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ACCESSIBILITY, USABILITY AND SEO

A study on social inclusiveness

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ABSTRACT

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The number of users using the internet grows continuously, which is why it has become even more critical to make the information on the websites easy to access. Websites and their content should be easy to find, but also easy to use. Usually the process to finding information starts from search engines. Search engine optimization focuses on making the information and the websites easier to find, and different websites compete on the highest rankings on the search results page. After the wanted website is found, the user starts to navigate through the website. If the website is usable, the user will enjoy his/her experience on the page and probably end up finding the information they are looking for.

But what about the situations when the user does not experience the website in the same way? Accessibility standards aim to provide the content of the website for users with different kinds of disabilities. When a website is accessible, it means that the content is available for everyone, without considering the fact if someone needs the help of assistive technologies. However, sometimes when the information of the website is separated from the whole, it changes the experience. Emphasizing both the usability and accessibility aspects of the website compose a socially inclusive website, a website that provides equal opportunities for everyone, regardless of their disabilities.

An analysis comparing different university websites reveals that compounding the aspects of usability, or more specifically a good information architecture, and accessibility can have a positive impact on how the website performs in search engine rankings. There are also other consistencies between usability, accessibility and search engine optimization. In summary, it can be assumed that combining accessibility and usability into social inclusiveness can affect on how the website performs in search engines.

Key words and terms: Social inclusiveness, accessibility, usability, search engine optimization.

The originality of this thesis has been checked using the Turnitin OriginalityCheck service.

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1. Introduction

The use of the internet and websites has grown significantly during the last years. Tasks, that earlier were dealt with visiting an office, i.e. going to a bank, can now be performed through the internet. However, not everyone uses the internet and websites in the same way. Some users might need the help of assistive technologies. When more and more tasks can be executed while sitting on a couch at home, it is important that websites react and respond to the situation and make their services work for everyone.

An accessible website provides possibilities for everyone, including the users with disabilities. Following the accessibility standards and guidelines can help to make the website work for every user, regardless of the fact if the user needs the help of assistive technologies. [Brophy and Craven 2007] There are various types of different disabilities and different disabilities need different solutions [Lorca *et al.* 2018]. When a website is accessible, it means that the content and functionalities can be operated with or without assistive technologies [Google Developers 2019a].

In addition, there are multiple problems that a user without any assistive technologies can face, if the website is not usable. The usability of the website is a quality attribute that tells how easy that website is to use [Nielsen 2012]. As in accessibility, there are also multiple guidelines and heuristics that target the website's usability. Usability helps the user to accomplish his/her tasks and it makes the website easier to use as a whole [Guo and Yan 2011]. Since both usability and accessibility aim at making the website easier to use and operate, it is important to note the similarities between these two topics. Usability and accessibility are connected to each other in a way that they share similar guidelines and elements [Petrie and Kheir 2007]. The relationship between these two concepts can be explained with the fact that if the website is not usable, users with disabilities can still face some problems, even though the elements of accessibility would be implemented [Erickson *et al.* 2013].

To operate and use the website, a user has to find it first. This is when search engine optimization comes in handy. Search engine optimization aims at getting the website as high as possible in a search engine results page. It uses different techniques that are done on and off the website. [Barbar and Ismail 2019] The different techniques are executed to make the content of the website optimized for the search algorithms, in order to rank higher in a search engine. Since both accessibility and search engine optimization focus on making the content accessible, for users and search engines, it has been noted that there are various similarities between these two topics [Moreno and Martinez 2012].

The purpose of this thesis is to examine the three topics, accessibility, usability and search engine optimization, and the relationships between them. This will be done in Chapters 2-6. The seventh Chapter focuses on analyzing three different university

websites in the terms of the three different topics. One automated audit is also performed during the analysis. After the analysis is completed, the eight Chapter introduces a new concept, social inclusiveness, which combines the previously discussed topics. The last Chapter is conclusion of the thesis. The purpose of the thesis is to examine the relationships between accessibility, usability and search engine optimization, and to determine if some of the topics, could be combined into a new concept by examining the similarities between them. The main aim is to define a new concept that is based on the similarities and relationships of already existing topics, and which is profitable for both the user and the website's owner.

2. Search engine optimization

The purpose of search engines is to give the best and relevant results for the user by his/her search query [Barbar and Ismail 2019]. When a search query is written and a search is performed, the search engine page listing the different websites that are matching the search query, is called Search Engine Results Page (SERP) [Umenhofer 2019]. The process of search engine optimization aims at getting the website to be in the first results of the search engine results page, so it could be easily spotted by the user. Optimizing a website also helps search engines to note the relevancy of that website and its content. [Sharma *et al.* 2019]

In the early years, search engines made the ranking mainly by the number of how many times a specific keyword appears on the website. Nowadays, Google uses algorithms to determine the relevancy of websites. [Umenhofer 2019] On a search engine results page there are both non-sponsored and sponsored placements. Non-sponsored results are the ones that are modified and improved with search engine optimization and that is why they are displayed on top of the page. Sponsored results are the websites that are paid to be shown on top of the list when a specific keyword used in a search query matches. The non-sponsored matches for a search query are known as organic or natural results. [Agarwal *et al.* 2019]

Search engine optimization (SEO) is done to make specific web pages better for search engine ranking, since many users will only look for the websites on the first page of the search results before modifying their search query [Umenhofer 2019]. And even more specifically, over 90% of users usually do not go further than the first page on the search engine results page and in most cases the top three results on the list are the ones that users tend to look for. If they do not find what they need or want, users often prefer to change their search query to find better results. To get the best possible results, several different search engine optimization techniques should be used. [Sharma *et al.* 2019]

2.1 How search engines work?

Since Google is the most used search engine in the world [Wikipedia 2020], it seems natural to shortly examine how it works. A search made in Google uses the Search index, which is Google's server full of data web crawler has gathered from numerous websites. The crawler uses a list of public website addresses and website sitemaps. The crawler navigates through the website using the links on the pages and notes any changes, additions and possible dead links, i.e. links that direct nowhere. The crawled data and any other important factors are held in the Search index, where the user-made searches are targeted. The website's owners can offer the crawler some instructions on how to process a specific page and they also can request a recrawl of a page or block the crawling from another page. [Google Search 2020a]

Google's algorithms are designed to provide the users the results they are looking for. The algorithms use various factors, for example the words used in the search query, the location settings, and the relevance and usability of websites. Different search queries are weighted in different ways to provide the best possible search results. The algorithms also use different language models to understand the search query the user has written and to match the search query with results that are appropriate for that situation. The algorithms analyze the content of the websites and deduce if the content of that page is relevant. Some factors that affect the relevancy include if the keywords of the search are found on the website or not; if yes, are they appearing in the headings or body of the text on the page. However, the algorithm does not just check if the website contains the keyword. It examines if the website contains any other relevant information that might be linked to that keyword. After gathering the websites that have relevant information available, the search algorithms start to prioritize the results by different factors, such as trustworthiness. Google also uses usability as a ranking factor. More usable websites, i.e. websites that have short loading times and work correctly on different browsers and different devices, are promoted more than the less usable ones. [Google Search 2020b]

2.2 Search engine ranking factors and SEO

Search engine optimization techniques are not just for the improvement in search results, they also make the website more usable and tempting for users. Search engine providers do offer guidance and recommendations on how to do search engine optimization and how to do it in the right way. [Roslina and Shahirah 2019] When marketing and search engine optimization are combined, search engine marketing is formed. Search engine marketing combines the best techniques of search engine optimization with improving the position of a website with money, a method called Pay Per Click (PPC). Search engine optimization can be a very time-consuming process, but still, compared to pay per click and other sponsored methods, it is not that expensive. [Agarwal *et al.* 2019] It has been examined that half of purchases made from websites are originated from the customer ending up to the website from a search engine [Umenhofer 2019]. That is why some websites do search engine marketing instead of just doing some optimizations on the website. Search engine marketing is used to get visitors to a website by boosting specific keywords with money [Roslina and Shahirah 2019]. The aim of search engine optimization is to increase the visibility of a website, so that it appears higher on the search engine results page [Agarwal *et al.* 2019].

The process of optimizing a website is continuous and it should be done constantly to enhance and ensure the website's position on search engine results page [Sharma *et al.* 2019]. Search engine optimization consists of two different types of techniques, which are white hat techniques and black hat techniques. White hat SEO techniques are ethical and genuine, whereas black hat SEO techniques are unethical and unfair [Agarwal *et al.*

2019]. White hat techniques follow the SEO guidelines made by Google [Google Search Console Help 2020] and they contain modifications to the website's structure. Black hat techniques are based on trying to hack Google's algorithms. These techniques include doorway pages and link farms, having hidden text and links and other keyword stuffing and cloaking. [Sharma *et al.* 2019] Using black hat technologies can also harm the users using the screen readers, since links and text made "invisible" can still be seen with the screen reader [Moreno and Martinez 2012]. White hat techniques can be subdivided into on-page search engine optimization and off-page optimization [Sharma *et al.* 2019].

White hat techniques consist of on-page optimization and off-page optimization. On-page optimization techniques are implemented by the developers of the website. Using keywords, proper length URLs, links to other websites and optimizing meta-tags are all techniques that are a part of on-site optimization techniques. [Agarwal *et al.* 2019]

Websites should use both on-page optimization and off-page optimization to perform in the best possible way in the competition of the first places of a search engine results page. On-page optimization is a technique that is done straight onto the website. On-page optimization techniques optimize the content and information for both users and search engines. Websites should be user-friendly as well as search engine friendly. [Barbar and Ismail 2019] The three most significant features that Google uses to determine the relevance of a website are keywords, title tags and meta tag descriptions. They are the main three parts of optimizing a website [Umenhofer 2019], among the on-page optimization techniques such as header tags, keywords, displayed in Figure 1, meta descriptions, page titles, proper URL structure and sitemaps [Sharma *et al.* 2019].

Having correct keywords on the website helps Google's ranking algorithms to determine the category of the website. The used keywords should belong to the category and theme of the website. The website can have multiple keywords on the website, and the number is typically between 25 and 30 keywords. The keywords should also belong to the user's everyday vocabulary, because those are the terms used in the search queries. However, the selection of keywords should also contain some unique keywords for the website to separate from its competitors. The repetition of the specific keywords on the website do also have more effect than the keywords that are not repeated. [Umenhofer 2019]

A meta tag description is a short text that shows below the address of the website on the search engine results page, as Figure 1 demonstrates. The meta tag description aims to describe either the website or the company, or even both. The description should not be longer than 250 characters and it should contain the main keywords of the website. [Umenhofer 2019]

The use of title tags, as shown in Figure 1, not only tells the user about the website, but they also make the purpose of the website clear to the crawlers of search engines.

Title tags and keywords should be used together, as they complement each other. However, title tags should not be longer than 60 characters, since search engines will likely ignore titles longer than that limit. [Umenhofer 2019]

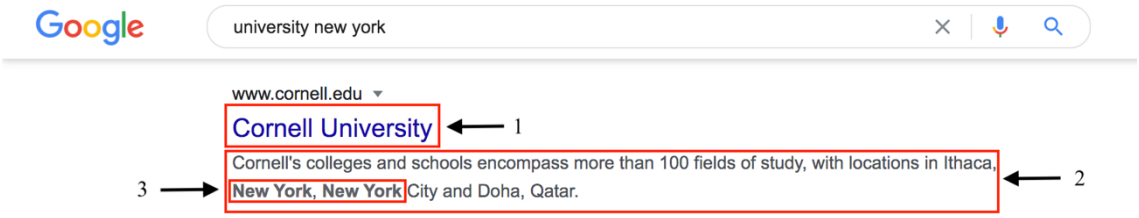

Figure 1. A title tag (1.), a meta description (2.), and keywords (3.) of a website [Google Search 2020c]

The sitemap of a website, displayed in Figure 2, contains all the pages of the website listed together with their links in order to a crawler to index the whole website. With all the links and pages, a sitemap contains the last modification date of the website, as well as how often is the website updated and what is the main priority of the page. [Barbar and Ismail 2019]

```
▼<urlset xmlns="http://www.sitemaps.org/schemas/sitemap/0.9">
  ▼<url>
     <loc>https://www.cornell.edu/about/</loc>
     <changefreq>monthly</changefreq>
   </url>
  ▼<url>
     <loc>http://www.cornell.edu</loc>
     <changefreq>hourly</changefreq>
   </url>
  ▼<url>
     <loc>https://www.cornell.edu/research/</loc>
     <changefreq>monthly</changefreq>
   </url>
  ▼<url>
     <loc>https://www.cornell.edu/admissions/</loc>
     <changefreq>monthly</changefreq>
   </url>
```

Figure 2. An example of a website's sitemap [Cornell University 2020b]

Off-page optimization techniques are not done straight on the website. Off-page optimization is done outside of the website by building backlinks, doing blog posts and articles, using social media, forums and different communities in order to gain visitors to the website from other sources than the search engine. Social media can be a big help when trying to get more visitors to a website. [Barbar and Ismail 2019] Having an option to rate something on the website is also considered as off-page optimization [Sharma *et al.* 2019]. On-page optimization techniques are done when the website is being built and implemented, while off-page optimization techniques are done after the implementation of the website [Barbar and Ismail 2019].

3. Accessibility

The creative and visual design of websites has become more common these days. As beautiful as displaying information with graphics can be, it can also be a big issue for users with disabilities. Information on a website should be displayed in a way that everyone has a possibility to exploit it. Designing websites to meet the accessibility standards means that the websites are designed for everyone including users with disabilities. [Brophy and Craven 2007] Accessibility means that a website is available for users with disabilities or other functional limitations [Kulkarni 2018]. Making a website follow the accessibility and usability guidelines means that the users will have the same experience browsing through the site regardless of the fact if the person has assistive technology or not [Brophy and Craven 2007]. The main concept of accessibility is to design and implement websites in a way that users with disabilities can use them. The accessibility of a website can be measured by user evaluation, testing, and expert inspection. The most accurate results are gained by using real users with disabilities. [Bai *et al.* 2019]

Accessibility aims at ensuring that websites are accessible for users and their devices, no matter the possible disabilities the user might have. Disabilities can be physical, cognitive, visual, auditory or neurological, and accessibility overcomes all of those to enable users with disabilities to use websites just like everyone else. [Lorca *et al.* 2018] Also aging can be thought as a disability too, since it can cause difficulties in modeling and understanding the structure of the website [Bai *et al.* 2019]. The guidelines of web accessibility can be summarized in four principles, which are perceivable, operable, understandable and robust [Baule 2019]. When a website is perceivable and operable it refers to the language and terminology used in the website, which should be simple and easily understandable. Also, the navigation of the website should support findability and browsing. [Matera *et al.* 2006] Accessibility should provide access to the information on the website for everyone. Making the content and information accessible on the website for users with disabilities or specific needs improves the whole usability of the website. Having accessible information for users with special needs and disabilities can also save them from having problems at the cultural and socio-economic levels. [Giraud *et al.* 2018] Accessibility can be included in the corporate social responsibility (CSR) strategy of an organization to provide equal chances for everyone [Lorca *et al.* 2018].

3.1 The key concepts of accessibility

Making the content and information of a website accessible is not enough, to be socially inclusive the website should also follow the main practices of usability to provide the same user experience for everybody and not just for users without any disabilities or special needs. To understand the users' needs, the designers and developers should also understand the basic functionality of assistive technologies and other accessibility tools. Instead of focusing on user-centered design, websites should focus more on user sensitive

inclusive design to provide the same possibilities for everyone. [Giraud *et al.* 2018] Accessibility guidelines can easily become out-of-date, since the rapid change in technology and especially in devices, for example, the increased use of mobile devices [Yoon *et al.* 2016].

Some of the elements of accessible websites might not even be considered as specific features, such as the possibility to navigate through the website without the need for a mouse. The most common problems with accessibility on a website are usually caused by the poor structure and lack of information on the website. Examples of these problems include difficulties to navigate through the website, the lack of alt-tags and descriptions in images and other media, and poor contrast on the different elements. Other general issues with accessibility can be the lack of labeling on forms and inputs, using absolute sizing instead of proportional sizing, and the poor usage of headings and other elements and sections that make the content readable and easier to navigate through. The lack of labeling can make it hard for visually impaired users to navigate forms and the wrong use of sizing makes it difficult to enlarge the text on a website. [Baule 2019]

The main features of the accessible design are making the structure of the page consistent and clear (headings, navigation), using alt-tags for images and having descriptions for links so that when taking the part out of context the reader knows what it is related to, as demonstrated in Figure 3. Users with disabilities find it hard to navigate through a website if the website is organized with too many layers or if the organization is not logical. Also, a lack of descriptive titles and headings can make it hard to find the information the users are trying to find. [Brophy and Craven 2007] There are different kinds of helping devices and hardware for users with disabilities, such as specific kinds of keyboards and screen readers [Kulkarni 2018].

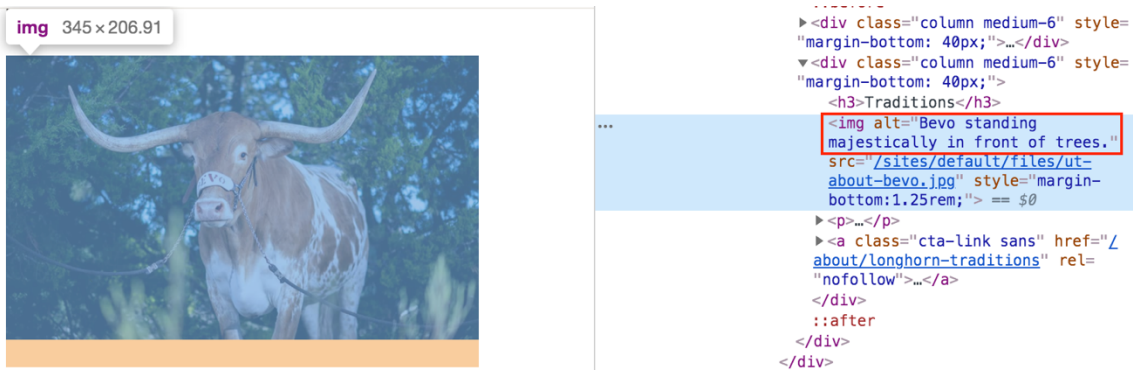

Figure 3. An example of an alt-tag [The University of Texas at Austin 2020]

3.2 Analyzing accessibility requirements

Users with blindness and other disabilities with sight can have a lot of problems when navigating through a website. There are at least seven reasons for these kinds of problems. For example, because not all information can be presented clearly without using visual

parts and some visual elements, the website may require users to memorize the position and placements of these elements. Other problems on the website can be caused by the lack of knowledge or the use of wrong kinds of tools. Developers should not use tools that can make websites inaccessible and all designers should be trained in some way to design and implement interfaces that are accessible for every person. However, making the website accessible after something is already implemented can require a lot of money and time. [Giraud *et al.* 2018]

The information on the website should be presented in a way that users with screen readers can understand the importance of that part without the need of actually seeing the text. Using boldness on the text will not come across when using a screen reader. Usability consists of three main parts, which are effectiveness, efficiency and satisfaction. And users with disabilities should not have to give up on those criteria when using a website. Using information filtering on a website gives the possibility for also users with blindness to access the information they need and is relevant to them, instead of having to browse through everything else that is inaccurate for them in that situation. Of course, there are the general functions of the browser, such as finding words or phrases with ctrl+f, but the problem with that is that the users with blindness do not see what is surrounding the found word or phrase. The context of that part of the text can easily be left unknown. Making accessible websites should start from the understanding of the possible problem and the lack of usability for users with disabilities. [Giraud *et al.* 2018]

There is over a billion of people with some kind of disability. Accessibility can be helpful in situations when the device might be the restriction [Lorca *et al.* 2018], since in accessible websites, the content is already optimized for users with poor sight by allowing users to resize it [W3C 2008], so users using displays of small size or low resolution will have the opportunity to resize the content. Accessibility can provide possibilities for users with disabilities in interaction, communication and even employment. [Lorca *et al.* 2018] To summarize the noted accessibility requirements, websites should provide the information in a way everyone can access it, the information should be possible to be filtered and the website should support resizing and other adjustments, of which the most important ones are listed in the Web Content Accessibility Guidelines 2.0 [2008].

3.3 Google's accessibility guide

According to Google's accessibility guide [2019a], accessibility can be explained as when "the site's content is available, and its functionality can be operated, by literally anyone". Accessibility focuses more on the users that might be having some kinds of disabilities, which can also be temporary or not physical. One easily forgotten accessibility problem is an availability issue, which can be experienced when trying to watch video content found in social media.

To make designing accessible websites easier, Google has roughly divided all of those disabilities into four categories: cognitive, visual, hearing and motor disabilities. Visual disabilities can be subdivided into users with no vision at all, users with low vision and users with just poor vision. All these subdivisions might use the internet differently and with various techniques, which can include assistive technologies such as screen readers or braille displays, text-to-speech technology, or possibly a screen magnifier. Some users might just come along by using the browser's zoom to make the fonts bigger or by using higher contrast, not to forget users with some kind of color blindness who might use a specific set of colors on their browser. Users with motor impairments can be someone who is physically paralyzed or maybe just has some symptom that makes using a mouse difficult or painful. Users without a mouse might use only the keyboard to browse the web or they possibly may switch up to voice control or eye-tracking. Hearing-impaired users could be somewhere between profoundly deaf and hard-of-hearing. For users with any kind of impairment with hearing, videos should have captions and elements making sound should have transcripts. Possibly the largest group of disabilities belong to the category of cognitive conditions. Mainly they are the users that need or might want to use the internet differently than what is held as "normal". Since the variety of different kinds of cognitive conditions, there is no common practice on fixing the situation. Some users might use the browser's zoom, such as the users with visual disabilities might use. [Google Developers 2019a]

4. The similarities between accessibility and search engine optimization

Having accessible content on the website can be taken as an indicator of the quality of that specific website, which leads to getting ranked higher on the search engine results page. In turn, the purpose of having accessible websites is to provide every user the same information and content of that page, regardless of the possible disabilities the user might have. Websites should take into account the users' diversity, as some users need additional assistive technologies to help them in their everyday tasks. Such assistive technologies include e.g. screen readers and alternative keyboards. In addition to the disabilities which are congenital or caused by an accident, another user-group to keep in mind is the elderly, who might also have problems using the websites in the "normal" way.

The search engine optimization techniques that are the most related to the principles of accessibility are the on-page optimization techniques. On-page optimization techniques ensure that the information and content on the website can be accessed with the search engine's crawler, a bot that browses through the whole site. Techniques conforming to accessibility guidelines ensure that the content of a website can be accessed by everyone, even if the user has an impairment which would make it different for him/her to access the web content.

Both web accessibility guidelines and techniques of search engine optimization aim at making the web content and information accessible, ensuring that a website is accessible will have a positive impact on the website's ranking on the search engines, and vice versa. For instance, if the website is not easy to navigate through, it can have bad consequences on both the creation of accessibility barriers and the lowering of the ranking of the search engine result page. It seems that the similarities of search engine optimization and implementing accessibility are not generally known, since they both are usually developed and implemented on their own, instead of combining the implementation. However, it has been examined that having an accessible website will have advantages in the field of search engine optimization. In order to clarify the situation between the similarities, the crawler of the search engine and a screen reader of a visually impaired user could be compared. Both systems rely on the structure and content of the website and navigate through links. To be thought from another angle, the elements that the crawler skips, for instance, any infographics, are also difficult for a disabled user to utilize, due to the reason of not having visibility. Using black hat technologies can also harm the users using the screen readers, since links and text made "invisible" can still be seen by the screen reader.

The specific techniques that are used both in search engine optimization and accessibility are keywords in the alt texts of images and subtitles of videos, a valid meta description tag, keywords in links, the location information about the site, keywords in titles and headings, and a logical structure of the content. The keywords used in images, videos and links tell the user what that specific element is about, without the need of the user having

to see by themselves. The meta description tag describes the website and its used language for the user and his/her assistive technology. The location information and the usage of keywords in titles and headings help to clear the website structure for the user and the crawler. The location information can be indicated with a sitemap. The used keywords help the user to find what they are looking for and they make the structure of the website clearer for crawlers also. Since accessibility and search engine optimization have a lot of similarities, neglecting one of them would have a negative impact on the other. On the other hand, doing at least one of them properly can have positive outcome on the other. [Moreno and Martinez 2012]

4.1 Similarities in Google's guides for accessibility and search engine optimization

Google helps the website owners by providing guides for both search engine optimization [Google Search Console Help 2020] and accessibility [Google Developers 2019a]. In the guides, there are a few consistencies when examining the elements of accessibility and search engine optimization. These consistencies include the use of headings, text on links and alt-tags. Headings make the structure of the website clearer and easier to understand. However, if the used headings are not in the correct order, from h1 to h6, then it can make it even harder for the user to understand the structure. Headings are used to indicate the hierarchy of the content on that specific site and they help both users and search engines to understand the structure. Using text on links is beneficial especially for users with disabilities. A descriptive text tells the user where the link is pointing to, instead of just saying 'click here'. Adding alt-tags on images and other multimedia describes what the image or video is about. Users with screen readers will only see the alt attributes so the more descriptive the text, the better. [Google Developers 2019b] A descriptive text will also help in situations when a slow network connection prevents the picture from loading, as well as when a Google bot tries to understand the content of the website. One element that is only included in the search engine optimization guide, but is also useful in terms of accessibility, is having a breadcrumb list on the site to describe the structure of the website for the user and to guide how to get back to a previous page. In addition to helping the user understand the structure of the website better, having breadcrumbs on the page can have a positive impact on search engine optimization. [Google Search Console Help 2020]

5. Usability

Usability is an important attribute to a website because if the users find it difficult to use the website, they leave and rather use some other website [Nielsen 2012]. Referring to a study made by Yesilada et al. [2015], Bai et al. [2019] define usability as "the ease of use of a website not only for people with disabilities but also for those without". If a website is easy to understand, learn, operate and is also attractive, then the website is usable. When measuring the usability of a website, two types of methods are the most common ones, user evaluations and heuristic checklists. Usually, the checklists include elements such as the navigability of the website, the structure and legitimacy of the information, and the accessibility of the website. [Bai *et al.* 2019]

Nielsen defines usability as "a quality attribute that assesses how easy user interfaces are to use". Usability can also be determined as methods and techniques that improve the ease-of-use of the website. Having good usability on a website is important especially on websites that sell something, since according to the first law of ecommerce, if a product cannot be found, then it cannot be purchased either. [Nielsen 2012]

Since information architecture forms the whole structure behind the user interface and the terminology and language used in the user interface [Cardello 2012], information architecture, therefore, determines the composition of the whole website, which is why it should be viewed more specifically.

5.1 Usability according to Nielsen

Nielsen [1993] defines usability as a multi-dimensional concept that consists of five usability attributes, and they are learnability, efficiency, memorability, having as few errors as possible, and user satisfaction. The usability of a website concerns the questions such as how well the users can use a specific functionality or a website. It can be measured by having users to test the website by performing some predefined tasks. The learnability means that the website should be easy to learn by all the different groups of users the website might have, not just the ones with some kind of earlier experience. The easiest way to test a website's learnability is to give some task to a user that has never used that website before and then monitor how well and fast they perform the tasks. The efficiency of a website aims at making the website efficient so the user can be as productive as possible. It can be tested and measured by using some experienced users by giving them a certain amount of time and measuring their efficiency during that period of time. The third attribute is memorability which focuses more on the structure of the website. The website should be easy to remember so the user does not have to learn the website over and over again to be able to use it. Memorability of a website is not tested as much of the other attributes, but if wanted, the test could be performed with users that have been taking some time off from the website and then asking them to perform some tasks. The fourth one is errors, which means that the website should have as few errors as possible.

If an error still appears, the website should recover from it easily. Error is not always something a user might face when performing a task differently than planned, it can also be the website not accomplishing a specified task. However, the number of errors a user might face should be held as low as possible. The fifth and the last attribute is satisfaction, which is kind of self-explanatory. The website should be enjoyable to use and the users using it should be satisfied. Different kinds of websites are satisfactory in different ways and different users experience satisfaction in different ways. The easiest way to test or measure the satisfaction level of the website is by simply asking the opinions of the users. [Nielsen 1993]

To support the usability design process, a good set of instructions and guidelines comes in handy. Instead of creating strict rules of how to make a website usable, Jakob Nielsen has defined 10 usability heuristics to work as guidelines in website design. The first heuristic is about the visibility of the status of the website or the system. Users should always be informed about what the current situation and status is. The second heuristic is matching the system and the real world, which means using the words and concepts the users use in their everyday life. The third heuristic is given the user some freedom to choose their functions and to make their mistakes. Supporting undo and redo is needed to give the users an "emergency exit" in situations something unwanted happens. The fourth heuristic is having consistency and standards, i.e. not using different terminology in different situations. The fifth heuristic is error prevention. However, implementing the website to prevent problems and errors from happening is not always enough, which means having good explanatory error messages is also important. The sixth heuristic is about having recognition rather than recall which means minimizing the user's memory load. It can be done by making options and actions visible so that the user does not have to remember everything. The seventh heuristic is the flexibility and efficiency of use. To make the use of the system or website efficient, the users should have an option to tailor frequent actions and tasks. The eighth heuristic is to focus on aesthetic and minimalistic design which means keeping the information in minimum and showing only the content and information that is relevant and needed. The ninth heuristic is helping the users recognize, diagnose and recover from errors. Errors and mistakes happen, which is why it is so important to have the error messages in plain understandable language, so that the problem is indicated, and a solution is proposed. The tenth and final heuristic is providing help and documentation for the user to help with their tasks. [Nielsen 1994]

Behind a usable website is the structure of it, the information architecture of the site, which determines how the different pages are related to each other and how everything is labeled. It helps the user find what they are looking for and defines the different functionalities of the website. [Cardello 2012] The information architecture of the website follows the usability attributes of learnability, efficiency and having few errors, as well as the

heuristics of matching between the system and the real world, and consistency [Matera *et al.* 2006].

5.2 Information architecture

In usable websites, the information is easy to find, and it is organized and presented correctly to support the user's actions. Usability can be held as a quality factor of a website or a product. According to Matera et al. [2006] the main aim of websites can be explained with Nielsen's usability principles and ten heuristics. Websites should be structured in a way that the content is understandable and the whole website is easy to navigate. The language used should be familiar to the user and the terms used should be consistent. The content of the website should be easy and efficient to find and use. User errors should be supported by providing easy ways to return to the previous page or section of the website. [Matera *et al.* 2006] This structure and labeling can be referred to as the information architecture of the website [Silvis *et al.* 2019].

To improve the usability of the website, the information architecture of a website should take the users' needs into account, as well as manage both the relevance of the content and the convenience of the users. Information architecture defines the structure and hierarchy of the website and how the content is organized to provide users the information they need, quickly and efficiently. It is the structure of the website and its content. It defines how the information is grouped, how the navigation works and how different parts are named, i.e. the terminology of the website. Having a good, structured information architecture will help the users to get through tasks more easily and efficiently. [Guo and Yan 2011]

Information architecture can also be called as the information backbone of the website since it defines the structure of the content. Having bad information architecture can have a bad impact on the user experience. Information architecture can easily be held as the same thing as navigation, displayed in Figure 4, but information architecture is much more than just the navigation part of the website. It defines the content and functionality of the website. The aim of navigation is to help the users find the information they are looking for. [Cardello 2012] Having a good information architecture on a website can impact the user experience significantly. Information architecture aims at providing access to the content of the website for the user. [Ruzza *et al.* 2017]

Figure 4. An example of a website's navigation [Dartmouth 2020]

In information architecture, the universal design aims at designing the website in a way that all users can navigate through the site and access the content and information they need. A good information architecture supports the findability of information. The organization, labeling, navigation schemes are important parts of information architecture. [Yoon *et al.* 2016]

A good information architecture also promotes the accessibility of the website. An accessible website supports the findability of the content, which is an aspect of information architecture [Matera *et al.* 2006]. Well-structured information architecture provides easier access to the information, which also is an important factor of accessibility [Giraud *et al.* 2018]. Other similarities between good information architecture and accessibility are the facts that consistent and clear structure improve accessibility [Brophy and Craven 2007], while a poor information architecture can worsen the accessibility of a website [Baule 2019].

Since different websites have different objectives, there is not a strict guide of how to define the information architecture of a website. However, to summarize what information architecture is and what the purpose is, it is valuable to understand the few main aims of it. A website that has good information architecture is effortless to navigate and understand, and even if some errors happen, there is always a way to go back to the previous page or action. The wanted information is easy to find, the structure supports the users' needs and terminology is consistent and matches with the real world. Good information architecture can improve the accessibility of a website.

6. The similarities between usability and accessibility

There are some disabilities that one might not even think about. Having a learning disability can affect the way a person uses a website. Having a website that is both usable and accessible is important to all the users, especially to users with some kinds of disabilities. If a website is not accessible or even usable, it can become an accessibility barrier that prevents the user from finding the information they were looking for. Generally speaking, improving the usability of the website can have a positive impact on the accessibility part of the website. If a website is not usable, a user with a disability can still face some problems when using the website, even if some accessibility requirements are fulfilled. Some website elements might have problems more often than others. One of them is a form. If the input fields do not have the right labels to inform what the expected input is, a person using a screen reader will have no clue what to fill into each field. For a user without any assistive technologies, if the form has poor contrast or the structure is off, they could still face some problems with finding the fields or knowing what to fill and where. [Erickson *et al.* 2013]

The usability and accessibility of the website should be thought as two closely related concepts, even though usually they are treated as their different non-related concepts. Aging can be thought as a disability too, since it can cause difficulties in modeling and understanding the structure of the website [Bai *et al.* 2019]. In a study made by Bai et al. [2019] it was noted that accessibility can be held as a predictor of the usability of the website. In the study, individuals had to perform some tasks on a few different websites and the results were analyzed with different regression models. The website's perceived usability was predicted with three different aspects, which were the user's confidence in their (online) abilities, the level of accessibility of the website and the time the user spent on a specific page. The results show that the accessibility level of a website is a predictor of the usability of the website, which means that implementing and following the accessibility guidelines can also have a positive impact on the usability of the website. It was also found that having an accessible website can benefit all the users of the website, not just the ones with some kind of disabilities. [Bai *et al.* 2019]

Problems with accessibility and usability can be caused by the same issue on the website, but they will affect the users with disabilities differently than the users with no disabilities. Forms with no labels for the fields or images without alternative texts can prevent users with disabilities from performing some tasks and that is an accessibility issue. If that same form is looking disorganized, then the frustration caused by that is a usability issue. Non-structured websites with a large amount of information or data and with no or unclear headings or subheadings are troublesome in terms of both accessibility and usability. However, some implementations and solutions might be found useful by a specific

group of users but for another group they might be fully useless or even be a problem for some. [Erickson *et al.* 2013]

Usability and accessibility are both related to the user interface and content of a website, instead of focusing on the backend of the website. There are a lot of guidelines and ratings about the importance and relevancy of accessibility and usability on a website but hardly any of these ratings have been studied thoroughly. Accessibility aims to provide the possibility for users with disabilities to interact and navigate the web. Usability and accessibility are so relatable to each other that sometimes accessibility might be explained as "usability for people with disabilities". The combination of usability and accessibility can be called "usable accessibility". However, the definition of the relationship between the two concepts might be quite unclear. There are only a few arguments supporting the claim that accessible websites are also more usable for users without any disabilities. [Petrie and Kheir 2007]

Defining the terms 'usability' and 'accessibility' can be hard, since different kinds of website are usable and accessible in different ways. One approach to define these terms is defining the lack of usability and the lack of accessibility on a website. In this approach, the measuring of the effectiveness of both these concepts can be done by measuring the problems a user might face because of the lack of implementations of usability and accessibility. On the other hand, accessibility could also be defined as a subset of usability, meaning that problems with accessibility are also problems with usability. The only difference between these two would be that accessibility problems are encountered only by users with disabilities, but usability problems affect all the users. Considering usability and accessibility as separate concepts might be due to the fact that hardly any problems encountered are intersecting, meaning that problems faced by users with disabilities are not problems for users with disabilities and vice versa. However, there are some solutions that serve both groups of users. For example, having intelligible headings and structured content is more accessible for users with disabilities, but it also helps users with no disabilities to understand the structure and content of the website. [Petrie and Kheir 2007]

The positive relationship between usability and accessibility means that having an accessible website could also have a positive impact on the usability of the website. In other words, making the experience better for users with disabilities could also enhance the experience of users without any disabilities. Usability can be defined as a concept that makes the usage of a website effective and satisfying and it helps the users to achieve their goals. Accessibility can often be thought to be only for users with disabilities, while usability is for everyone, with or without any disabilities. However, the relationship between usability and accessibility should be thought as an incentive. This can be explained in such a way that usability and accessibility support each other. [Bai 2019]

Having an accessible website will benefit all the users, not just the ones with some kind of disability, by improving the general usability. Accessibility can be defined and explained in many different ways, but the most important aim of it is to make websites easier to use for users with disabilities. On the other hand, usability is mainly defined as making the website easy to use and learn effectively, keeping the users satisfied and making the website attractive. The main difference between these topics usually is that accessibility is mainly thought to serve only the users with disabilities, while usability is meant to serve everyone. However, there have been studies pointing out that having an accessible website is valuable also on the usability's point of view, since enhancing the user experience for users with disabilities will also entirely enhance the user experience for all the users. That is why accessibility should be thought more as a subset of usability, or as a supportive subdivision. One big part of usability and accessibility is how the whole website and its information is structured. This can also be called as information architecture, which aims at having the information classified and organized in a way that the content of each site is easily accessible. Another important section of a website is the navigation, which should be structured in a way that it is easy for the users to navigate through the website and find what they are looking for. [Bai 2019]

7. Analysis of university websites

To understand better the relationships between usability, accessibility and search engine optimization, an analysis is done. The analyzed topics focus on the same sections of the website, which is the structure. The aim of the analysis is to indicate the possible similarities between the topics, and if having accessible website has a positive impact on search engine rankings. In this analysis, three different university websites will be compared in three different topics, which are the usability, accessibility and search engine optimization of the website. The three different universities are Cornell University in Ithaca, New York, in the United States, Ludwig-Maximilians-Universität in Munich, Germany and Tampere University in Tampere, Finland.

The analysis was chosen to be done on different university websites, since the European accessibility directive guide of the public services for the disabilities effects on universities websites [Directive (EU) 2016/2102 2016]. The directive applies for only the universities in Europe, but for the purpose of comparison, a university in the United States was also chosen in the analysis. Another reason to analyze university websites is that they all have the same aim. A university website provides information about the university and about what or where to study for different groups of users including the current and previous students, the parents of the upcoming students, etc. The analysis is mainly performed on the front page and 1-2 of other pages of the website, which were chosen on the basis of if the page contains the parts that are essential to the analysis, i.e. the pages that contain pictures, links and text content with headings. Since the variance between the different university websites, there was not an opportunity to always analyze coincident pages, such as the page that contains information about the mission of the university. The reason to analyze the front page is that the front page is usually the first page the user interacts with and where the user starts the navigation from.

In the usability analysis part, the main focus is on the information architecture of the website, since if something cannot be found on the website, it cannot be used either [Silvis *et al.* 2019]. It seems to be a natural choice to choose only the structural part of usability, i.e. information architecture, to be analyzed and compared to accessibility and search engine optimization, since all of the three topics focus more on the structure instead of just focusing on the visual side and how everything looks like. The accessibility part will be analyzed by inspecting the main accessibility concepts on the website. The performance of search engine optimization is analyzed by performing two different searches on Google and then examining the search results. The main elements of on-page optimization, i.e. title tags and meta tags, are purposely skipped in this analysis to gain better understanding if a website's performance in search engines can be affected by the lack or abundance of accessibility elements.

After the manually done analysis is made, Google's Lighthouse audit [Google Developers 2020] will be performed on all of the front pages of the universities' websites. The results of the audit will be compared to the findings from the manually done analysis to define if the audit reports the same weaknesses as the manually done analysis.

Information architecture	Accessibility	Search engine optimization	Google's Lighthouse audit
• Navigation • Labelling (+ the used terminology)	• Alt-tags (+ the content on them) • Labels on links (+ the content on them • Headings (+ their order)	• Performance on two slightly different searches (i.e. the website's ranking)	• Accessibility • SEO • Done on the desktop version of the website

Figure 5. The analyzed aspects

In summary, as displayed in Figure 5, the analyzed aspects are navigation and labeling in the topic of information architecture, the alt-tags, labels on links, and headings in the topic of accessibility, and the performance in search engines, by examining the ranking of the website, in the topic of search engine optimization. Also, a Google's Lighthouse audit will be performed on the topics of accessibility and search engine optimization. All analyzed elements in the information architecture and the accessibility sections are related to the search engine optimization. In addition, the alt-tags, labels on links, and headings in the accessibility section are related to information architecture since the labeling covers them too.

7.1 Information architecture

Information architecture focuses on the arrangement, structuring, organizing, and planning the content and information of a website. Information architecture aims at making the information findable. A successfully structured and organized website supports the user's tasks, which is why information architecture is usually held as a subconcept of usability. Information architecture can be divided into four main parts, which are the organization, labeling, search and navigation. The organization of the website supports the findability and it mainly focuses on grouping and classifying the information and the content of the website. Labeling determines and describes the terminology used on the website. Labels are mainly used in the titles of the pages, in the links and headings found on the website. Used icons and buttons can be called visual labels.

The navigation and the search system on the website are closely related, since they both help the users to navigate through the website and to find what they are looking for. Navigation can be defined as the part of the website that helps the user move from one page to another. There can be multiple different kinds of navigation systems on one website, which are the global navigation, i.e. the primary navigation, the local navigation, i.e.

the secondary navigation and the contextual navigation links. They all have their different purposes on the website. The global navigation is the one that is always present, and it contains all the links that are needed on all the pages of the website. The local navigation contains the links and information that is valuable in that specific page or topic. The contextual links are focused more on the content or information on that particular page and usually they can be found inside the content, such as a text paragraph. [Silvis *et al.* 2019] The analysis will focus mainly on the navigation and the labeling, but if some clear issues with other parts come across when browsing the website, the problems will be addressed.

7.1.1 Cornell University

On the Cornell University website, the global navigation is always displayed. On top of the page, there is also a search and a utility navigation, as displayed in Figure 6. At the bottom of the website is a footer containing different links for different categories. Moving the cursor on top of a button in the global navigation, a drawer opens where all the subcategories for that category are listed, shown in Figure 6.

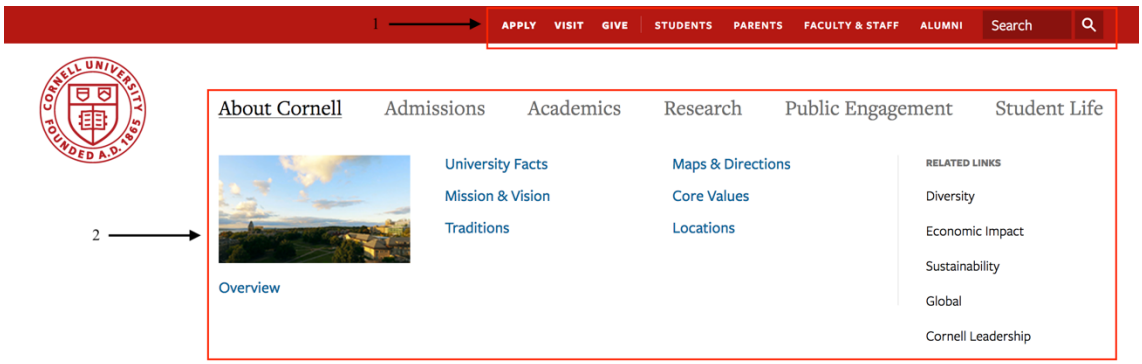

Figure 6. The utility navigation and search (1.), and the global navigation and its categories (2.) on Cornell University website [Cornell University 2020a]

When moving onto a page from one of those subcategories, all the other subcategories are displayed below the main labels of global navigation. This bar of subcategories is the local navigation. The Cornell University website does not have a normal breadcrumb list, where all the pages in that hierarchy are listed in a row. Instead, the website highlights the menu items in a different color, so that the user can easily see in what category or subcategory they are currently browsing in. The colored items can be seen in Figure 7. The contextual links can be found on some of the pages.

Figure 7. A different way to indicate the user's location on the website [Cornell University 2020a]

The information architecture for Cornell University's website is not that deep, meaning that there are not a lot of subcategories inside the subcategories of subcategories and so on. The terminology used in the different navigations is simple understandable language. In the navigation the used labels are grouped by the different categories and sections on the website. In the "Admissions" section, the terminology uses well-known everyday vocabulary, such as "Dates and Deadlines", as well as "Fields of Study". A user browsing through this section might not be as familiar with the university terminology as a user that has already graduated. In the "Public Engagement" section of the navigation, the terminology is not as mundane as in the other sections, but user looking for this category might know what they expect to find. The terminology in the utility navigation focuses more on the user groups that might benefit from navigating through those links, i.e. the parents of the students can easily navigate to their section of the website through the "Parents" label. The grouping of the categories and their subcategories is clear and supports findability, as well as the used terminology and how it is targeted for different kinds of users and situations.

7.1.2 Ludwig-Maximilians-Universität

The Ludwig-Maximilians-Universität website is quite minimalistic. On the front page, the website has a utility navigation on the top, a global navigation on the left side and some contextual links on some of the pages. The website analyzed is the English version of the website, but glancing the original website in German, having a few more links and elements on the front page, the visual appearance is still minimalistic. When navigating to the next page, the global menu still stays on the left side, but some subcategories appear

to it. These links are now called local navigation. Below the utility navigation forms the breadcrumb list of the website. The global menu and its subcategories, some contextual links, and the breadcrumb list can be seen in Figure 8. The information architecture of Ludwig-Maximilians-Universität website is three levels deep, meaning that the top category has a subcategory that again has a subcategory.

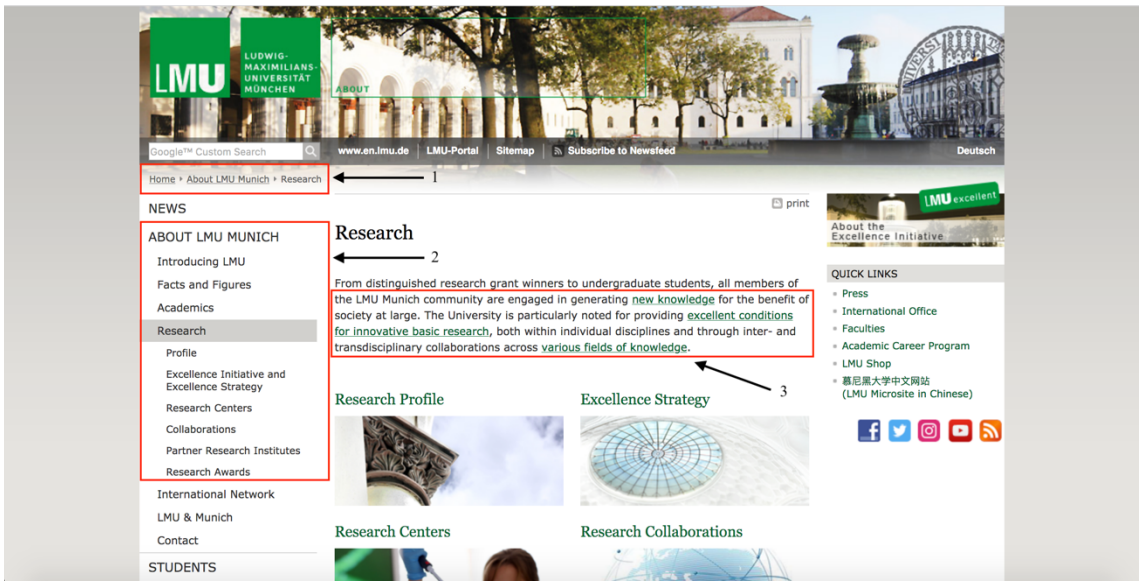

Figure 8. A breadcrumb list (1.), a global menu with subcategories and some contextual links on Ludwig-Maximilians-Universität website [Ludwig-Maximilians-Universität München 2020]

The terminology and labels used on the website are quite mundane, which might be due to the fact that the original language of the website is German. However, the Ludwig-Maximilians-Universität is a member of an international network of universities in Europe [Ludwig-Maximilians-Universität München 2020], so the website is presumably used in English a lot. The terminology used on the website is guiding, since information for students can be found behind the “Students” link in the menu and news are assembled in the “News” section.

7.1.3 Tampere University

The information architecture of the Tampere University website is quite simple. The global navigation, i.e. the main menu, is not always in the display, and the only sections visible on the front page are some related links and a footer. The front page contains some links to current news and events and few sections act as quick links to the most used sections. The global navigation can be found behind the burger menu symbol in the top right corner of the website. The different subcategories of global navigation, i.e. the local menu, expand in the global navigation, as shown in Figure 9. After navigating to a specific page, a breadcrumb list appears to the top left corner of the page. When being on another

page than the front page, the only visible navigation elements are the breadcrumb list and the footer. The global navigation can still be found behind the burger menu symbol. Another type of a breadcrumb list can be seen by opening the menu, since the chosen subcategory has stayed expanded and the title of the specific page is underlined.

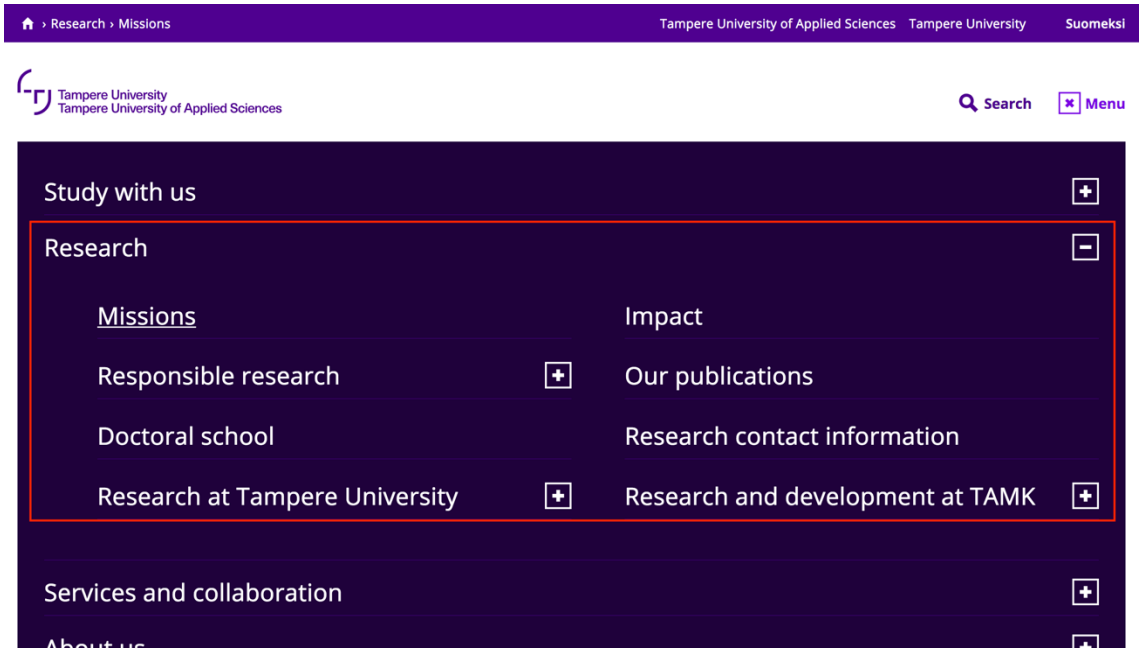

Figure 9. Subcategories in the global navigation on Tampere University website [Tampere University 2020]

The used terminology and labeling on the Tampere University website is guiding. Information about how to get to this university and what the studying possibilities are can be found behind the "Study with us" label. Some used terms are also explained, such as the "Student's Guide", which "offers you study-related instructions, curricula and teaching schedules for each academic year. It works as your handbook through your journey at the university" [Tampere University 2020]. The website analyzed is the English version of the website and the structure of the website is the same as the original version, which is in Finnish.

7.1.4 Summary

When comparing all the three websites, the first observation is that they all have different structures. Cornell University has always the global navigation displayed at the top of the page, when Ludwig-Maximilians-Universität has the global navigation on the left side of the page and the goal navigation of Tampere University opens from the burger menu symbol. In the other aspects analyzed, there were some similarities and differences between the websites. Cornell University website is only two levels deep, meaning that a category in the global navigation has a subcategory but that subcategory does not have a

subcategory. On the contrary, Ludwig-Maximilians-Universität and Tampere University websites both are three levels deep, so they both have one more subcategory on the navigation when compared to Cornell University. It is also good to note that both Ludwig-Maximilians-Universität and Tampere University have a breadcrumb list on their websites. This might have something to do with the depth of the website so that users do not have to memorize the path they navigated to get to that specific page. Since the navigation of the Cornell University website is not as deep as the two other websites, having the current menu items highlighted in a different color is enough of a breadcrumb "list".

7.2 Accessibility

Accessibility aims at making the content of the website accessible for every user, regardless of the possible disabilities the user might have. A user using a screen reader system will experience the differently than a user that has no assistive technologies in use. [Moreno and Martinez 2012] Accessible websites should be usable for users using assistive technologies. Making a website accessible takes time, but there are a few issues that should be taken care of in the first place. Images and other multimedia elements should have alt-tags on them to tell a visually impaired user what that element is about. Also, links should have some kind of description on them to tell the user where that specific link points to. The content of the website should be structured and organized to make it easily understandable. An easy way to keep a text structured is to have headings (h1-h6) to divide it into different parts. The website should also be navigated using only a keyboard, or at least with something equivalent to a keyboard, since not every user is able to use a mouse. [Brophy and Craven 2007] The analysis aims at reviewing if the website utilizes three main accessibility elements, i.e. alt-tags on images, descriptions or labels on links and having headings in the right order to make the structure clear. The analysis will be done on the front page and one other page of the website.

7.2.1 Cornell University

In the Cornell University website front page, almost all images have a descriptive alt-tag, which describes what the image is about if some reason the image does not load or if the user is using a screen reader, as demonstrated in Figure 10. The images that did not have an alt-tag were links to articles and blog posts to other parts of the website. Since those images acted as links, they also had a descriptive title in them. When moving to the certain blog post or article the image directed to, the image they used in the front page as a link, did have a descriptive alt-tag attached to it in that different page.

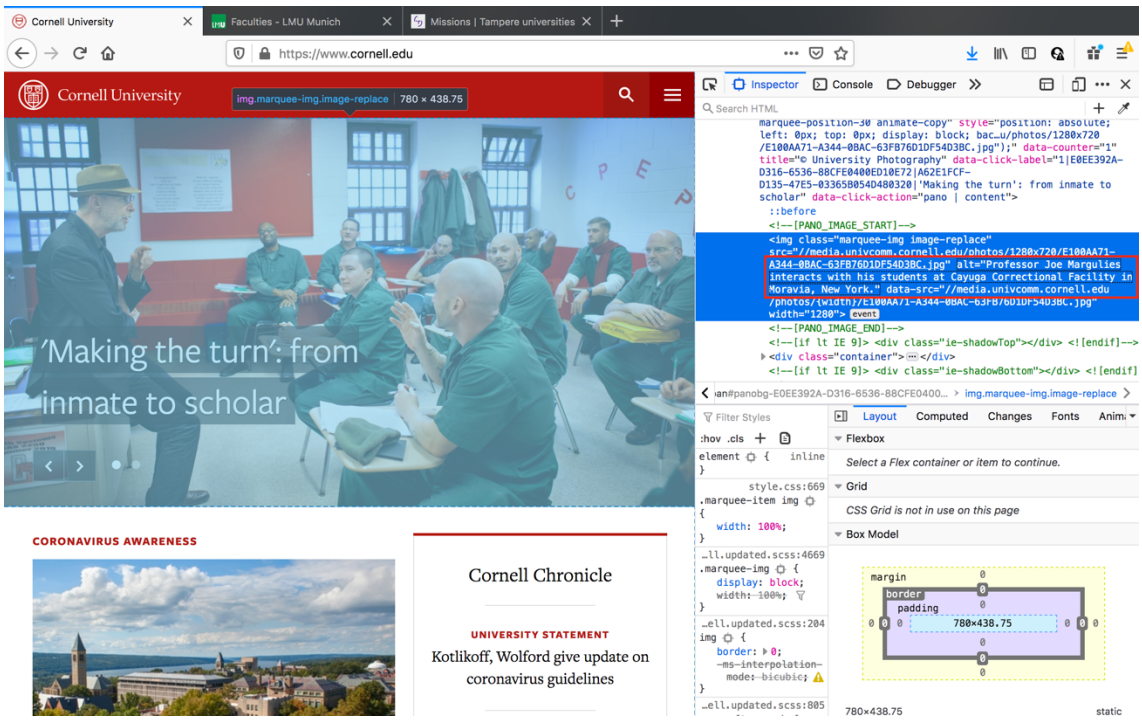

Figure 10. An example of an alt-tag on Cornell University website [Cornell University 2020a]

The links used in the website all have some descriptive labels on them, instead of just using links that say "click here". The terminology used in the labels of the continues the same theme of the terminology used in other places of the website, i.e. the used language and choice of words is understandable, and it is clear where each link points to.

The pages having more of a text-oriented content have the h1-h6 headings in them to make the content more structured and easier to follow. The h1 is usually used to describe what that page is mostly about and the latter headings are used to divide the content into smaller divisions, so that the user can easily look through the different subheadings to find out what each text section is about. Although the Cornell University website is very visual and has a lot of image elements, the website is still descriptive and structured even in situations when the images or other visual elements cannot be seen. Images having descriptive alt-tags and links having explanatory labels on them make the Cornell University website easy to browse through without the need to see what image is attached to an article or what icon a link has.

7.2.2 Ludwig-Maximilians-Universität

A lot of the images on the Ludwig-Maximilians-Universität website did not have any alt-tags. And in the ones that did have an alt-tag, they were not that descriptive. In some cases, the alt-tag was mainly the name of the photographer or possibly some non-descriptive pair of words that marked the name of the image used, as shown in Figure 11.

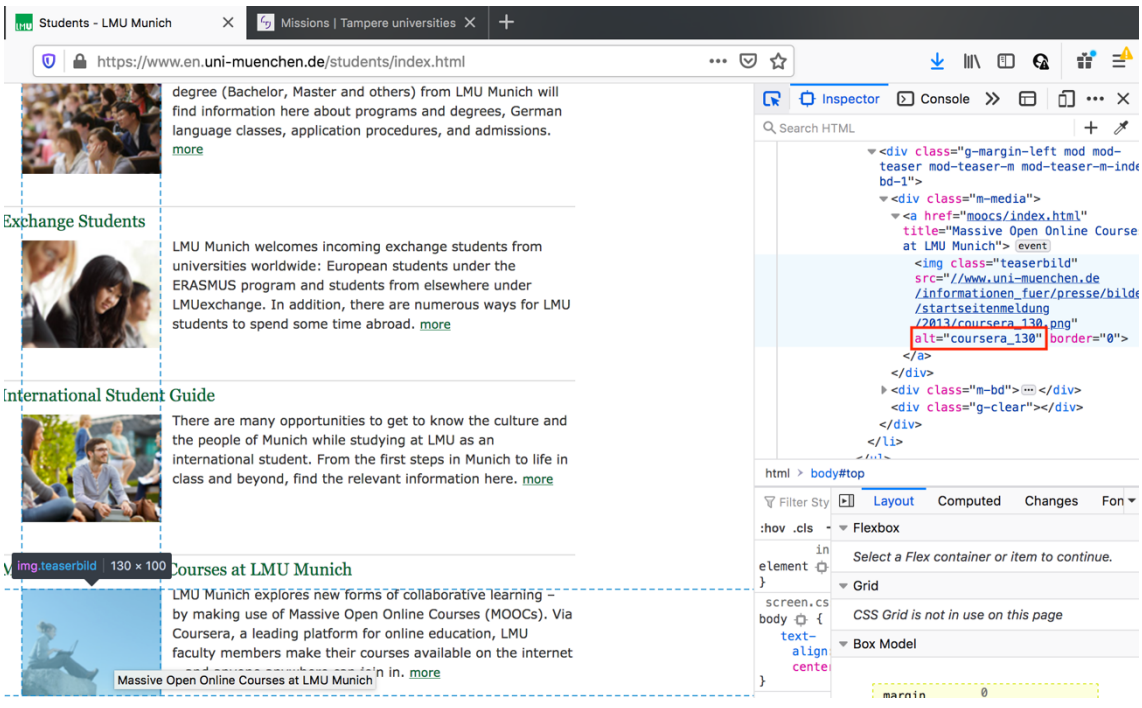

Figure 11. An example of an alt-tag on Ludwig-Maximilians-Universität website [Ludwig-Maximilians-Universität München 2020]

Most of the links on the Ludwig-Maximilians-Universität were descriptive and directive. The label of the link describes where the link points to or what is possibly does, i.e. the link where the user can print that specific page. Some links did not seem that descriptive at first but taking a look at the source code clarified that even though it might seem that only label the link has is the word “more”, the link also has the name of the article as its title.

In the articles and other pages that are more filled with text, it first looks like there are a few headings used to create some structure to the content. However, the “headings” are just bolded phrases, which means that it is harder for the user to use the website with a screen reader to understand the structure of the text. The article page analyzed did have an h1 heading as the main heading of the article, but the h2 heading on that page was the heading of the list of quick links. In this case, the headings do not make the structure of the page any clearer. In the Ludwig-Maximilians-Universität website there were a few good parts but mainly the website would not be that useful for a user that uses a screen reader.

7.2.3 Tampere University

In the Tampere University website, most of the images do have an alt-tag. However, since the main language of the university is Finnish, some of the used alt-tags are also in Finnish. Also, in some cases the alt-tag was only the name of the photographer and nothing else.

The labels of the links in the Tampere University website can be divided into two sorts. Some of the links are descriptive and indicate where the link point so and some of the links are not descriptive at all, since in some of them the label is only “Read more” and in some cases there is only an arrow icon. A few links have a label “Read the story”, which is kind of descriptive, since it tells that the link points to a page that has a story, but the link is not attached anyhow to the short descriptive text above it, so a user with a screen reader could have some difficulties in understanding the relationship between those two.

In the articles, the headings h1-h6 are used even somehow. The main title of the article is an h1 type of heading, but the next heading used is an h3 heading, which means that the whole h2 heading level is skipped. Even though the used headings are still in the right order, the missing h2 might confuse the user. A user using a screen reader might think that he/she has missed or skipped an important part of the text because of the skipping in the heading hierarchy. Mainly the Tampere University website fulfils the few accessibility criteria used in the analysis but there is still a lot which can be done better to provide even better usage of the website especially for users with screen readers or other assistive technologies.

7.2.4 Summary

In the accessibility analysis, there was a lot of variance between the three websites. Cornell University seemed to have almost every analyzed element in use. Images had alt-tags, labels on the links were descriptive and the text content on the website was structured and had headings. As narrow as the analysis is, Cornell University website appears to be usable for every user. On the other hand, the performance of Ludwig-Maximilians-Universität was not that good. The website has deficiencies in almost every element analyzed. Even though some images had alt-tags, the used tags were not descriptive or clear. Also, the text content was not structured with headings, but with some bolded text. For a user using a screen reader that bolded text does not show up as a distinguishable title that defines the topic of that part of the text as a normal heading would do. At a glance, the Tampere University website seems to use all the analyzed elements. But when taking a deeper look, it is noted that the situation is not as good as it first seemed. Having alt-tags is good, but when the alt-tag is in Finnish and the website is in English, the text in Finnish is as descriptive as no alt-tag at all would be. Also having a “Read the story” kind of text as a label of a link does not describe that well where the link points to if there is no more information available, for instance, as a title of the link.

7.3 Search engine optimization

Search engine optimization is a process to get a website as high as possible on a search engine results page. Search engine optimization includes changes to the code of the

website, adding sitemaps and creating links to that website from other places on the web. Search engine optimization techniques can be divided into the ones that should be used, aka white hat techniques, and into the ones that should not be used, aka black hat techniques. The white hat techniques consist of on-page techniques and off-page techniques, which are, as their names suggest, done on and off the website. [Sharma et al. 2019] The analysis will be done by performing a few search queries in Google and examining what position the analyzed website is on the search engine results page. Since search engine optimization and accessibility do have so many common elements, such as the use of headings, titles, and structured content, there is no need to inspect those elements again in the search engine optimization analysis. The analysis is done by performing two different searches, “university [country]” and “university computer science [country]”. Some of the searches are performed in different languages, since the main language of the university might be different than English, so the search results and their order could be altered if only the second language of the university was used. The searches were performed on the 2nd and 4th of March 2020.

7.3.1 Cornell University

When performing a search “university united states of america”, the Cornell University website did not appear until the search engine results page 4. A snapshot of the result can be seen in Figure 12. In terms one search engine optimization and how the users act, hardly any users navigate further from the first search engine results page [Sharma *et al.* 2019]. With this in mind, the Cornell University website did not perform that well during this search and this specific search query. With the search query "university computer science usa”, Cornell University did not appear until the result page 17, so the performance in search engine optimization is even worse, with this specific phrase at least. However, in the case of the second search query, the first few pages were full of websites having ratings about different universities in USA that have a computer science program.

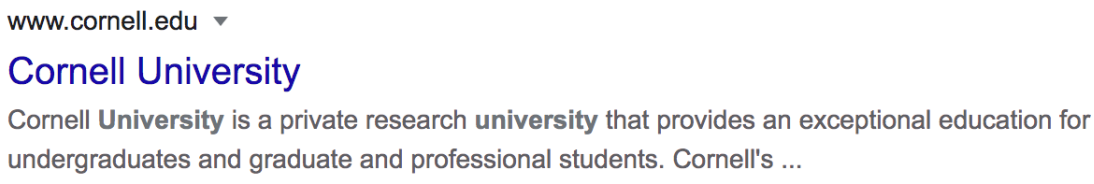

Figure 12. The title and description of Cornell University website when performing the search “university united states of america” [Google Search 2020d]

7.3.2 Ludwig-Maximilians-Universität

Analyzing the search engine optimization performance of the Ludwig-Maximilians-Universität, the search query was done in German, since it is the first language of this

university. In the search “universität deutschland”, which is “university germany” in German, Ludwig-Maximilians-Universität was only on the 5th result page, so the performance is not that good. However, just as in the earlier analysis of Cornell University, in this search, the first results were websites having ratings and reviews of different German universities. The search query used is quite general, which can affect the results. Since the Ludwig-Maximilians-Universität does not have a specific department of computer science, the more precise search was performed with the search query “universität informatik deutschland”, which means “university informatics germany”. Again, the Ludwig-Maximilians-Universität did not appear until the results page 5. The result page of Ludwig-Maximilians-Universität was the same on both of the searches, which means that the website performs just as well in both the broad and the precise search queries.

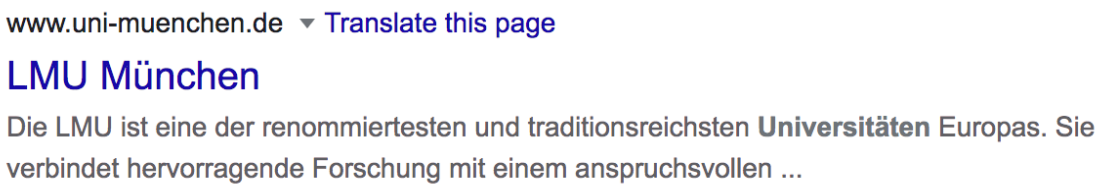

Figure 13. The title and description of Ludwig-Maximilians-Universität website when performing the search “universität deutschland” [Google Search 2020e]

7.3.3 Tampere University

The main language of Tampere University is Finnish, which means that it is more accurate to perform the searches in Finnish too. In the first search “yliopisto suomi”, meaning “university finland” in Finnish, the first result of Tampere University website is on the 3rd result page. However, it is interesting to note that other search results are usually the front pages of the website, but in the Tampere University case, the first appearing result is the page of Finnish studies in the open university. It might have something to do with the fact that the language spoken, and the name of the country are the same in Finland. In the first search result page, there are again a handful of different rating websites listing all the universities in Finland. In the second search “yliopisto tietojenkäsittelytiede suomi”, meaning “university computer science finland”, the Tampere University website is on the second search result page. On the first result page there is again a couple of comparison websites, so in the competition between different universities, the Tampere University performed quite well. It seems that in this case, the more precise search query performed better.

www.tuni.fi › tule-opiskelemaan › su... ▾ Translate this page

Suomen kielen aineopinnot, avoin yliopisto-opetus ...

Avoin **yliopisto**. **Suomen** kielen aineopinnot, avoin **yliopisto**-opetus. Korkeakoulu. Tampereen **yliopisto**. Koulutuksen kuvaus. Näin haet tai ilmoittaudut ...

Figure 14. The title and description of Tampere University website when performing the search "yliopisto suomi" [Google Search 2020f]

7.3.4 Summary

In the analysis, with the more specified search query, Cornell University performed badly but the reason behind that might be that in the United States, students usually apply to the entire university instead of just one specific program or major, while in Europe students might be more focused on a specific field [Wikipedia 2020]. The difference between the admission habits could explain why the computer science studies website is not as optimized as a front page of a university might be. The Ludwig-Maximilians-Universität performed at the same level in both of the search queries. Again, there might not be one specific reason or problem behind this but just the fact that other universities could be doing something even better. Tampere University performed quite well in both of the search queries, but one strange fact is that the first result of Tampere University in Google was not the front page, but the page of a study program. Usually, the front page of the website is the one that is being attempted to appear first in the search results. When comparing the different performances of the three universities in the search engine, it is important to note that sometimes the poor performance will not be caused by the lack of optimization on the website but might be just the fact that some website has done something even better. After all, it is important to remember that apart the optimizing that is done on the website, there are various other factors that might affect on the website's ranking. Google uses the location data of the user to provide more accurate results [Google Search 2020b], which lead into a situation where users from different locations get different search results. Another factor is the off-page optimization, i.e. using social media, blogs and forums to create links that point to the website [Barbar and Ismail 2019]. Also, the number of competitive websites on that search might have an effect on the ranking.

7.4 Google Lighthouse audit

Google's Lighthouse audit is an "automated tool for improving the quality of web pages" [Google Developers 2020]. The tool can be used with any kind of web page and it has different sections for at least accessibility, search engine optimization, and performance. After the audit is done to the website, the lighthouse generates a report stating how the website performed in the audit and what could be done to make the website even better.

The number of metrics the audit uses is quite large, but to mention a few, the used metrics include, for example, checking the navigation and the labeling of the website, the used aria and role attributes, the color contrast ratio, multiple different html elements and attributes (e.g. title, alt-tag, lang attribute), meta description, robots.txt, and many other checks. The higher the score the website gets, the better that website is performing in that category. The highest score to get in each of the categories is 100 and the lowest is 0. [Google Developers 2020] In every audit, the accessibility and SEO categories were chosen, and the audit was done on a desktop device. The scores and given tips are compared to the performance in those categories in the manually done analysis.

7.4.1 Cornell University

In the audit, Cornell University got 96 in accessibility and 90 in SEO, as shown in Figure 15. The main issue in the accessibility part was that not all links have a text to describe where the link points to. After checking those links, it was noted that all the links without the description were the links that point to Cornell University's social media accounts. In the search engine optimization part, the main issue was the lack of the viewport definition in one of the meta tags. This was not a part of the analyzed sections in the manually done analysis. All in all, the Cornell University website performed well in both of the analyzes, since no huge problems were encountered. The weaker performance in the search engine results pages in the manually done analysis could be due to the fact that the United States do have a large number of universities, so the competition is tough. Also, both of the analyzes are somewhat narrow and do not analyze everything, since going through every little detail would not bring that much difference into the end result nor there is any need to dig into the little details.

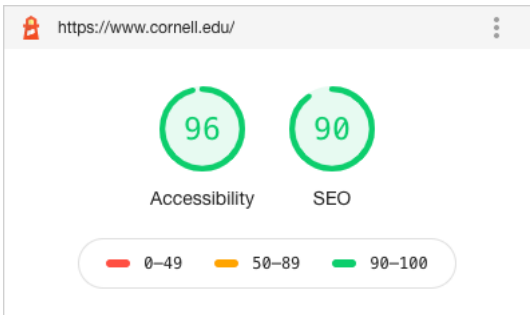

Figure 15. Cornell University's results in Google Lighthouse audit [Google Developers 2020]

7.4.2 Ludwig-Maximilians-Universität

Ludwig-Maximilians-Universität got 71 in accessibility and 70 in search engine optimization in the audit, as shown in Figure 16. In the accessibility part, there were two issues. The first issue was that the links in the footer did not have a sufficient contrast ratio,

which means that it could be hard for some users to read the label of those links. The second issue was that the search bar on the front page did not have any label attached to it, which means that users using a screen reader would not know what to fill into that field. In the search engine optimization part, there were three main issues. The first two issues were about the meta tags, since the website does not have a viewport, or a description defined in the meta tags. The last issue was about the links not having a descriptive text in them. This same issue was actually noted in the accessibility section of the manually done analysis. The description of the link helps the users to understand what that link is about or where it points to. In both of the analysis, Ludwig-Maximilians-Universität performed moderately. There were some issues in both analyzes and in all topics. However, in the Lighthouse audit, the Ludwig-Maximilians-Universität's website performed better in the accessibility section than in search engine optimization, while in the manually done analysis the website had more noted issues in the accessibility part than the search engine optimization part.

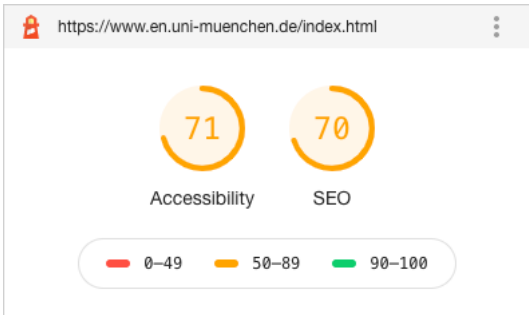

Figure 16. Ludwig-Maximilians-Universität's results in Google Lighthouse audit [Google Developers 2020]

7.4.3 Tampere University

In the audit, Tampere University got 98 in accessibility and full 100 in search engine optimization, as shown in Figure 17. The only note in the accessibility part was that the university logos that act as links, do not have an alternative text on them. In the search engine optimization part, there were no issues addressed since the score is the highest it can be. However, the Lighthouse audit does not take a stand on the content of the website. When doing the manual accessibility analysis, there were a few issues that are not noted in the audit. The audit only checks if some details exist but not much more. The Tampere University does have labels on almost every link but having a label that says "Read more" is not that much more informative than no label at all. Also, all the images do have their alt-tags but a user using a screen-reader and not speaking any Finnish does not benefit at all from alt-tags written in Finnish. Nonetheless, there were not that many issues in both the manually done analysis and in Google's audit.

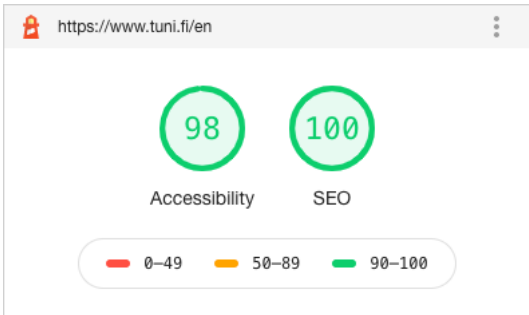

Figure 17. Tampere University's results in Google Lighthouse audit [Google Developers 2020]

7.4.4 Summary

It is worth noting that an automated audit does not detect the same issues a human does. An example would be the alt-tags of images. An automated audit will just note that some alt-tags exist, but a human can determine if the used tags are understandable or usable, i.e. having the tag in a different language or using just the name of the photographer does not tell anything about the image for the user using a screen reader. Another observation was that the website's performance in search engine optimization will not be good if the website is not accessible and usable. A lot of factors affect how a website performed in a search engine, but the websites should always be optimized for the users first. Also, the audit did offer multiple checks to perform manually, which validates the fact that not everything can be automatized or figured out by a machine. Making a website the best possible version still needs humans to figure out some details to provide the best possible experience for the users, the humans.

7.5 Summary

During the analysis, it was noted that even though the main aim of a university website is usually the same, there still can be a lot of differences between the websites of different universities. Some might want to focus more on visual aspects, as Cornell University and Tampere University do, but some others might want to keep it simple and focus more on just presenting the essential information. However, having the menu or its items hidden or using a lot of images should not have an impact on the accessibility of the website. All images and links should have descriptive alt-tags and labels on them to make it possible for users to use a screen reader to understand what the images are about and where the links point to. The labels and alt-tags should not be a "necessary evil", but a way to help all users have the same experience when navigating through the website, regardless of the fact that somebody might be needing the help of a screen reader.

Informative and descriptive labels on links and alt-tags on images can also help with how the website ranks in Google. The Googlebot, also known as the crawler, does not see

so it has to rely on the structure, the links and the descriptions of different elements to understand what the website is alike, just as a user using a screen reader does. In other words, optimizing the website for the users can be helpful and valuable in terms of ranking higher in search engines.

	Information architecture	**Accessibility**	**Search engine optimization**	**Google's Lighthouse audit**
Cornell University	• Two levels deep • Menu items partially hidden • Directive labeling	• Alt-tags used • Links have labels • Text is structured and has headings	• Performance was better in the more broad search query • Possibly more competition	• Accessibility score 96: missing some labels on links • SEO score 90: missing some meta-tags
Ludwig-Maximilians-Universität	• Three levels deep • Breadcrumb list • Mundane terminology	• Missing or nondescriptive alt-tags • Incorrect use of headings • Links have labels	• No difference between the broad and the more specific search query	• Accessibility score 71: poor contrast ratio, missing an input label • SEO score 70: missing some meta-tags, missing link descriptions
Tampere University	• Three levels deep • Menu always hidden • Breadcrumb list	• Nondescrptive alt-tags • Nondescriptive labels on links • Some headings levels skipped	• No difference between the broad and the more specific search query • First result was not the front page	• Accessibility score 98: missing some alt-tags • SEO score 100

Figure 18. A summary of the analysis

In conclusion, it was noted that compounding the aspects of a good information architecture and an accessible website could have a better impact in the search engine rankings than in the situations where only either of information architecture or accessibility is attained. This can be noted when comparing Ludwig-Maximilians-Universität and Tampere University. The main structure of the information architecture is roughly the same between the websites, meaning that they are both three levels deep and they both have the breadcrumb list visible, as indicated in Figure 18. However, the Ludwig-Maximilians-Universität does not perform well in accessibility and multiple aspects that affect on accessibility, are missing. Whereas in Tampere University website, the main elements of accessibility are mostly taken care of. Even though some of the used labels or alt-tags are not that descriptive as they could be, even having the few elements implemented can have a better impact on search engine rankings than having no or only a few accessibility elements implemented.

8. Social inclusiveness

Many usability studies refer to Jakob Nielsen's five usability attributes [Nielsen 1993] and ten usability heuristics |Nielsen 1994]. However, these recommendations focus mainly on the usability aspects of a website, as it can be seen from their definitions. Nielsen [2012] also defines usability as "a quality attribute that assesses how easy user interfaces are to use". Considering the heterogenous users, the usability attributes lack concretized instructions to take users with disabilities into consideration comprehensively in web design. Accessibility guidelines are developed to suit the needs of users with disabilities by making small modifications to the website [Brophy and Craven 2007]. Following the World Wide Web Consortium's Web Content Accessibility Guidelines [2008] can make the content of the website more usable to users in general, as they state in their guidelines. This definition, as multiple other accessibility definitions, focus mainly on how to make the content accessible, instead of trying to provide the same experience for everyone [Giraud *et al.* 2018; Moreno and Martinez 2012]. Google Developers' [2019a] definition of accessibility is a little wider, since accessibility is fulfilled when "the site's content is available, and its functionality can be operated, by literally anyone".

As United Nations define, social inclusiveness ensures equal opportunities [2020]. To understand what social inclusiveness is in web design, it is important to understand what social inclusiveness generally means. The Collins Dictionary [2020] defines social inclusiveness as "the act of making all groups of people within a society feel valued and important". Social inclusiveness can also be explained as "the process by which efforts are made to ensure equal opportunities – that everyone, regardless of their background, can achieve their full potential in life", as United Nations [2020] conclude. All in all, the aim of social inclusiveness is "to promote equal opportunities and resources between people with and without disabilities", according to IGI Global [2020]. And even more specifically, the Cambridge Dictionary [2020] defines inclusiveness as "the quality of including many different types of people and treating them all fairly and equally".

Accordingly, socially inclusive websites would provide the same experiences and opportunities for everyone, without considering the fact if someone uses assistive technologies. It shall emphasize both usability and accessibility. The process of implementing a socially inclusive website would follow guidelines of both usability and accessibility, instead of implementing usability aspects first and then shifting into implementing accessibility aspects.

During the analysis of three different university websites it was noticed that taking care of both usability and accessibility of the website can have a positive impact on how the website performs in search engine rankings. It was also mentioned in a study made by Moreno and Martinez [2012] that following the accessibility guidelines can help with the website's ranking. Further, in a study made by Bai [2019], it was noted that taking

care of accessibility will benefit all the users and the usability of the website. But also, increasing the usability of the website can enhance the accessibility of the website, as mentioned in a study conducted by Erickson et al. [2013]. More precisely, focusing in a good information architecture covers multiple usability heuristics and it can refine the website's accessibility [Matera *et al.* 2006]. And since both the search engine's crawler and a user using a screen reader rely on the structure of the website [Moreno and Martinez 2012], bettering the usability of the website with some accessibility aspects will help both the user and the crawler trying to understand the website better. Figure 19 helps to gain better understanding of the various common elements that accessibility has with usability and search engine optimization. In the figure, it can also be noted that there are identical similarities between usability and accessibility, and accessibility and search engine optimization. This supports the hypothesis that the search engine ranking of the website could benefit from compounding usability and accessibility. The overlapping elements concern different levels of the website, since the desired level of accessibility, usability or search engine optimization is rarely reached by just adding a few new html elements here and there.

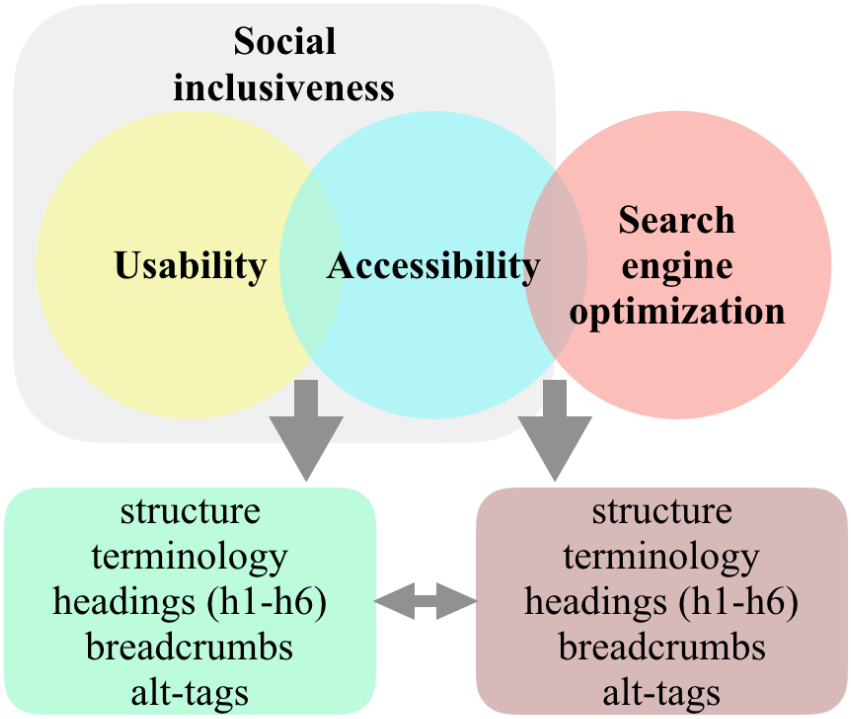

Figure 19. The consistencies between usability

Since good usability can help to get better accessibility and improving accessibility can help the website to gain better ranking in search engine, it can be stated that combining usability and accessibility into social inclusiveness could have a positive impact on

the website's performance in search engines, as demonstrated in Figure 20. The similarities between usability, accessibility and search engine optimization, indicated in Figure 19, also support this statement.

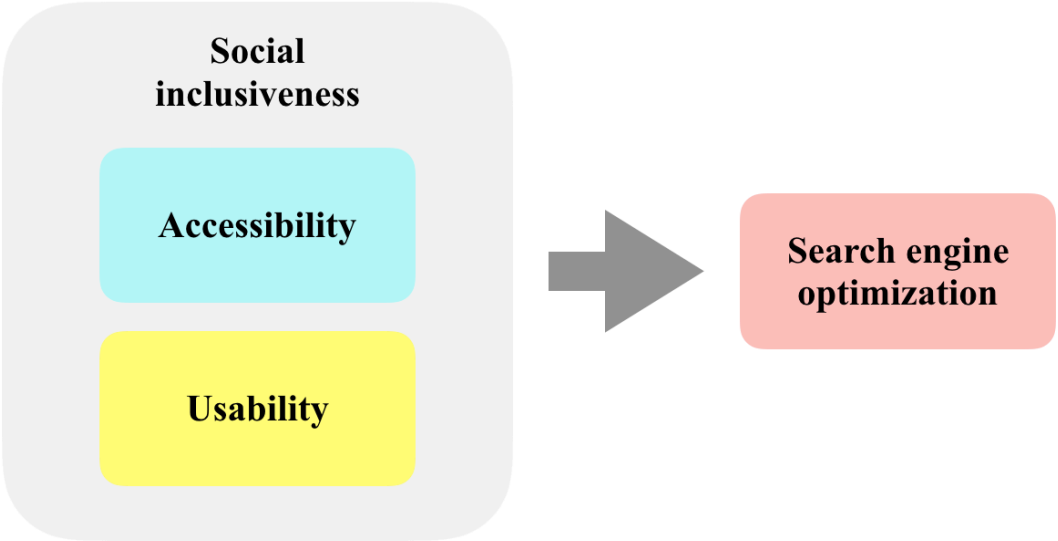

Figure 20. Demonstration of the relations between social inclusiveness, accessibility, usability and search engine optimization

In conclusion, social inclusiveness aims at providing equal opportunities to everyone using a website. A good addition to that is the fact that following both usability and accessibility guidelines can profit in performing better in search engines without trying to understand the complexity of Google's ranking algorithms. When a website is socially inclusive, it has the main aspects of accessibility covered and usability guidelines followed, but not in a way that everything feels forced. The content of a socially inclusive website is structured with headings that are understandable and describe the section of the information. The terminology used is consistent and it uses every-day language, so the user does not need a dictionary to understand it. The structure of the whole website, i.e. the information architecture, supports findability by using clear hierarchy and labeling to help the user navigate through the website. Links have descriptive labels on them to indicate where they point to and if, however, an error occurs, there is always an easy way to return to the previous page. Used images and other media have descriptive alt-tags on them to describe what the element is about. And instead of just using brief descriptions, such as "a building", more detailed descriptions should be used, such as "the main building of campus surrounded by blooming cherry trees", since sometimes the description is the only way a user can experience the element.

9. Conclusion

The information and content on a website should be easy to access. Individual users experience websites differently, which is why it is important that websites provide access to the information for everyone, even if the user uses an assistive technology. The purpose of this thesis was to understand the relationships between accessibility, usability and search engine optimization and to discover if utilizing the relationships and similarities could produce a new concept.

The guidelines of usability and accessibility focus on many different aspects, and then there are guidelines for search engine optimization to gain more users from search engines. Accessibility guidelines aim at making the content of the website accessible for every user, regardless of the fact if they are using assistive technologies. There are various disabilities and an accessible website tries to conquer all of them by providing the content in a way it can be accessed with assistive technologies, e.g. a screen reader. Yet, accessibility guidelines concern only making the content of the website accessible. To make the usage of a website easier, usability guidelines should be studied and followed. Following usability guidelines and heuristics can help to make it easier for the user to fulfil his/her tasks, and it also makes the website easier to use. In order to use the website and perform tasks, it is important that the user first finds the website they are searching for. The purpose of search engine optimization is to provide the content of the website for the users by getting the website ranked as high as possible in a search engine results page by following the optimization guidelines. Different optimization techniques aim at making the website's content accessible for the crawler, in order to rank higher to gain more visitors.

During the thesis it was noted that there are multiple consistencies between the guidelines of accessibility and usability, and with accessibility and search engine optimization. Combining the implementations of usability and accessibility would enhance both of the topics and create a new concept, social inclusiveness, that promotes providing equal opportunities for every user, with or without any disabilities. Since there are also observations about the similarities between accessibility and search engine optimization, it was determined that social inclusiveness could have a positive impact on how the website ranks on search engines. An analysis was done to gain more understanding about the coherence between the topics. Providing a socially inclusive website would create opportunities for all users to experience and use the website equally, but it could also be beneficial to the website's ranking in search engines. Granting equal opportunities would therefore be profitable to all parties.

References

Harsh Agarwal, Amit Birajdar and Manan Bolia. 2019. Search Engine Marketing Using Search Engine Optimisation. *Asian Journal for Convergence in Technology (AJCT).*

Yang Bai 2019. The Relationship between Website Accessibility and Usability: An Examination of U.S County Government Online Portals. *The Electronic Journal of e-Government*, 17, 1, 47-62.

Yang Bai, Jenna Grzeslo, Ryan Wang, Bumgi Min and Krishna Jayakar. 2019. Does Accessible Design Benefit General Users of e-government? Examining the Relationship between Website Usability and Accessibility. http://dx.doi.org/10.2139/ssrn.3427413. Checked 10.2.2020.

Aziz Barbar and Anis Ismail. 2019. Search Engine Optimization (SEO) for Websites. In: *Proc. of the 2019 5th International Conference on Computer and Technology Applications (ICCTA)*, 51-55.

Steven M. Baule. 2019. Evaluating the Accessibility of Special Education Cooperative Websites for Individuals with Disabilities. *Tech Trends*, 1-7.

Peter Brophy and Jenny Craven. 2007. Web Accessibility. Librarytrends 55, 4, 950-972.

Cambridge Dictionary. https://dictionary.cambridge.org/dictionary/english/inclusiveness. Checked 3.2.2020.

Jen Cardello. 2012. The Difference Between Information Architecture (IA) and Navigation. https://www.nngroup.com/articles/ia-vs-navigation/. Checked 19.2.2020.

The Collins Dictionary. https://www.collinsdictionary.com/dictionary/english/social-inclusion. Checked 3.2.2020.

Cornell University. 2020a. https://www.cornell.edu/. Checked 3.3.2020.

Cornell University. 2020b. Sitemap. https://www.cornell.edu/sitemap.xml. Checked 19.4.2020.

Dartmouth. 2020. https://home.dartmouth.edu. Checked 19.4.2020.

Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies. 2016. https://eur-lex.europa.eu/eli/dir/2016/2102/oj. Checked 28.3.2020.

William Erickson, Sharon Trerise, Camille Lee, Sara VanLooy, Samuel Knowlton and Susanne Bruyère. 2013. The Accessibility and Usability of College Websites: Is your Website Presenting Barriers to Potential Students? *Community College Journal of Research and Practice*, 37, 11 864-876.

Stéphanie Giraud, Pierre Thérouanne, Dirk D. Steiner. 2018. Web accessibility: Filtering redundant and irrelevant information improves website usability for blind users. *International Journal of Human-Computer Studies* 111, 23-35.

IGI Global. https://www.igi-global.com/dictionary/independent-living-support-disabled-elderly/27360. Checked 3.2.2020.

Google Developers. 2019a. Web Fundamentals: Accessibility. https://developers.google.com/web/fundamentals/accessibility. Checked 3.2.2020.

Google Developers. 2019b. Web Fundamentals: How To Do an Accessibility Review.https://developers.google.com/web/fundamentals/accessibility/how-to-review. Checked 16.2.2020.

Google Developers. 2020. Tools for Web Developers: Lighthouse. https://developers.google.com/web/tools/lighthouse. Checked 22.3.2020.

Google Search. 2020a. How Search works: Organizing information. https://www.google.com/search/howsearchworks/crawling-indexing/. Checked 6.4.2020.

Google Search. 2020b. How Search works: Search algorithms. https://www.google.com/search/howsearchworks/algorithms/. Checked 6.4.2020.

Google Search. 2020c. Search: university new york. Checked 19.4.2020.

Google Search. 2020d. Search: university united states of america. Checked 2.3.2020.

Google Search. 2020e. Search: universität deutschland. Checked 2.3.2020.

Google Search. 2020f. Search: yliopisto suomi. Checked 2.3.2020.

Google Search Console Help. 2020. Search Engine Optimization (SEO) Starter Guide. https://support.google.com/webmasters/answer/7451184?hl=en&ref_topic=9460495. Checked 5.4.2020.

Jiao Guo and Pei Yan. 2011. User-centered information architecture of University Library Website.

Mukta Kulkarni. 2018. Digital accessibility: Challenges and opportunities. *IIMB Management Review* 31, 91–98.

Pedro Lorca, Javier De Andrés and Ana B. Martínez. 2018. The Relationship Between Web Content and Web Accessibility at Universities: The Influence of Social and Cultural Factors. *Social Science Computer Review* 2018, 36, 3, 311-330.

Maristella Matera, Francesca Rizzo and Giovanni Toffetti Carughi. 2006. Web Usability: Principles and Evaluation Methods. In: *Mendes E., Mosley N. (eds) Web Engineering*, 143-180.

Lourdes Moreno and Paloma Martinez. 2012. Overlapping factors in search engine optimization and web accessibility. *Online Information Review*, 37, 4, 564-580.

Ludwig-Maximilians-Universität München. 2020. http://www.en.uni-muenchen.de/index.html. Checked 3.3.2020.

Jakob Nielsen. 1993. Usability Engineering.

Jakob Nielsen. 1994. 10 Usability Heuristics for User Interface Design. https://www.nngroup.com/articles/ten-usability-heuristics/. Checked 22.2.2020.

Jakob Nielsen. 2012. Usability 101: Introduction to Usability. https://www.nngroup.com/articles/usability-101-introduction-to-usability/. Checked 19.2.2020.

Helen Petrie and Omar Kheir. 2007. The Relationship between Accessibility and Usability of Websites. In: *Proc. of the SIGCHI Conference on Human Factors in Computing Systems*, 397-406.

A. H. Roslina and M. F. Nur Shahirah. 2019. Implementing White Hat Search Engine Technique in E-Business Website. In: *Proc. of the 10th International Conference on E-Education, E-Business, E-Management and E-Learning (IC4E '19)*, 311-314.

Mirko Ruzza, Barbara Tiozzo, Claudio Mantovani, Fabiano D'Este and Licia Ravarotto. 2017. Designing the information architecture of a complex website: A strategy based on news content and faceted classification. *International Journal of Information Management*, 37, 166-176.

Dushyant Sharma, Anil Kumar Giri, Rishabh Shukla and Sumit Kumar. 2019. A brief review on search engine optimization. In: *Proc. of the 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*, 687-692.

Isabel Mariann Silvis, Theo J.D. Bothma and Koos J.W. de Beer. 2019. Evaluating the usability of the information architecture of library websites. *Library Hi Tech*, 37, 3, 566-590.

Tampere University. 2020. http://www.en.uni-muenchen.de/index.html. Checked 3.3.2020.

The University of Texas at Austin. 2020. About. https://www.utexas.edu/about. Checked 19.4.2020.

Lance Umenhofer. 2019. Gaining Ground: Search Engine Optimization and Its Implementation on an Indie Book Press. *Publishing Research Quarterly* 35, 2, 258-273.

United Nations. https://www.un.org/development/desa/socialperspectiveondevelopment/issues/social-integration.html. Checked 3.2.2020.

Wikipedia. 2020. College admissions in the United States. https://en.wikipedia.org/wiki/College_admissions_in_the_United_States. Checked 29.3.2020.

Wikipedia. 2020. Web search engine. https://en.wikipedia.org/wiki/Web_search_engine. Checked 6.4.2020.

World Wide Web Consortium (W3C). 2008. Web Content Accessibility Guidelines (WCAG) 2.0. https://www.w3.org/TR/WCAG20/.

Yeliz Yesilada, Giorgio Brajnik, Markel Vigo, and Simon Harper. 2015. Exploring perceptions of web accessibility: A survey approach. *Behaviour & Information Technology*, 34, 2, 119-134.

Kyunghye Yoon, Laura Hulscher and Rachel Dols. 2016. Accessibility and Diversity in Library and Information Science: Inclusive Information Architecture for Library Websites. *Library Quarterly: Information, Community, Policy*, 86, 2, 213-229.