The method includes the target users of the system in the design process and makes it possible to monitor their way of doing in their working context (Holtzblatt, et al., 2005). The later could not be utilized in this process as the target users of the tested product live in China and their working context was not familiar for the company.

The paper objects for the paper prototype testing session were created from printed version of the mockup that was created based on the first user tests and other feedback data from the early phase. The mockup was created by *Balsamiq Mockups* (Balsamiq Studios, 2015) and the complete webpages within the mockup were designed to fit an A4 paper with horizontal alignment. Smaller parts of the user interface were cut down to separate objects and the smallest objects were glued on cardboard background for easier handling. The paper prototype used for the first three tests is displayed in Figure 5-10.

After the first iteration round it was noticed that some of the objects that were used in the prototyping were too small for comfortable testing even though they were glued to a cardboard background. In addition the amount of objects made it hard to keep track where

certain objects were when a page was changed. In the second iteration round most of the smallest objects were connected to the larger objects which made the prototype less versatile, as some major objects were not adjustable with the smaller objects, but it made the prototype as a whole, a lot more convenient to test with. The prototype used in the second set of tests is displayed in Figure 5-11.

Figure 5-10: First version of the paper prototype was versatile, as many objects could be altered with the small object, but hard to use because of multiple small objects

Figure 5-11: Second version of the paper prototype, less versatile as the major objects could not be adjusted with small object but it was easier and faster to use in the tests

The final design for the website was still altered for the developed version of the website. The final version is presented in Chapter 7.

5.6 User tests with interpreter

Having an interpreter for conducting UCD research in China is essential because only a small percent of Chinese speak English (Sun & Qingxin, 2007). Language is not the only issue interpreter has to work with as China is a very high-context culture. In addition to the spoken language a successful interpreter has to detect body language and power relations in order to form a correct, wholesome picture about the situation. It is also beneficial if the interpreter has worked in the host country of the research so that they can understand both cultures and form the translation based on all of these aspects. (Kumar & Worm, 2011)

The third set of user tests that were conducted in China were done with a Chinese employee of Pegasor working as an interpreter. The employee is fluent with both English and Chinese. The employee was not familiar with UCD methods and was not educated as an interpreter.

At the beginning of the testing sessions the participants were told in English and Chinese that they could answer for questions either in English or Chinese and that the website could be translated to Chinese during the tests if required. All the material including questions, tasks and consent form for participating to the research were displayed in both English and Chinese. First user test discovered that it was beneficial to encourage the users to always answer in Chinese if their English was not fluent, in order to get faster and more detailed answers from the users. The answers in Chinese were immediately translated to the facilitator to open a possibility for additional questions. Testing with the interpreter was fluent and discussion felt natural. Even though the users could answer in Chinese, it took significantly more time to proceed through the questions compared to the tests conducted in Finland even if the questions were asked only in Chinese.

According to (Vatrapu & Pérez-Quiñones, 2004) participants of user tests find more usability problems with a facilitator from the same culture. Also (Smith, 2011) states that local UX moderator should be used when conducting user tests in foreign culture. Yet, as the field of usability is still new in China, finding a suitable facilitator is hard (Sun & Qingxin, 2007). In the user tests conducted in China during this study, the most critical feedback was from participants that did not require interpreter and used English for communicating with the facilitator. Having English-speaking Chinese participants would likely yield greater amount of usability related data than using an interpreter but finding participants that are qualified enough with English is difficult in China (Sun & Qingxin, 2007). Conducting the tests in English was also considerably faster than with the interpreter. As Pegasor does not have a Chinese employee that is qualified in UCD, the answering speed and amount of critical feedback could not be tested with a Chinese test moderator leading the tests.

6. RESULTS

This chapter presents the results from the task based user testing and interviews as well as the results received from the paper prototype testing. These results were used to improve the tested website as well as to form guidelines for developing for the Chinese and to evaluate the behavior of the Chinese in user tests. The used testing methods provided only qualitative data as answers. The data was quantified to see the relevance of similar problems or ideas that were discovered from the data. This chapter discusses the frequency of the appeared problems and ideas as well as some exact quotes from the participants of the user tests.

6.1 First user tests

Results for these tests were gathered from the videos of the interview and testing sessions and from the few notes taken during these sessions. The results were divided into three main categories: Usability and UX problems, navigation problems and ideas displayed respectively in Table 4, Table 5 and Table 6. Each problem and idea is included with a relevance value and total score which is calculated by multiplying the appearance frequency with relevance. The relevance of problem was evaluated based on the severity that it had on participant test performance and satisfaction towards the website. Relevance of ideas was rated based on the suitability of the idea for the website and also depending how strongly the user and the moderator felt that the idea would support the website. These tests consisted of 10 participants, 5 Finnish and 5 Chinese.

From the problems displayed in Table 4, the most frequent was the confusion with image colors that represent the sensor status. In the original website the areas in the main page displayed the data from up to two of the sensors (See Figure 6-1). Almost all of the users were confused about the colors as there were no explanation about their purpose. Suggestions for the meanings of the colors included "the best and worst case situation" and "day and night values" when in reality the colors display if the device is offline (grey) and the color, which in Figure 6-1 is green, depends on air quality.
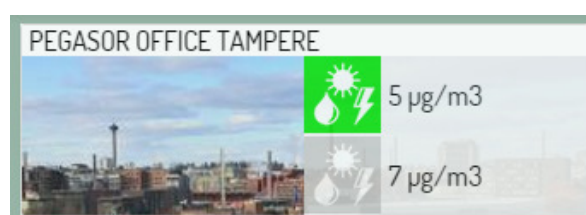
Figure 6-1: Area in a main page of the original website with two sensor readings

Table 4: Usability problems in the first user tests. The relevance is estimated based on how strongly the problem affected the performance and satisfaction of the user. Total is calculated by multiplying the amount of users having the problem with relevance

Usability and UX problem	Finnish	Chinese	Relevance	Total
Confusion with the image colors that represent sensor status (online / offline)	4	5	3	27
Report does not work or works un-expectedly	2	4	3	18
Sensor names cause confusion. (e.g. ,what is "pe-05"?)	3	2	3	15
Icon with raindrop, lightning and Sun causes confusion	2	3	3	15
There is no shown scale for the presented colors that correspond to air quality (e.g. green is 0-50)	4	2	2	12
It is confusing that the graph y-axis changes scale depending on the shown max and min value	3	2	2	10
Not pleasing visually	0	3	3	9
Elements are too small or space usage is insufficient	1	2	3	9
It is not clear what the 3 images (areas) are in the main page	0	2	3	6
No indicator in the graph if the device has been offline	1	1	3	6
Measured value cannot be determined by only the unit ($\mu g/m^3$)	0	1	2	2
Custom time picker only works for 1 month at a time	1	0	2	2

Figure 6-1 also displays another problem which was the icon in the color square which users found confusing and empowered the previous problem. Some users suggested that the rain drop and lightning on gray background forecasted rain and other participant also though that it promises meteorology.

Other main problems were that the Report feature did not work properly during the user testing round and the names of the sensors caused confusion. Reports did not usually load the graph element or the minimum or maximum values of the selected time periods and was therefore unusable for some users. The sensor names used the original names of the devices, such as pe-02. This was confusing for many users as they tried to figure out what the code next to the sensor represented. One Finnish and one Chinese participants asked if the "pe" is abbreviation of "perjantai", Friday in Finnish.

Table 5: Navigation problems in the first user tests

Navigation problems	Finnish	Chinese	Relevance	Total
Second page navigation causes problems	5	4	3	27
Cannot find time changer in graph	2	2	5	20
Trying to navigate in a way it was not intended	3	3	3	18
Cannot zoom out in graph	0	2	3	6
Chinese users did not change the language to English until told to*	0	4	2(*2)	8(16)

*This problem is not relevant to the Finnish users so the relevance for this problem is doubled to make the total count equally valued with the other problems.

Navigation had several serious problems in the original website as it can be seen from Table 5. The most severe problems were caused by the second page of the website which consisted of the contents of an area that is selected from the main page. Figure 6-2 displays the action bar of the left side of the second page. The two sensors that are displayed below the search field are clickable elements that enables the user to monitor the data history of the sensor through the graph element. Many users did not recognize that these elements are clickable and could not find a feature to evaluate the measurements of the past. Instead, the users tried to use the report feature which can be accessed with the button next to the "Pegasor Office Tampere"-label in the Figure 6-2.
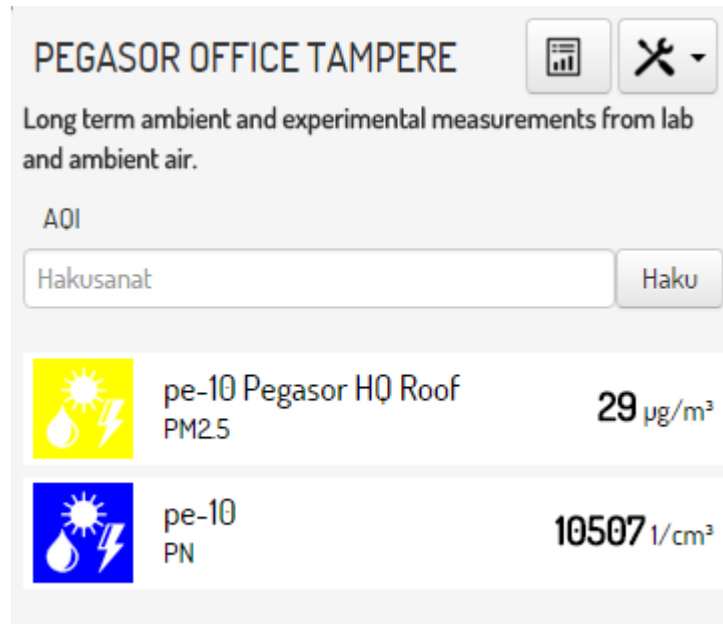
Figure 6-2: Second page action bar with two sensors

Other problems include falsely interpreted use of elements, such as trying to use the logo to navigate back to main page and using a breadcrumb list instance "Pegasor Office Tampere" to navigate back to area selection, instead it took the user to the second page. First object of the breadcrumb list was named "measurements" which confused the user as the first page consists of areas and not just measurements.

Some minor improvements were made to the website after the first four user tests. One of the improvements changed the graph time interval selector element to different form (See Figure 6-3) and place. The new time selector was positioned on the top right corner of the graph. In the previous solution the object used to be positioned on the bottom right side of the graph. In the last 6 user tests only 2 found the time element without help whereas in the previous tests every user found the element.

Figure 6-3: Different implementations of the time selector feature

From the Chinese users 4 out of 5 did not find the language changing feature which was positioned on the footer of the website. Yet, as the website hardly contains any text elements, the users did not complain about the website being in Finnish.

Table 6: Ideas for development from the participants of the first user tests. The relevance value is based on the suitability of the feature for the website as well as on user and moderator opinion about how important the feature would be.

Ideas	Finnish	Chinese	Relevance	Total
Displaying limits for air quality color values	5	3	2	16
Map	1	3	3	12
Easing graph navigation	2	2	3	12
Customization	3	3	2	12
Changing the structure of the page	1	3	3	12
Graphical improvement	0	3	3	9
Easing general navigation	2	1	3	9
Additional measurements or content	2	2	2	8
Video or changing picture instead of the static picture on the 2nd page	2	3	1	5

From the ideas displayed in Table 6 most commented was to display which air quality values represented which color. Ideas for use of these colors was not limited to the main page sensor color display as the users also wanted to have the colors in the graph either in the curve or in the Y-axis. They also wanted to be able to customize the color value ration depending on the area of measurement.

From the Chinese participants 3 out of 5 mentioned that the website is not pleasing to the eye and that it needs graphical improvement. According to the participants, one part of the graphical improvement should be to make the buttons more attention drawing as they could not find the element they needed on the website. In comparison, Finnish participants found the website simple which they considered to be positive.

From all users 6 out of 10 suggested some type of customization for the website. Two participants wanted to have a feature for changing names of the sensors, which was already implemented, but clearly hard to find from the site. Three users suggested having user accounts for different type of users.

Four users suggested to have a different type of page structure where the most desired change was to remove the second page as a futile additional step to access the graph. Two Chinese users also advice that the website should be converted to a smart phone application for the Chinese users.

In the interviews the participants were asked about the 2 or 3 features which they considered to be good in the website. The results are shown in Figure 6-4 with total of 15 answers. There were 2 Chinese that answered in the "Simple" category, the 3 other Chinese were the ones who were dissatisfied with the graphical quality of the website.
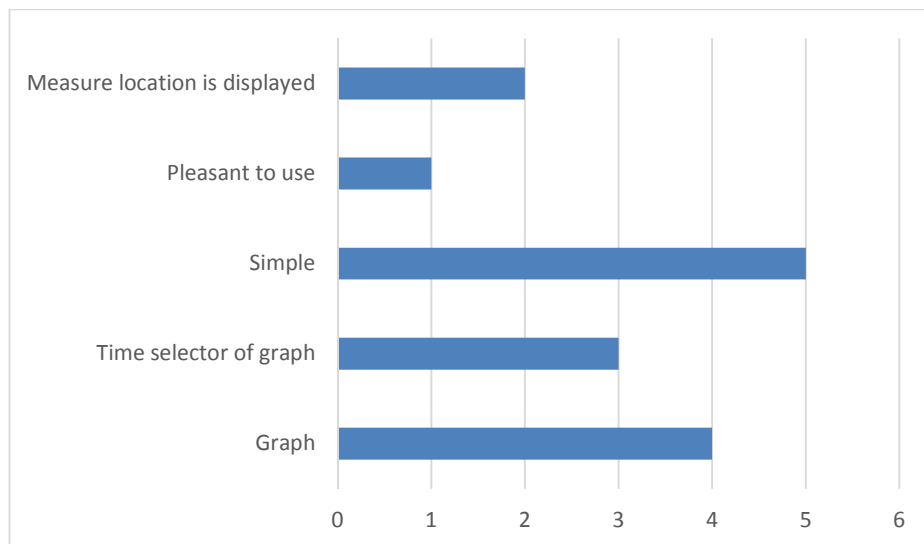
Figure 6-4: The good features of the original website according to the users

The users were also asked for the 2 or 3 biggest problems of the website but these were usually discussed already earlier during the overall discussion about the website and the problems are displayed in the tables above.

Same questions about good and bad features was asked from a similar type of website (AQICN, 2016). Only 8 out of 10 participants had time to answers the questions about the other website. The results for good features is displayed in Figure 6-5. It was clear that the map feature and clear display of air quality index number were favored in the website. Users stated that the map was a good tool for seeing the overall picture of air quality with one glance.
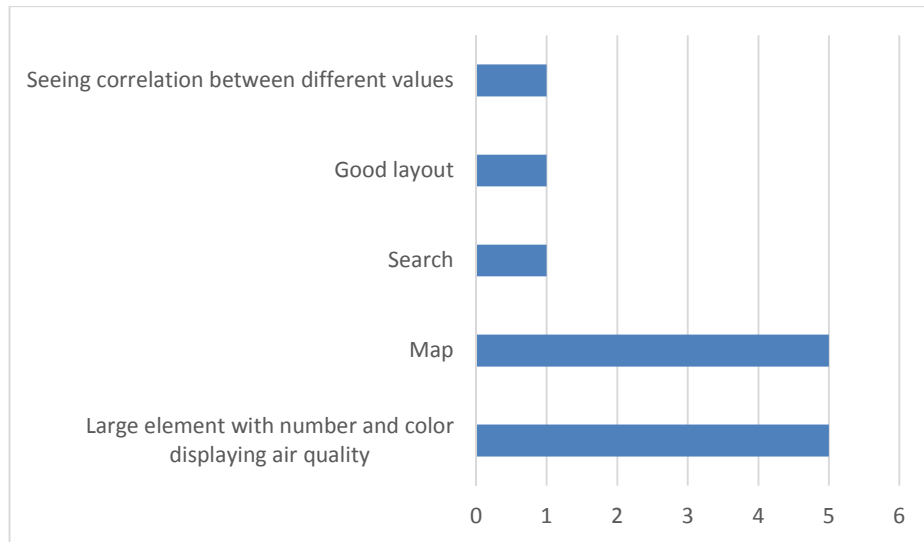
Figure 6-5: The good features of the aqicn.org website according to the users

The most problematic feature in the website was an element, which users referred to as graphs, but were in fact bar charts. The charts in this site were plain and gave only an overall picture about the air quality. The time interval of the charts could not be changed which limited the user to see only the average air quality of previous 48 hours. One of the participants complained that he could not "bite in to the data" with this type of website. Other comments from the users concerned the advertisement and bad use of colors. The results of these questions can be seen in Figure 6-6.
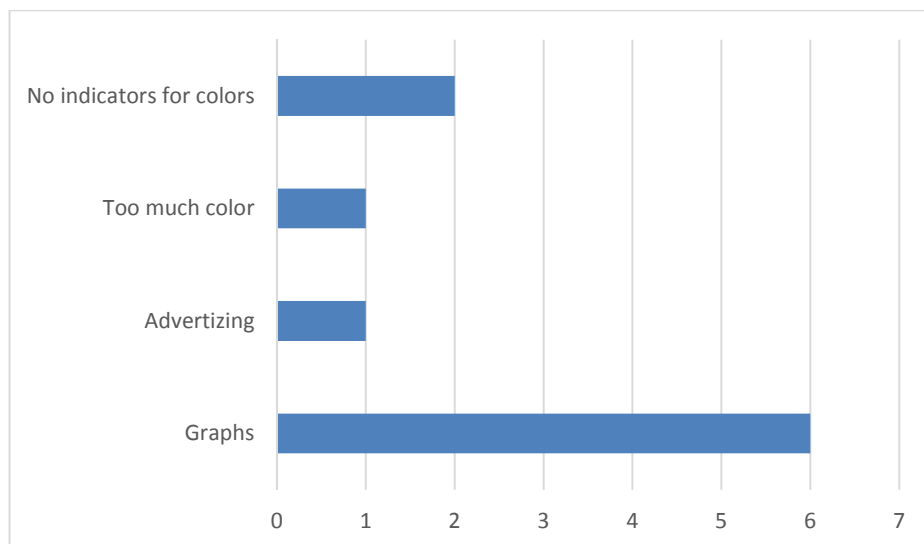
Figure 6-6: The problems of the aqicn.org website according to the users

From these results, all of the problems and ideas that had total score of over 15 were taken as the main tasks for the new implementation. Many of the problems and ideas that scored over 10, were also worked on in the new implementation. There are some instances below 10 that were included like the visual pleasantness, as all of the participants that were complaining about it were Chinese. As the good and problematic feature questions from

both websites showed that graph feature was the one of the most liked feature in the original site and most despised feature on the compared website, one of the main priorities of the new implementation was to ease the access to the graph feature and to make it more usable. Map feature was desired by the testers of the original website and also most appreciated feature of the compared website which made it the other main feature of the new implementation.

Some differences in Chinese and Finnish test behavior could be detected during these user tests. Chinese tend to be more critical about the website, especially about the visual aspects. Where Finnish saw a simple and pleasant solution, Chinese saw bad space usage and too small objects. The Chinese participants were generally more curious about the features of the website and more dissatisfied with the lack of features.

Based on the results of first user test, a mockup for the new version was created over several iteration rounds. This mockup was later converted into a paper prototype. The prototype altered the navigational model of the website and made changes to the visual look of the site as well as added some desired features. One of the earliest versions of the new prototype can be seen in Figure 6-7. The completed navigational model of the new implementation is described in Chapter 7.
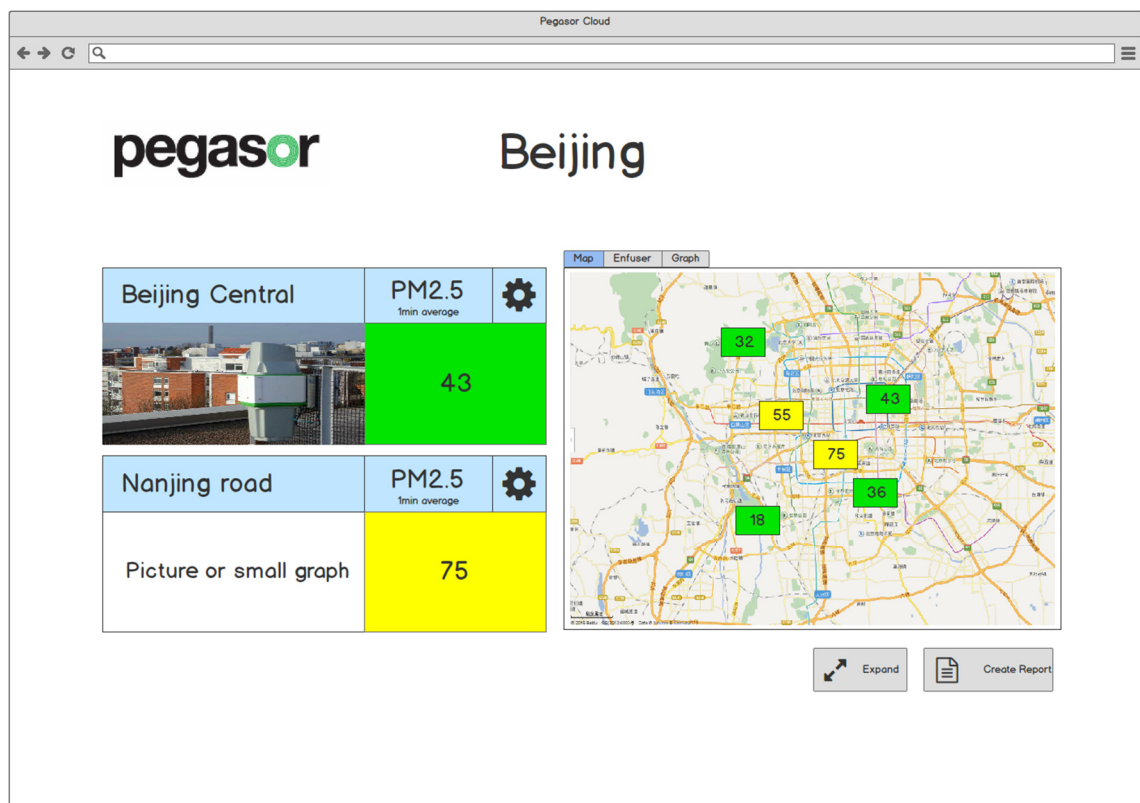
Figure 6-7: One of the first versions of the new version prototype

6.2 Second user tests

The paper prototyping session did not have any set tasks or questions and the testing was based on the free use of the website by the participants. If the participants did not come up with a way of using the website, a task similar to the ones in the first user tests, was given to the user. The results of the tests are limited to changes in the designed UI and the reasoning behind them. The prototype session was divided to two sessions with first having 2 Chinese and 1 Finnish participant and second having 1 Chinese and 1 Finnish participant. The first three tests revealed many problems in the prototype which were solved and the prototype was redesigned before the second tests. As the development of the prototypes is not the main focus of this thesis the problems and ideas that lead to the UI changes are displayed in Appendix F and are not discussed here in a great detail. Also, according to (Snyder, 2004b) documenting paper prototypes in written form is not very efficient way of conveying the results to the requiring audience as they should contain lot of information about the prototype and the interaction to be descriptive.

The first round of prototyping invoked several big changes in the prototype UI. The Graph y-axis limits and rolling average features from device settings (see Figure 6-8) were moved to the settings of the graph as they were more related to the graph than to a single device.

Figure 6-8: Device settings page in the first prototype

Alarm feature was moved to single devices from map, graph and Enfuser because the feature related more to the devices than to these three elements. Time interval setting feature marked with red rectangles in Figure 6-9 was changed so that the display and changing elements were closer to each other and clearly related. The bar which was used for selecting map, graph or Enfuser was made bigger and separated from the element.
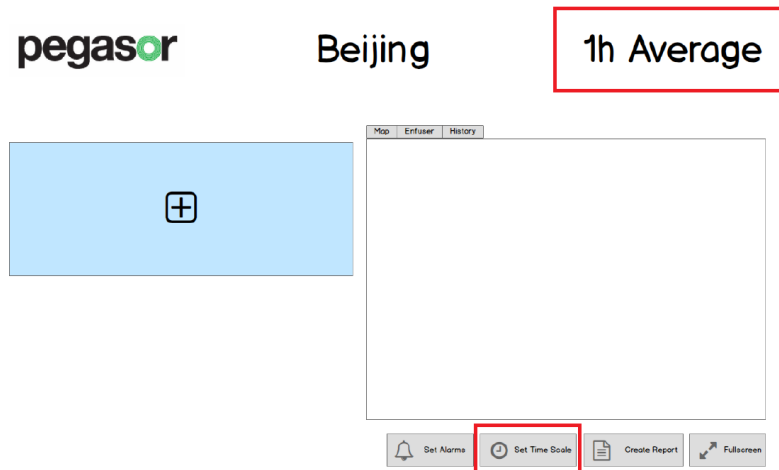
Figure 6-9: Time interval setting and display were too far apart in the first prototype

Results from the second round of prototyping consisted mostly of suggestion and minor improvements for the website. The found problems and design improvement ideas are displayed in Appendix G. There were some significant changes that were made to the prototype based on these results before moving the prototype to development. The compare feature was added to the prototype. Modified version of a device element that displayed city average values was removed as it caused confusion. Report functionality was altered to be more tied to the current state of the page when it is created. Sorting feature was added for the device list. Size of some elements was adjusted and objects were renamed.

Some differences could be noticed in the test behavior of the Finnish and Chinese participants. The Chinese users were more concerned about the background color and overall visual look of the site. The Chinese were more aware of the air quality issues and the usage of the prototype felt more natural for them. The Finnish participants needed to be guided more than the Chinese. Even though the Finnish participants did not understand the whole concept of the website, every prototyping session provided new well-argued ideas for developing the website. The ideas were not necessarily related to air quality measurement but to objects such as the map or the graph which can also be found in other concepts.

6.3 Third user tests

The third user test results were gathered in a similar way to the first round of tests. The testing was done with a working implementation of the new website which was remade from the original site based on the prototype that was tested in the second set of user tests. This testing round was slightly different as all of the tests were done in China and 3 out of 6 tests were done with users that had experience of using the original website. 5 tests were done with an interpreter present and 2 of the tests mostly in English and rest mostly in Chinese with interpretation. Every participant understood English to some extent and

could read the English text on the website. The results are separated to three categories; Original website workflow and issues (See Table 7), new website problems (See Table 8) and new website ideas (See Table 9).

From the 3 users of the original website, 2 used the site every other day and 1 used it two times a week. The most regular work tasks for all users were to use the report feature or to check if the device was online or not. The export feature was mostly used to generate comma-separated values (CSV) files and these files were used with a spreadsheet program. The website was used with mobile phone by 2 of the users. The most common task for mobile was to see if the devices were running. All of the users used the website with a desktop computer or a laptop. Table 7 displays the problems and ideas that were discussed with the 3 users.

The most important result of these tests was to find out the way that real users used the website. The users required most changes to the report function which was not taken into account in the earlier phases of the development. All of the ideas for the report function were implemented for the website in the last iteration phase. Most of the other improvement ideas and problems were already taken into consideration during the previous phases and some ideas like the user accounts were already discussed during the time of these user tests. Two of the participants had problems with signing in to the website and finding the website from the web. For desktop computers this should be solvable by using browser features, such as bookmarks or password saving, but for mobile use a link based authentication through a QR code could be considered to improve UX.

Table 7: The issues and improvement suggestions in the original website according to users with experience of the site found out in third user tests. Frequency value displays the amount of times the problem or idea appeared in all of the third user tests

Problems	Frequency
Login to the website is complicated. Password is hard to remember and it does not always work with automatic login.	2
Graph should be faster	1
Too simple	1
Ideas	
Possibility to create e.g., 1h averages of the data to the reports instead of having measurements from every 2-5 minutes	2
Different customers should have different user accounts	1
Possibility to select custom time for the export	1
CSV files should be automatically separated to different columns in the spreadsheet program	1
Would be good if the website was listed on a search engine (Baidu) so it would be easier to find	1
Map feature. Would be good for knowing where the devices are	1
Devices should have customable names and changing the name should change name of all the sensors of the device	1
Would be good to have open source data on the website, such as weather or wind data	1

Some of the problems on the new website had to be discovered from the use of the website as the users did not mention all of the problems that happened during the user. One of the major issues that was mentioned only by 2 out of 6 participants was that the graph was

loading slowly at some part of all of the user tests. The loading might take over 10 seconds and sometimes display the loading message for minutes until the user reloaded the page

Table 8: Problems of the new website found out in the third user tests

Problem	Frequency
Did not find graph or did not realize it could be used to get history data	6
Did not find the device-add feature	6
Device-add feature was expected to add the device and close the dialog by single click.	3
Zooming causes problems	2
Graph got stuck on loading	2
Graph is slow	2
The meaning of time scale on the map needs to be more clear	2
Mistakes the average values to current value (old website displayed only current values)	1
Map loads slowly	1
Reducing zoom on the graph was not clear	1
The feature for selecting values that are plotted to the graph is not clear	1
Double clicking the icons on the map adds and then removes them from the list	1
Clicked an area on the area selecting page many times and did not realize it was loading	1
Device-add feature does not make it clear which device was selected from the map	1
Did not find a named sensor from the map	1
Too much hidden information	1

The most troublesome problems that were discovered during these tests was that the users did not find neither the graph feature nor the device selector feature. As the graph object is big and users tend to see the element but not click it, it was assumed that the problems is either with the object naming or because the object was not translated to Chinese. Even though the device selector object is big and visible, it was not considered as a button and therefore not used. Other most meaningful problems were the problems with the time frame. The interaction of the time frame between elements of the website was unclear. The users expected that the device selector would add a device from the list by a single click without need for confirmation. Users also usually kept only one device in the device list at all times. This is not actually a problem but more of an unexpected way of use.

Table 9: Ideas for the new website based on the third user tests

Idea	Frequency
Map should be bigger, left side smaller	2
Guide for using the website	2
Add "last time online" feature from the original website	1
"Chinese language would be great"	1
Show minimum and maximum values of a time interval	1
The selector for which devices are plotted to the graph should have device names with background the same color as the curve	1
Mouse hovering on the map could show the picture of the device and detailed address	1
Option for not loading the map	1
Graph color specification to the legend of graph	1
Selecting a device with add device centers the map to that device	1
All values from the devices to the mouse hover information on graph curves	1
Use open source data to provide more measurements to the map	1
Map is loading, similar to the graph	1
1-24 hour scrollbar for the time interval selector	1

Show timeframe on mouse hover of the graph	1
Elements to their own containers. Only need to scroll the left side of the page if there are many devices	1
Decrease size of alarm (bell) and remove device (x)	1
Sort should not be separate from the devices	1

Some of the ideas that were presented during these tests (See Table 9) were already implemented but were left out from the latest deployment build to the Chinese server. Yet, there were several usable ideas that were added to the website.

In these user tests, the participants had several problems with finding certain important elements of the website such as the device selector, graph or the report feature. Still, after the users were shown the location of these elements, they used them fluently. As the developed website is only usable by a few customers and it is a website that the customers will be using frequently the suggestion for having a guide for the website instead of over optimizing the visual cues of the elements was considered reasonable. Still, some adjustment for the hidden features were made before the release in order to make them more visible.

The users were generally satisfied with the website. Some of the users of the original site said that the website is clearer, more powerful and looks more like a website. First time users of the website said that it is good, easy to navigate or straightforward.

7. DESIGN OF PEGASOR AQ^{TM} URBAN WEB SERVICE FOR THE CHINESE USERS

The website improvement was done in order to improve the UX for the Chinese users. Based on the problems discovered during the first round of UCD, the usability goals for the new website are as follows:

1. Every user can find any named device from the system

2. Every user can find the history (graph) data for the device

3. Every user have a general idea about where each of their devices are located

4. < 20% of the users complain about the website being boring or not pleasing to eye

5. <20% of the users has a general idea about the meaning of the shown values in the system (without expertise)

6. <20% of the users won't find more than 1 feature totally useless or meaningless

7. 80% of the users don't have more than 2 problem with navigation

8. 80% of the users find the first time usage pleasing or interesting

From these usability goals 4,6 and 8 were reached in the last set of user tests. Goals 3 and 5 could not be tested as the real Chinese devices were offline during the user tests and the users were familiar with the shown values on the website. The test users had some problems with the goal 1 but most of the users could find all of the named devices without help. The goals 2 and 7 failed as the test participants could not find the graph and the device selector features without help. It is expected that solving these issues is not a difficult task.

The main idea for navigational model in the new design of the website was to make the second page of the original site, the main page. This would provide straight access to the core features of the system from the first page of the website. Navigation highlighting was one of the main priorities as lot of information was hidden from the users in the previous implementation with lack of visual cues for navigation. The navigational model for the new design is displayed in Figure 7-1.
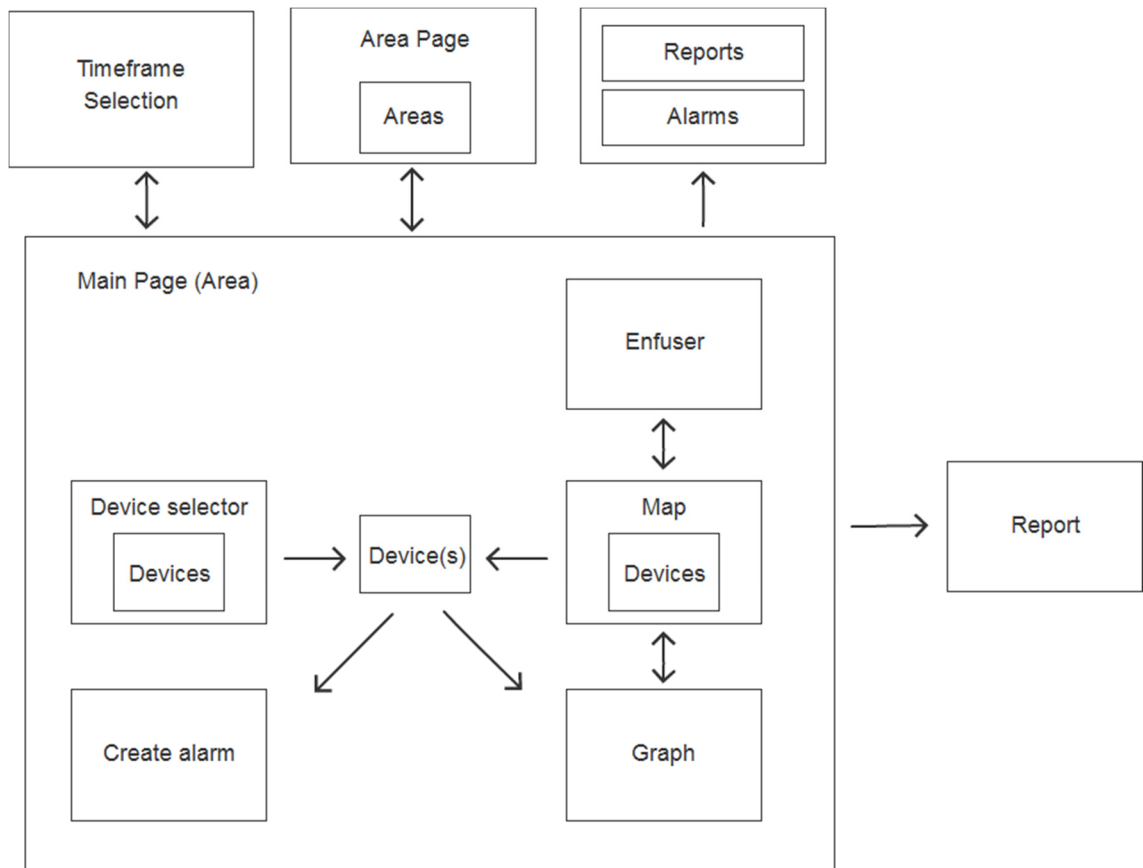
Figure 7-1: Navigational model of the new website

This model is more flexible than the previous as many of the features can used simultaneously and from different states of the main page. Users enter the website on the Main Page which presents the last used area that they are authored to use. In the original site the user would enter on the area page. Currently, none of the customers of Pegasor have need for more than one area for this system so using the area page as the main page slowed the users down in most cases. The user can browse between the core features of the website, map, Enfuser and graph, without the need to load the page every time. Instead of having a set structure of the devices that are visible in the area, this website allows users to select the wanted devices for inspection from map feature or from a list by using device selecting. These devices display their primary measurement values and they can be taken into closer inspection with the graph element. Devices and the map display their timely averages on a selected time interval which can range from one hour to one month. Graph displays the same time interval with a curve that includes every measurement point within that time period. The use of report feature was aimed to be improved by making it possible to report the current state of the main page, including the selected devices, time interval and element, such as the map or graph. The original system could only provide reports from either one or all sensors that were registered within an area.

7.1 New features

This chapter describes the most significant new features of the new web service and the reasons behind the made changes.
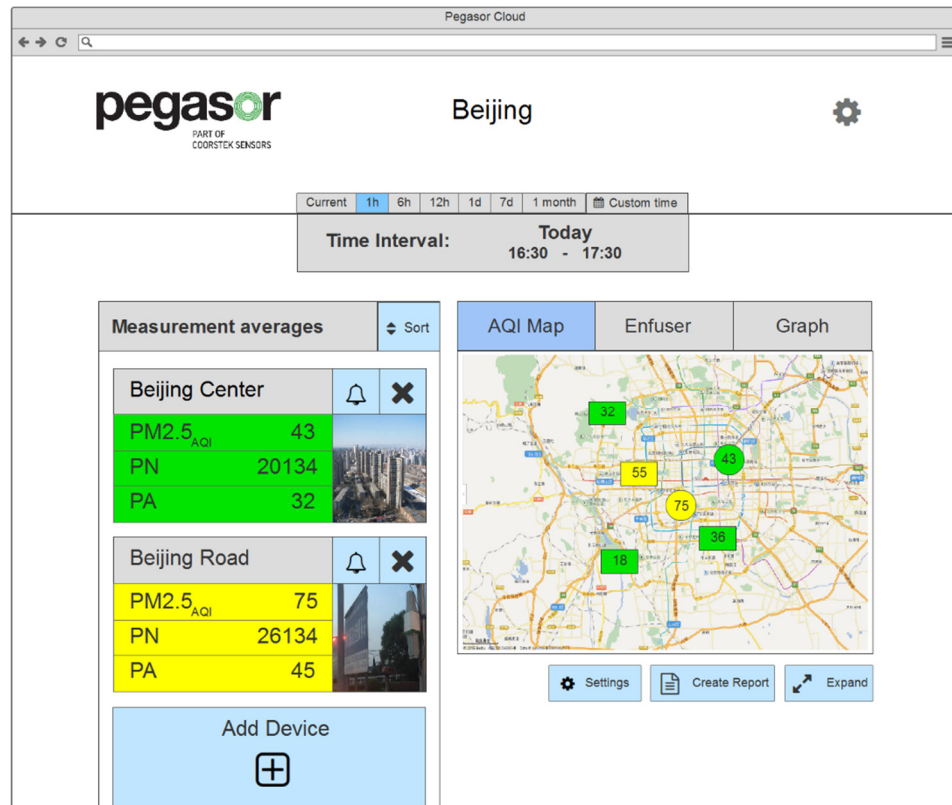
Figure 7-2: Main page of the new design

The new main page seen in the Figure 7-2 has many new features and other additions. These changes are described in the following chapters.

7.1.1 Map

Greatest single addition to the website was the map feature. The map can be used with either Google maps or Baidu maps which made it available also in China where all services of Google are blocked. The map was added to improve the navigational model of the system, to improve UX of the system and to make the page more pleasing visually. It was used for replacing part of the functionality of the second page of the original website where sensors are selected for closer inspection. Different color rectangles on the map represent the locations of the devices. The color and number on the units display the average air quality on that spot. Compared to the original system, the new solution made it easier to inspect the general situation of air quality within an area. In the original website the user had to know where the units were located based on the name of the unit and comparing the measurements with other nearby units was complicated. As many in the interviews and tests mentioned, it is curious to see the values on the map because you get

a better idea about the air quality close to the places that are relevant for you. Clicking the units on the map opens a tab of information on the left side for closer inspection. The devices can be added to the left side tab also by the add device button on the bottom of the list.

7.1.2 Device list

The left side of the screen functions as a list for all selected devices. This side represents the left side of the second page on the original site and the functionality is very similar to the original implementation. Greatest changes to this part of the page are that the device objects are made bigger, they have multiple values, alarm feature was moved to the device and the devices features concerning the graphs functionality were moved to the graph feature. Aim for the improved feature was to make it more visual, display more information, to move features to their correct places and also to make adding and removing of devices easier for more flexible simultaneous monitoring.

7.1.3 Time interval selector

In the original website, the only element that made time selecting possible was the graph whereas all other displayed values were the latest measurements from the devices. The time selector in the new website affects the whole main page including the device values, map, graph and the Enfuser. Displaying only current value is mostly useful for error detecting situations and not as much for air quality monitoring as sudden spikes might give misleading picture about the overall air quality. Time interval was found as a pleasant feature in some of the first user tests but in some tests the feature could not be found. Highlighting the feature and extending the capabilities of use, is expected to provide greater user experiences on the website.

7.1.4 Enfuser

Enfuser is a feature that provides a visual model of the air quality along with several other features. Figure 7-3 displays the planned visual implementation for the Enfuser on the website. From this element the users could see the overall air quality of an area and also select any point in the map for closer inspection. Enfuser is being constantly developed by Finnish Meteorological Institute (FMI, 2016), and is planned to be integrated as a part of the system during the next development round of the website. As the Enfuser is a separate software and project, this thesis is not going to discuss it in greater detail.
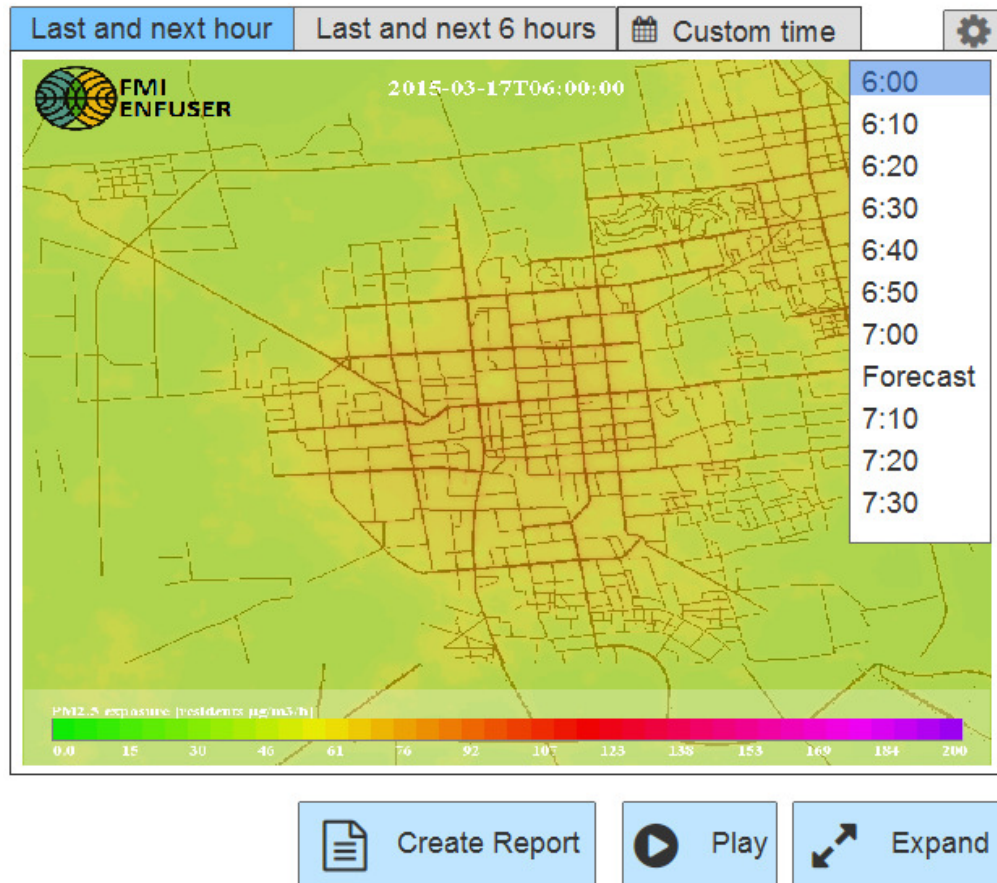
Figure 7-3: General overview of the Enfuser

7.1.5 Compare

In some interviews during both first and the second user tests the participants wanted to have a better feature for noticing trends in the measurement data. In the paper prototype tests two of the users suggested that there could be a feature where the data from different days in a same device could be compared in the same graph. This feature was already partially implemented as different devices could be compared on a same graph on the same time interval. During the third iteration phase, before the last user tests, this feature was decided to be left out as there was not enough time to implement it.

7.2 Colors

The selected colors are based on the background research done for the Chinese culture and preferences, also taking into consideration the color palette of the air quality index (AQI) (Ministry of Environmental Protection of the People's Republic of China, 2012) standard colors. Because of the AQI standard and the elements that use these colors there will usually be from 1 to 4 colors of the AQI color palette on the page at the same time. This limits the amount of other colors that can be used as there should not be too many. The colors that the standard uses should not be used in other elements to avoid association

between objects that should not be associated. According to the background research the most common background color used in China is white, which is used in the website as well. Three other colors that are used are grey (#dcdcdc) and light blue (#d7e6fd) and dark blue (#b3d1ff). Grey was used for backgrounds of objects that are not clickable such as titles. Light blue indicates the objects that can be clicked. Dark blue represents the objects that were currently selected from a group of objects, such as the time interval. Use of color blue is based on the background research which discovered that blue was the most preferred foreground color for the Chinese. Blue is also not used in the AQI standard. The used grey color is based on company guidelines.

Table 10: AQI values and color codes (Ministry of Environmental Protection of the People's Republic of China, 2012)

AQI value	AQI Description	AQI Color	AQI hex value
0-50	Good	Green	00e400
51-100	Moderate	Yellow	ffff00
101-150	Unhealthy for sensitive groups	Orange	ff7e00
151-200	Unhealthy	Red	ff0000
201-300	Very unhealthy	Purple	99004c
301-500	Hazardous	Maroon	7e0023

Table 10 displays the AQI values and the expected severity for health as well as the colors that represent the different ranges of values. It is not uncommon to see websites that display the AQI values with different shades of these colors. Whether the text on the colorful background should be black or white varies between different sites. According to W3C guidelines minimum requirement for contrast ratio between the highest and lowest relative luminance is 4.5:1 when the contrast ratio for white on black is 21:1 (Caldwell, et al., 2015). If the used colors for text would be only white and black the highest possible contrast ratios with these AQI colors would be reached by having texts from green to red as black and from purple to maroon as white.

7.3 Cultural aspects

As the background research did not provide many unquestionable guidelines concerning design for the Chinese, the use of guidelines is mostly limited to the color usage of the website, which is also limited by the AQI standard colors, and to several other guidelines. Like suggested for high power distance culture, the website was made to follow axial symmetry. Using the 16:9 or 4:3 layout was discussed but later left out from the task list due to excessive amount of other required changes. Implementing features that support collectivism was difficult as the website was only for private use of the customers. Compared to the original website, the new implementation was made more crowded with elements. The effect of UI crowdedness was observed during the last round of user tests. The users were generally pleased with the interface and one participant mentioned that it is good that the site is not too crowded like many of the Chinese websites are.

The cultural differences that were noticed during the first round of user testing had higher priority than applying the guidelines from other sources to the website. Chinese participants required more visual and less boring solution which were both main goals for the development. Some participants also emphasized the mobile usage and, even though the mobile development was not the main priority in this thesis, the website is slightly optimized also for mobile.

Along with comprehensive support for mobile, another important feature that was still left undone was the translation of the website into Chinese. The problems caused from the lack of translation could be seen during the last user testing session in China were the users could not find some elements in the interface. It is also possible that the users did not find the elements because of the element positioning but the lack of translation is most likely at least partially responsible for it. The translation and the mobile support are both features that are likely implemented to the website in near future.

One of the main problems of the website in China, which persisted through the whole design process was the slow loading times of the graph, and later of the map. The development team tried to prevent this problem with different measures but currently the problem still persists. Testing this kind of issues is difficult from Finland as having a remote connection to China for testing also slows the loading which makes the results unrealistic. In addition to slow loading pages, the Chinese firewall was also one of the most time consuming problems that was encountered while making the website. It is worth considering that would problem prevention guidelines for foreign cultures be more beneficial than ones that provide content based advice.

8. GUIDELINES FOR DESIGNING FOR AND EVALUATING IN CHINESE MARKET

This chapter describes a set of guidelines that are proposed based on the results of the background research and the results of this study. The guidelines are usable for product evaluation and for interface design for Chinese culture. The guidelines from 1 to 3 are for UCD in China and the guidelines from 4 to 11 are for product design, targeted for Chinese. As this thesis was focused on website development, the guidelines concerning product improvement are most suitable for website improvement but they might be usable in other contexts too. The use of these guidelines is context dependent and not always the best practice for designing or evaluation.

There were only few possibilities to interview the authentic users of the original website during the UCD process of this thesis. Only data from these users is from the last part of the users studies. The majority of the other two studies explored the functionality of the UI whereas the interviews with the authentic users were more focused on the realistic use cases of the website. Only a few differences in answer meaningfulness or cultural significance could be detected between the Chinese participants living in Finland and Chinese participants living in China that had not used the original website. Both participant groups found problems affecting usability and user experience and had ideas for improving the websites. However, the studies that were done with the authentic users of the website provided valuable information about the way that the website is used which none of the other tests in China or in Finland could provide. For these and cost efficiency reasons it is proposed that:

1. **Product usage evaluation should be done in China with authentic users.** Evaluation of how a product is used and which features are important should be done with the authentic users in their natural context of use. This research should be conducted after the product has been used by the users for a short period of time. In addition to other results, this evaluation is likely to reveal any restrictions such as law, web connection speed or web connection limits that obstruct the working of the product in the working context.

2. **Overall usability and UX evaluation can be done within the host country of the research.** If the traveling costs are high for reaching the target users in China, the evaluation of product overall usability, user experience and the UI with qualitative methods, can be done in the host country of the research, preferably by having some local Chinese participants evaluating the product in addition to the natives.

Concept of face affects the way that products can be evaluated on the Chinese market. In some cases it might be hard to receive negative feedback from the Chinese users. The study discovered that product evaluators that speak fluent English are more likely to give open critic about the product than the ones that speak mostly Chinese. Therefore it is proposed that:

3. **Do the usability and UX evaluation in English if possible.** The product evaluation should be done with participants who are fluent in English. This does not override the importance of having authentic users of the product for usage evaluation even if the evaluation would then be done in Chinese.

As Pegasor does not have Chinese employee specialized in UCD, the effect of concept of face could not be studied by having Chinese moderator perform the user tests in Chinese. Having the moderator from the same culture and speaking the same language might ease the effect of the face concept which could encourage the participant to give more critical feedback.

Based on this study, Chinese are more concerned about the visual look of websites than the Finnish. Where Finnish saw a simple solution Chinese saw boring solution, bad usage of design space or design that was not pleasing to the eye. In (Walsh, et al., 2010) five countries, USA, UK, China, Denmark and India, were compared for various factors in user tests. It was mentioned that the Chinese used the word "style" in their answers more than any other country.

4. **Create visually pleasing products for Chinese.** It is possible that Chinese users are generally more sensitive about the visual look of the used products. Therefore additional effort for visual improvement and for wise use of design space, is advised when designing products for the Chinese.

The debate about the crowded design is still ongoing in China and the discussion about it was also present in the user studies. The original website was probably not crowded enough for the Chinese preference as some participants mentioned that the use of space in the UI could be better, one of the six participants in China mentioned that the new design for the website is not too crowded and that crowdedness was something he disliked in common Chinese designs. As the opinion about the matter seems to be greatly varying and it is still a present issue it is suggested to approach the problem on the middle ground:

5. **Use the website design space efficiently but do not make the UI too crowded.** Maximize the use of UI space while leaving empty space between elements to make the UI look tidy. The product should look like it offers significant amount for information to the user.

The color choices for the redesigned website were effected greatly by the color palette of AQI. While using wide color palette such as the one used in AQI, only some additional

colors should be used for background, highlighting and text. Any extra use of colors should be avoided and none of the colors from the existing palette should be used for other design elements. Based on the results of this study:

6. **Use colors that suit Chinese culture**

   6.1 **Use white or light background color:** For computer screen interfaces the background is suggested to be white or a light color for the Chinese users.
   6.2 **Use blue, red, orange and qing foreground colors:** Blue, red and orange are commonly used colors for highlighted elements such as buttons or text. The use of color qing, a mixture of blue and green, can be used in foreground elements to empower the Chinese feel in the UI.
   6.3 **Use dark color for text**: Dark colors are usually used for plain text.
   6.4 **Use analogous color schemes**: It is recommended to use analogous color schemes, such as blue and qing or red and orange together instead of complementary schemes, such as blue and orange together as a basis of a product UI.
   6.5 **Avoid inappropriate use of colors**: Avoid excessive use of yellow and do not use golden text on red background unless the aim is to appear festive. Do not use black and white pictures of people as it displays them as dead.

Use of Chinese text is highly recommended for any design targeted to China. Using large fonts for Chinese text in normal sized computer screens is advised.

7. **Translate to Chinese and use appropriate font sizes for the text**

   7.1 **Use large font size for Chinese text, at least 13px**
   7.2 **Use large font size for Chinese headings, at least 20px**
   7.3 **Use SimSun font for Chinese text**
   7.4 **Use Microsoft Yahei font for Chinese headings**
   7.5 **Use calligraphy to appear more Chinese**: can be used to improve the products visual appearance if the aim is to appear as a Chinese product.

As suggested by many researched based on the culture dimensions of Hofstede, certificates related to a product should be made visible for products that are targeted to high power distance cultures like China. This also applies to the company logo and even to pictures of people in high rank positions of the company. Displaying these features ensures the user that the content is verified by some high authority and it is therefore easier to be trusted.

8. **Display logos, certificates and pictures of high ranked people**

As Chinese are very active and versatile mobile users, the possibility for supporting mobile use of a product should be always considered before developing. Chinese are aware

and willing to use many technologies that are usable by mobile such as QR-codes or mobile paying. If the generated product is a website, it is better that the mobile version would be a separate optimized application generated from the website instead of making a mobile version of the website.

9. **Support mobile usage**
10. **Chinese want applications instead of mobile optimized websites**
11. **Support sharing features when possible:** As a collective culture, Chinese appreciate the possibility to share information about the product through some media to their peers. This type of feature was suggested by a Chinese participant during the first round of user tests but implementing it to the original website was not beneficial as the site was limited to customer use only. Enabling share features may prove to be a powerful tool for spreading a product in China should the product support sharing features. If the product is made to support mobile features and sharing it is essential that the features are compatible with the most popular Chinese social media WeChat (Schaefer, 2015a).

9. DISCUSSION AND CONCLUSIONS

This chapter evaluates how well the research questions were answered and discusses the various finding that were made during the study. Based on the findings, future work for developing the website and studying the relation of culture and user experience is discussed in the end of this chapter.

9.1 Discussion

The aim of this study was to improve the website for one of the company products as well as studying the differences between Chinese and Finnish culture and the effect that the differences have on UCD studies. The study was the most successful in improving the website which was the main goal of the thesis. Studying differences between Finnish and Chinese culture and providing reliable guidelines for development or evaluation targeted to the Chinese culture was proven to be an enormous and complicated task. The total sample size of the studies 7 Finnish and 14 Chinese combined with the background research was not large enough sample to form many solid guidelines between these cultures. However, some findings in the thesis provide suggestions for future research related to the cultural differences. Applying the presented guidelines for projects that are targeted at China, might be beneficial in some projects.

One of the greatest problems for this user research was that there was no clearly defined user group for the AQ^{tm} Urban and therefore for the original website. At the beginning of the project the target user was portrayed as a Chinese student, scientist, real estate agent or a city official. Based on this definition, the purpose of the website would range from a research tool to a presenting or marketing tool depending on the user type. In addition to the widely defined scope of user base, the current users of the system were most of the times out of reach for traditional UCD methods as they lived in China and finding the described Chinese users from Finland was mostly limited to students and scientists. As the target user group and the context of use were hard to reach, the project was more focused on generating better general usability and user experience while respecting the expected values and needs that the target users have. Despite having these problems, the used methods; task based user testing, interviews, competitive evaluation and paper prototyping, provided useful feedback which was used to improve the website. The new implementation was commended by the real users of the original website at the end of the project.

Material that refers to website UX usually concerns websites that are accessible for majority of people that are connected to the Internet. The website that was improved during this project is by definition a website but the user group for this website is very limited,

as it is only provided for the customers of Pegasor. This means that using the general web design guidelines or especially national culture guidelines might not be the most effective ways to increase the UX for this exact user group. It is still assumed in this thesis that considerate usage of these guidelines for a certain culture like China is more likely to increase the UX rather than to decrease it.

Because of the "Chinese firewall" many of the most popular websites in the west are blocked in China. This usually causes some inconveniences when browsing the internet in China as a foreigner but it can also make website development harder in unexpected ways. During the implementation of the new website there were two situations where the blocked connections caused major problems. One of which was the creation of graphs that used a programming library of Google, which is blocked in China. The feature had to be reworked to be usable in China. Second was the Google maps which cannot be used in China. Even though Baidu maps could be used with similar interface to Google maps, there were some problems with the usage e.g., with different coordinate system. There were also several other technical problems such as the website not supporting simultaneous use of secured Https connection of the website and Http connection of Baidu maps. When making web based UCD research in China, these type of problems should be taken into consideration well before the user testing.

Concept of face was expected to affect the study on part of all Chinese participants. It was expected that the Chinese either avoid giving negative feedback or give generally very positive feedback. In the tests in Finland, face concept could be detected in one of the eight user test situation with the Chinese participants. In many cases the Chinese users were actually more critical about the website than the Finnish users, especially about the visual appearance of the website. In China the users were generally satisfied with the website even though it still had some clear issues such as the graph and map loading times and hidden information. This might be partly caused by the concept of face. It should be noted that the participant that was most fluent in English also gave the most critical feedback in these tests which suggests that the importance of the face concept might be also tied to the used language instead of only the cultural background. It is also possible that the critique is left ungiven as communicating over the interpreter might be found difficult or uncomfortable.

The culture dimensions of Hofstede were an effective tool for approaching a foreign culture from the UCD perspective. The dimensions provide a general overview about the culture and understanding cultural phenomena such as concept of face is easier through this type of framework. However, using the dimensions as a base of web design guidelines is risky as the dimensions are old and not designed for the web design, the national cultures are not nearly as prone to change as web design trends within the cultures and the researches that propose the guidelines based on the dimensions might be over ten years old which is a long time in the web design development. For these reasons, the culture dimension guidelines were not extensively included to the developed website.

The used paper prototype was not entirely optimal in this study. Usually, the paper prototypes are less finalized (Snyder, 2004a) than the one that was used during these tests. Unfinished prototypes on paper give the user a picture of less complete system that can still use their input for development and the hand sketched objects would fit better together with hand sketched notes. Because the first interview tests revealed a problem concerning the visual look and feel, the prototyped user interface was required to be tested on that aspect too. There was no time for validating the graphical side of the interface separate from the paper prototypes. The mockup of the website was also already close to completed when the paper prototype sessions begun and the mockup was easily converted to paper so it was used instead of sketching by hand. Using too finalized prototype might have discouraged the test users to make concrete changes to the UI. Most of the suggestion in the tests were verbal and most of the participants did not feel that it would be necessary to add paper objects or notes to the system.

9.2 Research questions

RQ1: *What type of web site for Pegasor AQ^TM Urban supports the needs and values of Chinese users of the device?*

Based on the feedback from the first 8 user tests and last 6 user tests with the Chinese participants, the website has become considerably better as a results of the UCD process. Because the original website had many issues that required attention to improve the general usability and UX of the site, localization for Chinese culture was not the main emphasis in the development. Additionally the increasing influence of the western websites has made the Chinese web design less separate from other cultures which decreases the need for localization. Answer to this research question is also dependent on the user and the context of use. A scientist or a student that is using the website for checking the values or exporting the data from the website is less likely to be interested in the cultural aspects of the website whereas a city official or a real estate agent might benefit more from a website that conveys a Chinese feeling through the graphical UI. From these two categories of users, the new website would have greater support for the former.

RQ2: *What kind of guidelines can be given for creating a product for Chinese users?*

This was the most difficult research question. The definition of Chinese user naturally consists of enormous amounts of different type of users. These users also encompass various levels of expertise and experience in matters such as web usage. It is likely that there are Chinese users who feel that websites should have crowded design or that they should display images of powerful members of companies and it is also likely that there are people that feel that these design trends are old fashioned. Therefore, giving specific guidelines for UI development is difficult and might be misleading. One general aspect that was found out to be persistent between the Chinese participants of the tests in this study, was the preference for visually pleasing design. Also some practical guidelines could be given for color and font usage based on the background research. One of the most important guidelines concerning the current situation of China, is to make the products mobile friendly.

RQ3: *What needs to be taken into consideration when conducting user experience research in China or with Chinese participants as a foreigner?*

This question was considered in many parts during the study and it was answered in detail, yet some of the conclusions require additional research for confirmation. Concept of face was, as expected, the most significant aspect that differed the user tests between Finnish and Chinese participants. The Chinese participants were more prone to give positive feedback or avoid giving negative feedback. Negative feedback was also sometimes replaced with suggestion for improvement without conveying the problem to the facilitator. It was noticed during these studies that Chinese participants who discussed with the facilitator in English were more open for giving critical or negative feedback than the ones that communicated with the facilitator through a Chinese interpreter. Other noticed differences include that the Chinese participants that were answering in Chinese, took more time in answering than their peers that answered in English. It was also noted that as the last set of user tests had to be done with Finnish air quality information the Chinese participants were confused with the values. To avoid confusion, the user tests material should be always adjusted to the context of use of the user tests.

9.3 Future work

The changes that need to be made for the developed website in the near future include the translation and mobile conversion of the website. Translation to Chinese was asked by several participants during the user studies and lack of the translation was likely to cause some navigational problems with the new design of the website. The importance of mobile was also emphasized by some users, including the current users of the site. Making of the mobile version of the website has already been discussed and it is likely made as a separate application in the near future.

The user studies detected a difference in behavior between Chinese that spoke fluent English and those who spoke to the facilitator through a Chinese interpreter. The reason why the behavior is different between used languages might be caused through the nature of the language, it might be easier to criticize or be negative in English. It could also be because the user was more familiar with other cultures through previous use of English and could therefore be more open with the customs of the other culture during the tests. It might also be caused by the interpreter which makes the one on one discussion more complex and giving negative answers through another person might be considered unpleasant. There are various factors that affect the answering style and this question of difference requires greater study in order to be answered. One way of studying the issue would be to compare results of a user tests with an interpreter with user tests that has a local moderator.

9.4 Conclusion

This thesis introduced the concepts of user experience, usability and user-centered design and an air quality monitoring website was redesigned by using user-centered methods. The website was developed for Chinese users and therefore the thesis also discussed Chinese culture and web design. The website was improved by using task based user testing, interviews, competitive evaluation and paper prototyping. Based on the user-centered process the website was improved and the new implementation was commended by the users of the original website. In addition the thesis proposed several guidelines for product designing for the Chinese as well as guidelines for user-centered research in China.

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APPENDIX A: USER TESTS PART 1 – TASKS

Tasks

Log in to **the website**

What is the PM2.5 around **Pegasor Office Tampere** right now (number is enough)?

Estimate the air quality

What was the PM2.5 around **Metropolia Espoo** 3 hours ago?

When was the last time that the PM2.5 was high around the **Pegasor Office Tampere**?

When was the latest measurement done for **Tekes Building Helsinki** (date)?

What was the highest PM2.5 value today at **Metropolia Espoo**?

Estimate the air quality

During the past 2 days what have been the most pollution heavy hour(s) at **Pegasor Office Tampere?**

Tasks part 2

Go to www.aqicn.org

What is the PM2.5 of **Beijing** right now?

Estimate the air quality

What was the PM2.5 of **Hongkong** 3 hours ago?

When was the last time that the PM2.5 was high in **Beijing**?

When was the latest measurement done for **Shanghai**?

What was the highest PM2.5 value today at **Hongkong**?

Estimate the air quality

During the past 2 days what have been the most pollution heavy hour(s) at **Beijing**

APPENDIX B: USER TESTS PART 1 – INTERVIEW

Interview part 1

What do you think about website?

What do you like about this website? (2-3 positive things)

What do you dislike about this website? (2-3 biggest problems)

What was it like to do the tasks?

What improvements would you suggest?

Interview part 2

What do you think about aqicn.org website?

What did you like in aqicn.org website? (2-3 positive things)

What did you dislike in aqicn.org website? (2-3 biggest problems?)

What was it like to do the tasks?

How does aqicn.org feel compared to the Pegasor website?

Is there something you would like to add to the Pegasor website?

Open comments

APPENDIX C: USER TESTS PART 3 – TASKS

Tasks

Log in to "**New Website Address**"

登录到新的网页

What is the average PM2.5 around **Location X** right now?

现在，位置 X 附近的 PM2.5 的平均值是多少？

What was the average PM2.5 around **Location Y** 3 hours ago?

3 个小时前，位置 Y 附件的 PM2.5 的平均值是多少？

When was the last time that the PM2.5 was high around the **Location X**?

位置 X 附件，最近一次最大的 PM2.5 的测量值发生在什么时间

When was the latest measurement done for **Location Z (offline)**(date)

位置 Z (离线)最近一次的测量是什么时候，哪天？

What was the highest PM2.5 value today at **Location Y**?

今天位置 Y 的 PM2.5 的最大值是多少？

During the past 2 days what have been the most pollution heavy hour(s) at **Location X?**

在过去两天里，位置 X 监测到的最污染的时间段是哪几个小时？

Estimate the air quality of:

评估空气质量:

Location X now:

现在位置 X:

Location Y 3h ago:

3 小时前位置 Y :

Location X close to previous high peak:

靠近位置 X 的前一个峰值:

The highest PM2.5 value of today at **Location Y**:

APPENDIX D: USER TESTS PART 3 – INTERVIEW

Interview start

What is the browser that you most commonly use?

您通常使用那个浏览器

Ok/Cancel – Cancel/Ok preference

在做决定的时候，您习惯使用 '是/取消'，还是 '取消/是'

Interview part 1 – original website (without tasks)

How much have you used the website?

您使用的频率是多少?

Describe how you use the website

请描述一下您如何使用这个网页

Which devices do you use to browse this website?

您利用什么样的设备浏览此网页？

What do you think about the current website?

您认为网页怎么样？

What do you like about this website? (2-3 positive things)

您喜欢此网页中的那些内容?(2-3 个正面的内容)

What do you dislike about this website? (2-3 biggest problems)

您不喜欢网页中的那些内容？（2-3 个最大的问题）

What improvements would you suggest?

您对我们网页改进的建议是什么?

Interview part 1 – New website

What do you think about the new website?

您如何看待新的网页？

What do you like about this website? (2-3 positive things)

您喜欢此网页中的那些内容?(2-3 个正面的内容)

What do you dislike about this website? (2-3 biggest problems)

您不喜欢网页中的那些内容？（2-3 个最大的问题）

How does the new website feel compared to the current website?

与目前的网页的相比，新的网页您感觉如何？

What do you think about the navigation?

您怎么看待网页的导航功能?

What do you think about the visual layout?

您怎么看待网页的可视化布局？

What do you think about the descriptions given about the values from the devices?

您怎么看待由设备给出的监测值得描述？

What improvements would you suggest?

您对我们网页改进的建议是什么？

APPENDIX E: SURVEY FOR THE CUSTOMERS

Pegasor Oy

pegasor

HATANPÄÄN VALTATIE 34 C,33100, TAMPERE, FINLAND
TEL. +358 (45) 2663395 | WWW.PEGASOR.FI

Dear customer

尊敬的用户，您好！

At Pegasor, we are constantly working to improve our customers' using experience for our webpage, and would like to hear your thoughts about your using experience for our cloud webpage by inviting you to complete our survey.

感谢您填写 Pegasor 云端网页用户调查问卷，此次问卷是为了更好的了解用户的需求，您的宝贵意见将成为推进我们云端服务的重要参考 。非常感谢您的参与。

We thank you in advance for taking part.

Sincerely,

Pegasor cloud web service team

1. How much have you used the website?
   您经常访问该网页吗?您的访问频率是多少?

   _____

   _____

2. What do you think about the webste?
   您对该网页的使用感想是什么?

   _____

   _____

   _____

   _____

3. What are the best things in the website?

   您认为该网页中最让您满意的是什么？

   _____

   _____

   _____

   _____

4. What are the biggest problems in the website?

   您认为该网页最大的问题是什么？

   _____

   _____

   _____

   _____

5. Do you think it's useful to have this website for our devices?

   您认为该网页对使用设备有用吗?

   _____

   _____

6. Do you have any suggestions for improvement?

   请留下您的建议，这将帮助我们提高完善我们的网页

   _____

   _____

   _____

   _____

APPENDIX F: RESULTS OF THE FIRST PROTOTYPE TESTS

Problem and ideas	Frequency
Changing the graph Y-axis from the sensor settings was not clear	2
Map/Enfuse/Graph bar is confusing or too small	2
Alarm should not be feature of Map/Graph/Enfuser but the devices	1
How does the alarm work if the message is for both min and max values?	1
Time interval changer is not easy to find	1
The graph element was renamed to History in the prototype. The test participant insisted that it should be changed back to graph instead	1
Create a simple report with only minimum and maximum values and less detailed map	1
Devices should be selectable for the report from the report dialog	1
Would like to see history data in the map	1
Name changing in the sensor settings was considered as a search feature	1
Expected more pages	1
Information boxes for devices should be smaller	1
The picture of device is not interesting	1
Change background color or make it customable	1
Temperature, winds speed, other measurements	1
1h Average is not clear on the map	1
Language change	1
Make changes to the device settings	1
Timeframe button and indicator are in different places	1

APPENDIX G: RESULTS FROM THE SECOND PROTOTYPE TESTS

Problem and ideas

City average feature that shows the average value for the whole area was seen as a device which caused confusion

Would be good to have a compare feature that enables the user to compare graphs from different days or from different devices on same days

Report should display what you have currently selected for map

Separate name and measurement type of the devices

Add the device name to the alarm so the user is aware which device they are creating the alarm for

Alarm should explain what it means if the user confirms the alarm or if they do not

Show the status of the alarm

Rolling average is not clear

Add unit for Y-Axis limits

Create more reliable solution to provide more information about rolling average and y-axis limits than the "? "-symbol on the top right corner of the header label of the feature.

Use should be able to choose measurement type (PM,PN,PA) from the graph settings

Show device on map functionality

Map / Enfuser / Graph element was huge

Time selection was weird for the map

Selecting devices for export was confusing

1h Average is not clear on the map

Logo could be smaller

Background could be changed from white to something else e.g. background changing depending on the air quality

Sorting feature for the devices.