Search Engine Optimization Meets e-Business
A Theory-based Evaluation: Findability and Usability as Key Success Factors

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Abstract: What can not be found, can not be used. Consequently, the success of a Website depends, apart from its content, on two main criteria: its top-listing by search engines and its usability. Hence, Website usability and search engine optimization (SEO) are two topics of great relevance. This paper focusses on analysing the extent that selected SEO-criteria, which were experimentally applied to a Website, affect the website's usability, measured by DIN EN ISO 9241-110 criteria. Our approach followed (i) a theory-based comparison of usability-recommendations and SEO-measures and (ii) a scenario- and questionnaire-based usability evaluation study combined with an eye-tracking analysis. The findings clearly show that Website usability and SEO are closely connected and compatible to a wide extent. The theory-based measures for SEO and Web Usability could be confirmed by the results of the conducted usability evaluation study and a positive correlation between search engine optimization and Website usability could be demonstrated.

1 INTRODUCTION

Today, the Internet is the most important medium for consumers all over the world. Index measures of 44% for UK, 45% for Germany and 46% for France show that it is now twice as important as TV (McRoberts and Terhanian, 2008). Besides its importance as a research tool, communication and entertainment platform, it is a fact that approximately 97% of the internet users (Kaspring, 2011) consult the Web as their main information source when making purchasing decisions ("search before the purchase"). To benefit from the Internet as a company, the aim should be pursued to lead as many visitors as possible to one's own web offerings. Furthermore, the optimization of the website usability with the aim of conforming to user expectations all over the world (Auinger et al., 2011), it is equally important to achieve a top position in search engine results. End-users should be able to use a website; however, before they can use it, they must find it, even by using a standard search engine (e.g. Google).

In the literature, a number of policies and measures can be found, which have to be taken into consideration when designing a useable and search engine-friendly website (Nielsen, 1993, Nielsen and Loranger, 2006; Leavitt and Shneiderman, 2006 etc.), (Hearst, 2009), (Baeza-Yates et al., 2011). Different aspects must be considered with mobile search (Bloice et al., 2010).

SEO is of high relevance, especially for E-Business, because more than 60% of search engine users click only on the results that appear on the first search engine results page (SERP) and less than 10% of users click on results that appear after the third page (Malaga, 2008).

If "ease of use" is a primary goal of Web usability, then "findability" is the most critical concept, because both accessibility and usability depend upon findability (White, 2003).

For this reason, this paper will address search engine optimization as well as web usability. The aim is to analyze to what extent proven SEO-measures reconcile with established usability-guidelines. To be more precise, this paper analyzes to what extent applied SEO-recommendations affect website usability.

To meet this objective, the paper first outlines the topic of usability and the implementation of usability guidelines within the DIN EN ISO 9241-

110 standard. Hence, the understanding of usability in the course of this paper is focused on the fulfillment of those guidelines. Furthermore, not only recommendations found in ISO Standard 9241-110 but also relevant literature and recommended guidelines of acknowledged usability-experts were taken into consideration.

Secondly, the topic of search engine optimization is dealt with, and on-site measures and factors that are crucial for a top ranking in search engine results lists are analyzed. In a next step, the SEO-measures are examined with regard to their impact on website usability. A theory-based comparison of usability recommendations and SEO-measures is then conducted. To further refine results and validate findings, a usability evaluations study is part of the present paper. Hence, the defined objective is approached based on theory found in literature as well as based on the results of the conducted usability evaluation study.

2 WEB USABILITY AND ITS IMPLEMENTATION

A generally applicable definition of usability can be found in ISO Standard 9241 (ISO 9241:2006: Ergonomics of human-system interaction, 2006).

ISO Standard 9241-110 sets seven dialog principles for human-system interaction (ISO 9241-110:2006: Dialogue principles, 2006):

- suitability for the task
- self-descriptiveness
- conformity with user expectations
- suitability for learning
- controllability
- error tolerance
- suitability for individualisation

In addition to those seven principles the ISO 9241-110 provides over 50 recommendations for implementing usability.

In the course of the present study, those seven principles were taken as a reference framework to point out principles for designing a useable system. Therefore, the recommendations in ISO Standard 9241-110 were enriched by suggestions and guidelines of prestigious usability experts. This section outlines how the particular dialog principles can be implemented in practice. Because these recommendations will be used later on in this paper they are provided with shorthand symbols, apposite to the particular dialog principle.

2.1 Implementing Suitability for the Task (T)

A website is suitable for a certain task if it supports users getting a particular task done. That means that functionality and design of dialog are based on the characteristic attributes of the task, rather than on those of the applied technology. (ISO 9241-110:2006: Dialogue principles, 2006).

To implement the suitability for the task, certain recommendations can be found in the relevant literature (e.g.(Gould, 1991), (Diaper, 2002), (Holzinger, 2005)).

Cross-platform Design (T1): To ensure that a website is suitable for a certain task, designers on the one hand have to consider that the right information is provided. On the other hand, they also have to deal with limitations and constraints due to different hardware and software employed by the users (Leavitt and Shneiderman, 2006).

Hence, it is necessary to consider different web browsers, operating systems, screen resolutions and hardware (Nielsen and Loranger, 2006).

Separation of Content and Design (T2): To make sure that a website is accessible for a wide public, it is essential to stick to certain web standards. Separating content and structure (HTML) from design (CSS) provides the basis for that (Bornemann-Jeske, 2005) and allows a higher flexibility, e.g. when a website is viewed on multiple output devices, which has positive effects on the accessibility (Krug, 2006).

Visual Clearness (T3): To ensure that a website is easy to understand and suitable for a certain task, it is necessary to follow a consistently defined structure. "Visual clearness" states that each website should be clear in presentation, correctly aligned, should not convey an impression of being overloaded and its components should be easy to comprehend (Stickel, Ebner & Holzinger, 2010).

Content and Page Structure (T4): To support users in finding relevant information in a timely manner, important information should be placed at the top of a webpage. Thereby scanning and comprehending content is considerably facilitated (Herendy, 2009) . During scrolling, headings should be constantly visible or at least repeated (Leavitt and Shneiderman, 2006).

Writing for the Web (T5): Information in text format should be presented clear and simply and should comply with three rules: text on the web should be scanable, short, precise and objective (Morkes and Nielsen, 1997). Hence, meaningful headings, highlighted keywords and lists and

enumerations should be used while excessive adjectives and buzzwords should be avoided.

Typography & Colour Scheme (T6): The legibility of a website is a crucial factor of success (Nielsen, 2000). Therefore, standard fonts and an adequate and adjustable font size should be provided, whereas animated text and text in capital letters only should be reduced or avoided entirely.

Scrolling and Paging (T7): There is no general rule on whether scrolling or paging is more convenient for presenting information on a website. However, studies showed that especially elderly or inexperienced people are significantly slowed down by scrolling and would prefer paging. Nevertheless, when it is a matter of reading comprehension, information on a single page is perceived more related (Leavitt and Shneiderman, 2006)

Pop-ups (T8): Information that is not needed in order to complete a certain task should not be displayed (ISO 9241-110:2006: Dialogue principles, 2006).

Pictures and Graphics (T9): To keep loading times low, image files should not be too large. When high-resolution images are available, thumbnails should be provided (Leavitt and Shneiderman, 2006). Text in pictorial form should be avoided and each image should be provided with alternative text to support screen readers and improve accessibility (Nielsen and Loranger, 2006; Krug, 2006)

Animation and Flash (T10): Animated website elements are likely to distract and annoy users and often cause usability problems (e.g. with bookmarking or by deactivating the back button). Hence, they should only be used when conveying information can be countenanced, e.g. for presenting motion sequences (Manhartsberger and Musil, 2001). Especially Flash-animations often cause usability and accessibility problems (Nielsen and Loranger 2006; Broschart, 2010).

Multimedia Content (T11): Multimedia content should be used with caution and only when added value is created and interacting with the website is facilitated (Nielsen and Loranger, 2006). Furthermore, alternative text or subtitles should be provided for disabled users (Lynch and Horton, 2008).

Frames (T12): Frames are used to separate navigation from content. Thus navigation has a fixed position on a website while at the same time content can be scrolled. Nevertheless, frames also implicate a lot of disadvantages, e.g. when setting bookmarks or printing websites (Manhartsberger and Musil, 2001). Therefore, frames are only used within limits (Broschart, 2010).

Design of Forms (T13): Forms should be kept as simple and lean as possible. The less data a user has to put in, the higher the probability that he will fill out the entire form. On account of this redundant inputs, such as zip code plus federal stat, should not be requested (Fischer, 2009). The acceptance of forms can also be increased by providing selectable default values which are recommended to facilitate the input of data (Manhartsberger and Musil, 2001).

2.2 Implementing Conformity with User Expectations (E)

A website should always be designed to meet user expectations. Every action a user conducts is associated with certain expected results. If a website does not consistently deliver the same expected results it can easily lead to a confused user. The following recommendations explain how to meet user expectations (Manhartsberger and Musil, 2001).

Consistency and Conventions (E1): If a website is designed in a consistent way, this will also increase the predictability when interacting with it. Users know which functionality to expect where and how to get to a desired result. Therefore, it is important that design elements have a fixed position and a consistent terminology is used. (Nielsen and Loranger, 2006; Leavitt and Shneiderman, 2006)

User-oriented Information Architecture (E2): A user visits a website to get a certain matter done as quickly and simply as possible. This matter could e.g. be to gather information about or to purchase a desired product. The website operator on the other hand wants to present himself and advertise and sell his products. As a result of those two positions websites are often designed following the website operator's needs rather than those of the customers (Nielsen and Loranger, 2006). Measures to avoid a situation like this include; keeping navigation as simple and as expectation-conform as possible and putting similar elements side by side (Fischer, 2009).

Expectation-conformal Positioning and Presentation of Important Website Elements (E3): Despite the necessity of an individual website structure there are certain web-standards and generally applicable conventions. Standards and conventions facilitate the human-system interaction by using established elements (Krug, 2006). This includes a fixed, expectation-conform position and design for navigation elements, the search function and the corporate logo.

Presentation of Hyperlinks (E4): A hyperlink should always work as the user expects it to: when the link is clicked, the desired result is delivered.

Hence, expectation-conformity of hyperlinks is very important (Fischer, 2009). Hyperlinks should therefore be underlined, blue if they have not been clicked yet and violet if they have been clicked (Cappel and Huang, 2007; Nielsen, 2000).

Use of Interactive Controls (E5): To enable human-system interaction different control elements are used: mainly hyperlinks, radio-buttons, checkboxes, pull-down menus and input fields (Manhartsberger and Musil, 2001). Although those controls are widely known it is important to make sure they work in the expected and conventional manner (Lynch and Horton, 2008).

Feedback and Status Display (E6): Every website should deliver direct and expectation-conforming results and feedback to user actions. If a direct result cannot be delivered the user should be informed about the delay and when the result can be expected (ISO 9241-110:2006: Dialogue principles, 2006). For instance, when the download of a large file is requested, a status display should inform the user about the remaining download time (Nielsen and Loranger, 2006). Another example would be a progress bar during the process of buying products in a web shop (Erlhofer, 2011).

2.3 Implementing Self-Descriptiveness (SD)

According to Krug's first law of usability "Don't make me think!" a website should be self-descriptive. Users should be able to realize what a website is about without long-winded thinking (Krug, 2006).

Clear Navigation (SD1): Navigation allows users to move between the different pages and parts of a website. To make navigation structure as clear and self-descriptive as possible, it should always answer the following question: where is the user right now, where has he been before and where can he go from here (Nielsen, 2000).

Page Titles and Bookmarks (SD2): The title of a webpage is displayed on the upper left of a web browser. Although this area is not in direct user focus, a page title is important for search engines, reference purposes and for setting bookmarks (Leavitt and Shneiderman, 2006; Nielsen and Tahir, 2002). With standard Websites setting bookmarks is simple but can become a problem area when technologies, such as AJAX are used. AJAX facilitates designing interactive and optically appealing websites (Holzinger et al., 2010). Regarding bookmarks AJAX makes it problematic to bookmark particular content because the URL

does not change (Carl, 2006).

Meaningful Headings (SD3): Meaningful headings are of great significance for making content scannable, supporting user orientation and for structuring. Headings should always be provided with appropriate HTML-tags and should be defined distinctive and clear (Leavitt and Shneiderman, 2006; Nielsen, 2000).

Navigation Wording (SD4): Every navigation element should have a distinctive, clear and meaningful description (Nielsen and Loranger, 2006). Hyperlinks should give an indication of where they lead, the language used should be adapted to the users' language, unknown abbreviations and wordings should be avoided (Lynch and Horton, 2008; Fischer, 2009; Nielsen and Loranger, 2006).

Self-explanatory Icons and Symbols (SD5): Icons and symbols should be self-descriptive, but only a few – e.g. the printer or the magnifier icon - really are. According to Fischer icons usually show objects but trigger a process. Hence, users can easily get confused and icons should only be used if they are widely known and can easily and doubtlessly be interpreted (Fischer, 2009).

Labelling of Input Fields (SD6): A logical arrangement as well as a clear and distinctive description of input fields should be used and information on how to fill out a form should be provided (Nielsen and Loranger, 2006; Manhartsberger and Musil, 2001).

2.4 Implementing Suitability for Learning (L)

A system or a website is suitable for learning if users receive support and instructions when needed. Suitability for learning contradicts other dialog principles because a self-descriptive, expectation-conformal, error-tolerant, controllable and customisable website should not need to be learnt (Arndt, 2006). Nevertheless, a website which is too complex and cannot be understood instantly by the user will lead users to leave if there is no form of support whatsoever (Nielsen and Loranger, 2006).

Help (L1): The need for a help function depends on the users' experience and the complexity of a website. If complicated and non-standard functionalities are used, it is advisable to provide a separate help area (Broschart, 2010).

Guided Tour (L2): A guided tour makes sense when a website offers revolutionary or unknown features. In that case, it can help users to understand the way the website works (Jacobsen, 2005).

Frequently Asked Questions (L3): Frequently asked questions (FAQs) must not be confused with the help function: FAQs are meant to list the most common user questions and the answers to them. Furthermore, FAQs are usually used for product or company related rather than for usability questions (Manhartsberger and Musil, 2001).

Sitemap (L4): A sitemap allows the user to obtain a quick and simple overview of a website and provides orientation aid. It is usually presented in a tree structure and consists of logically arranged groups of hyperlinks (Balzert and Klug and Pampach, 2009).

2.5 Implementing Controllability (C)

A dialog is controllable when users are able to start it and to influence its direction and speed until a desired result is reached (ISO 9241-110:2006: Dialogue principles, 2006).

Process Control Navigation (C1): Clearly structured and easy to use navigation is a key element to navigation through multi-step processes, such as the order process one can find in web shops: users should be able to realize in which part or step of the process they are at the moment, how many process steps there are in total and they should have the possibility to switch between the different steps (Broschart, 2010).

Supporting Keyboard-operated Input (C2): Many internet users are not equipped with a mouse, because they are using devices, such as mobile phones or speech commanded input devices. Hence, all website elements should also be controllable via a keyboard (Lynch and Horton, 2008).

Deactivating the Back Button and Opening New Browser Windows (C3): According to Nielsen and Loranger, deactivated back buttons, and opening new browser windows without notification, rank among the biggest usability mistakes and should be avoided entirely (Nielsen and Loranger, 2006). Especially AJAX causes problems with back buttons (Carl, 2006).

Controlling Multimedia Elements (C4): Users should always know what to expect, so that they do not have to invest redundant time in playing or downloading multimedia files. A summary of its content could precede a video file and the indication of a file's size and the estimated download file could help users to decide whether to download it or not (Nielsen, 2001; Lynch and Horton, 2008).

Designing Printer-friendly Pages (C5): Information often needs to be printed to share it offline e.g. in a company. Hence, each page should be printable. The print version should contain the total content in one file und should be formatted in a printer friendly way (Fischer, 2009; Nielsen, 2001).

2.6 Implementing Error Tolerance (ET)

A website can be regarded as error tolerant if a desired result can be obtained despite incorrect input. Hence, errors have to be detected early and support for error correction has to be provided (ISO 9241-110:2006: Dialogue principles, 2006).

Error Prevention (ET1): Most errors occur due to incorrect or incomplete input to forms, which is often caused by insufficient labelling of mandatory fields or by unclear description of the input format. Thus, input fields should be accurately described, the maximum number of characters stated and non-permitted characters indicated (Fischer, 2009).

Error Detection and Correction (ET2): A usable website should provide immediate feedback when incorrect input was made. Hence, a website should not only detect but also give an indication of how to correct errors. Error messages should easily be identifiable as such, clearly assignable to a particular input field and should provide short and meaningful feedback on how to correct any errors made (Fischer, 2009; Manhartsberger and Musil, 2001; Lynch and Horton, 2008). Technologies, such as JavaScript or AJAX support validating input during the input process itself, respectively directly after the input is confirmed (Broschart, 2010). One big disadvantage of validating input with AJAX or JavaScript is the fact that JavaScript has to be activated in the users browser, therefore server-sided validation should not be omitted (Wenz, 2007).

2.7 Implementing Suitability for Individualisation (I)

A website is suitable for individualisation when users can adapt interaction, presentation and content to their specific needs (Arndt, 2006).

Personalising a Website (I1): Personalising a website means that individual, user-specific content is provided. There are different ways of how a website can be personalised: e.g. customizable layout, individually selectable content or scalable font size (Broschart, 2010; Balzert and Klug and Pampuch, 2009).

3 ON-SITE SEARCH ENGINE OPTIMIZATION

Search engine optimization (SEO) describes the process of "how to" and methods used to improve a website's rank in organic search results (Lammenett, 2010), (Chen et al., 2011). When talking about SEO, one has to distinguish between on-site and off-site optimization. On-site optimization encompasses all methods which can be implemented on the website itself, e.g. content, source-code or keyword optimization (Erlhofer, 2011; Bischopinck and Ceyp, 2009). Off-site optimization on the other hand involves methods which are implanted on third party websites, e.g. external linking (Lammenett, 2010).

Since the aim of the present study was to analyze the influence of implemented SEO-methods on website usability, off-site methods will not be relevant for this paper. Hence, the following sections deal with on-site SEO methods only.

3.1 Accessibility for Search Engines

Website accessibility describes the fact that a website can be accessed independent of physical user attributes or of hardware used. Furthermore, an accessible website can be analysed and processed by search engines without any problems (Erlhofer, 2011).

Using Appropriate File Formats: In order that websites can be listed in search engine results, they have to be indexable. More precisely, the website content has to be searchable, analysable and rateable according to its relevance. Hence, only search engine friendly file formats should be used. Besides HTML-documents; text files, PDF-Files, MS-Office files and structured XML-formats, such as RSS can be indexed easily (Bischopinck and Ceyp, 2009; Broschart, 2010; Erlhofer, 2011). Nevertheless, HTML is the best choice for relevant content, because it is most appropriate for being processed and analysed by search engines (Bischopinck and Ceyp, 2009).

Valid HTML-Code and Use of CSS: Correct use of HTML and CSS is a key factor for successful SEO. Hence, syntax errors have to be avoided entirely (Erlhofer, 2011).

Potential Problem Areas: Web designers often want to create an extraordinary website and leave search engine relevant technical aspects aside (Broschart, 2010). Especially the use of dynamic content, frames, Flash, JavaScript or AJAX is frequently at the costs of usability.

Robots.txt: The robots.txt-file can influence websites indexation behaviour. This file is located in the root directory of the webserver and is requested before crawling (Erlhofer, 2011). In this file, one can define which directories and files may be accessible for crawlers and which are hidden (Bischopinck and Ceyp, 2009).

3.2 Navigation and Page Structure

A logically structured navigation and page construction enables users to navigate through a website intuitively. Furthermore, it is also of great significance when the site is processed by search engines (Erlhofer, 2011).

Overall Structure and Directory Depth: The deeper a file is located in the file directory the more irrelevant it is interpreted by search engines (Erlhofer, 2011). Also the number of clicks it takes to access a file is important for search engines (Broschart, 2010). Hence, important files should be placed high in file directory and should easily be accessible for users.

Meaningful Directory and File Names: Search engines also analyse the URL when processing a document. Therefore, file directory and file names should be specified carefully and relevant keywords ought to be used (Alby and Karzauninkat, 2007).

Internal Link Structure: As mentioned before, the number of clicks it takes to access a file is important for search engines. Relevant content should hence be placed as close to the homepage as possible and direct links to access those files should be provided (Broschart, 2010). Sitemaps and other subscript lists offer further starting points for search engines (Erlhofer, 2011).

3.3 Search Engine Relevant Entries in Website Headers

An HTML-document consists of a header and a body: the header contains the document title and additional information, the so called meta-information. Meta-tags are not visible for users but are relevant for search engines (Fischer, 2009).

Page Title: The page-title is one of the most important ranking criteria for search engines. Hence, it should represent the documents content as accurately as possible (Broschart, 2010).

Meta Tags: In the past, meta-tags were often used to analyse and rank websites. Due to the misuse of meta-tags to manipulate search results, a number of search engines either minimized the impact of meta-tags on their ranking system or do not consider

them at all (Erlhofer, 2011).

3.4 Text Optimization

Search engines operate text based and still have problems dealing with images, pictures and Flash. Hence, text optimization plays a key role for SEO (Lammenett, 2010).

Keyword-oriented Writing: Keyword-oriented text design is very important for search engine oriented writing. Therefore, the keywords which were defined during keyword research have to be integrated in the webpages' content to enable a simple indexation of content (Erlhofer, 2011). There are three factors influencing search engine ranking: keyword density, keyword prominence and keyword proximity.

Amount of Text: The optimal amount of text can only be defined with due regard to usability (Broschart, 2010).

Headings and Mark-up: Headings should be defined using HTML-tags and should be simple and clear. Furthermore, they are relevant for search engines, lists and mark-up text and should therefore be used purposefully (Erlhofer, 2011).

Alt-attribute: Due to the fact that search engines are not yet able to interpret images and graphics reliably and that disabled users often have problems with them, providing alternative text is of great significance (Broschart, 2010; Bischopinck and Ceyp, 2009).

Content is King: According to IAB Switzerland, unique and high-quality content is the most important ranking criteria for search engines. Hence, providing topic-relevant content of high-quality is a key factor for SEO (IAB Switzerland, 2010).

4 SEO-METHODS AND THEIR EFFECT ON USABILITY

SEO-methods are influencing website usability and vice versa. The following tables sum up in detail, which SEO-methods have which effect on the usability criteria mentioned. Therefore, the SEO-methods presented in section three are assigned to the web usability guidelines and its effects described in section two. Positive effects are marked with "(+)" and negative with "(-)" .

Table 1: Accessibility for search engines and its effects on usability.

SEO-methods	Effects on usability
Appropriate file formats: primarily HTML-files, PDF, .txt, .rtf or MS-Office documents	(+) supports accessibility (T2) (+) makes content accessible for screen readers (T2)
Valid HTML-Code and use of CSS: Semantic characterization of content	(+) supports accessibility (T2) (+) facilitates access for screen readers (T2),(T5) (+) smaller HTML-files → reduction of loading time (T2) (+) Enables individual design for different output devices (T2),(C5)
Potential problem areas: Dynamic contents, frames, Flash, JavaScript and AJAX	(+) AJAX makes interactive websites possible (SD2) (+) JavaScript and AJAX supports validating inputs during input process (ET2) (-) Frames, Flash and AJAX are potentially problematic for bookmarking (T10), (T12), (C2) (-) Frames can cause printing problems (T12) (-) Flash and AJAX deactivate the browsers back-button (T10), (C3) (-) Flash-animation is not accessible for screen readers (T10) (-) Inappropriate Flash-animation distracts and disrupts users (T10) (-) Long Flash-intros take bandwidth and annoy users (T10) (-) Without having JavaScript activated in the browser, JavaScript and AJAX-applications cannot be run (ET2)
Robots.txt	No effects on usability

Table 2: optimal navigation and page structure and its effects on usability.

SEO-methods	Effects on usability
Overall structure and directory depth: Logical navigation and page-structure, flat link and directory structure	(+) supports visual clearness and site control (T3),(C1) (+) facilitates search for information (T4)
Directory and file names: Meaningful terms and relevant keywords	(+) directory and file names are part of the URL (SD1),(SD4) (+) An URL with a descriptive name is more professional an trustworthier (SD1),(SD4)
Internal link structure: Flat link structure, descriptive link titles, sitemap and subscript lists as starting points	(+) a flat link structure supports efficient working (T4) (+) meaningful link titles support predicting its content (SD4) (+) sitemaps provide a table of contents an support capturing a websites structure (L4)

Table 3: Search engine relevant entries in website headers and its effects on usability.

SEO-methods	Effects on usability
Descriptive page title: individuality and context relevance	(+) supports finding and distinction between websites in browser history, favourites and bookmarks (SD2)
Meta-tags	No effects on usability

Table 4: Text optimization and its effects on usability.

SEO-methods	Effects on usability
Keyword-oriented writing: Consideration of keyword density, prominence and proximity	(+) Using keyword supports scanning and helps identifying relevant information (T5) (+) too high density influences text readability and understand-ability, text may appear ex-aggerated and unprofessional (T5)
Optimal amount of text: dependent on context, from a half up to two pages	(+) short and precise text without redundant information is preferred by users (T5) (+) short pages avoid scrolling, longer pages facilitate fast and continuous reading (T4),(T5),(T7)
Using headings and mark-up Apply suitable HTML-tags	(+) improves website scannability (T5) (+) provides orientation marks (T5) (+) supports accessibility (T5) (+) facilitates access for screen readers (T5)
Using the ALT-attribute Providing alternative text for images	(+) Offers text alternative for disabled people (screen reader) and users of text-browsers (T9) (+) Supports accessibility (T9)
Content is king	(-) duplicate content appears unprofessional (T5) (+) unique and high-quality content generates additional value for users and increases trust (T5)

Collectively, it can be concluded that SEO-methods also lead to improved website usability and that these two areas are closely connected. Furthermore, the following statements can be made:

- Search engine optimized websites are more accessible because they facilitate using a website for visually handicapped people
- Search engine oriented text improves website usability by increasing scannability and readability
- SEO-methods primarily meet the requirements of the ISO 9241-110 dialog principle "suitability for the task"
- Except for meta-tags and the robots.txt-file, all quoted SEO-methods have effects on usability
- Potential SEO-problems also have negative effects on usability
- Decisive contradictions between SEO-

methods and usability could not be found

5 USABILITY EVALUATION OF SEO OPTIMIZED WEBSITES

To further analyse the effects of SEO-methods on website usability, a scenario-based usability evaluation study was conducted. The goal of this study was to determine if, and to what extent, SEO influences effectiveness and efficiency of task accomplishment and user satisfaction. In the following sections, study design and results will be presented.

5.1 Study Design

The usability evaluation study includes an eye tracking analysis with additional questionnaires to qualitative refine the results. The study followed a determined design, which will be described in sections 5.1.1 to 5.1.4.

5.1.1 Test Object

The usability evaluation study was conducted in cooperation with BMD Systemhaus GmbH, a local software house in Steyr that made their website available as a test object. The target audience of this website is professionally qualified but has only little interest in technological issues.

5.1.2 Test Subjects

To ensure that the selected test subjects correspond to the website's target audience, test users were selected from students of topically matching study courses. In total, 22 students of different ages and experience levels (fulltime and extra-occupational) participated in the study.

5.1.3 Test Scenarios

Four different scenarios were designed to conduct the usability evaluation study. For each scenario, two versions of one webpage were used: one version was optimized according to SEO requirements (on-site optimization) while the other one was left entirely unchanged and was equivalent to the publically accessible version of the website, as shown on the screenshot below:
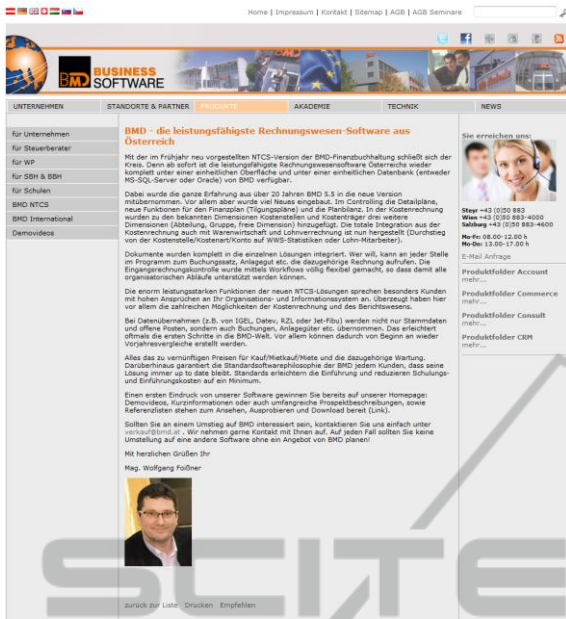
Figure 1: Unchanged version of a test page.

The optimized versions of the webpages were changed with regards to the following SEO-criteria:

- Focus on defined keywords: three terms max. per document, consider context relevance, keyword density and keyword prominence, use synonyms.
- Use meaningful page-titles (title-tags)
- Structure content by using headings, lists and mark-ups
- Write according to the inverted pyramid style
- Use internal links
- Define meaningful alternative text (alt-attr.)

The screenshot below shows the optimized version:

Figure 2: Optimized version of a test page.

Thus, the current usability evaluation study focussed on content and text optimization, page structure and navigation were negligible.

To make it possible to contrast them, the two versions were shown to different subject groups: the unchanged versions were presented to group A and the optimized ones to group B.

In each scenario, test subjects were given the task of informing themselves about a certain topic or keyword. For this task, the unchanged page version was shown to group A and the optimized one to group B, each was displayed for a defined timespan:

In scenario one ("One2Meet") the test pages were shown for 30 seconds while in scenarios two ("Controlling Software"), three ("Financial Accounting") and four ("Costing Software") they were shown for 60 seconds. Those timespans were not chosen randomly but correspond to the pages' actual visitor retention time from Google Analytics which indicates how long users stay on the webpage on average.

5.1.4 Test Procedure

As mentioned before, the conducted usability evaluation study consisted of four scenarios, whereby in each scenario different tasks had to be solved. Before solving the respective tasks, users got a brief introduction to the page and were prompted to inform themselves about the given topic.

When users were ready, the page was shown for the defined timespan, during which eye movement was recorded by using an eye tracking system.

After each task, users were given a scenario-specific questionnaire containing questions about the content and the topic of the page. Furthermore, users had to evaluate the fulfilment of the characteristics of presented information as found in ISO 9241-12 (ISO 9241-12:1998: Presentation of information, 1998):

- Clarity
- Discriminability
- Conciseness
- Consistency
- Detectability
- Legibility
- Comprehensibility

After completing the eye tracking for each of the four different scenarios, another questionnaire containing seven general questions was handed out. This questionnaire had to be answered considering all four scenarios at once.

5.2 Study Results

In the following three sections, the results of the usability evaluation study will be presented: First, evaluation of scenarios-specific questionnaires allows drawing conclusion as to the efficiency of task accomplishment and perceived quality of information presentation. Second, eye tracking analysis results are presented, followed by an evaluation of the general questionnaires handed out after all four scenarios were completed.

5.2.1 Evaluation of Scenario-Specific Questionnaires

The evaluation of scenario-specific questionnaires clearly shows that group A, who was given the unchanged page versions, had far more difficulty answering the questionnaire than group B, who was given the optimized version. When being asked comprehension questions, for example: to describe page content and summarize content-related topics, group B performed noticeably better than group A.

The following charts illustrate those findings based on the results from scenario one "One2Meet":
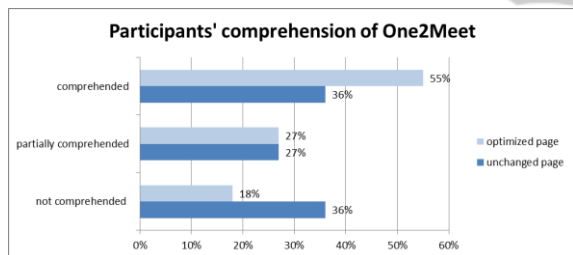

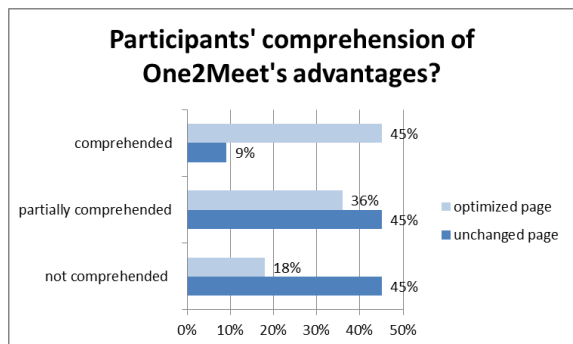Figure 3: Comprehension of One2Meet (1).

Figure 4: Comprehension of One2Meet (2).

In addition to comprehension questions, enumeration questions were part of the scenario-specific questionnaire. These questions were asked in order to analyse how many specific content-related details users were able to remember,

depending on which version (unchanged and optimized) they were shown. Therefore, the questionnaire particularly asked for specifics, such as fields of application, planning levels of the particular tool, single functionalities, tool areas, new improvements or development details. For this purpose, a mixture of open questions and multiple choice questions was applied, as the following table shows:

Table 5: composition of enumeration questions applied.

Question	Choices	Correct answers
Scenario 1, question 3	10	6
Scenario 2, question 1	open question	3
Scenario 2, question 2	8	4
Scenario 3, question 1	9	6
Scenario 3, question 2	open question	4
Scenario 3, question 3	open question	1
Scenario 4, question 1	open question	4
Scenario 4, question 2	open question	5

When multiple choice questions were asked, test subjects were given the number of right answers, which was at the same time the maximum number of choices allowed. Open questions had to be answered without any answers to choose from.

The following charts visualize the differences in results between subject group A (unchanged page version) and subject group B (optimized page version):
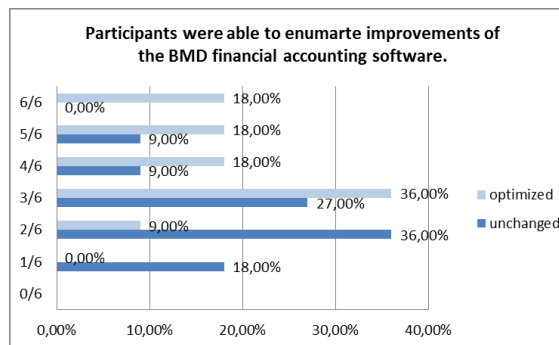

Figure 5: Participants' enumeration of specific points in scenario 3, question 1, refer to table 5.

As figure 5 clearly shows, subject group B, who was shown the SEO-optimized page version, performed considerably better in terms of remembering specific points than subject group A. This could also be

found in all the other scenarios.

In total, the average percentage of correct answers in subject group A was about 42%, while in subject group B 69% of all answers were correct:
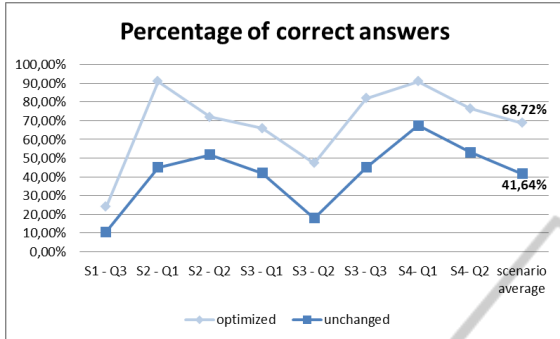

Figure 6: comparison of percentage of correct answers.

As shown in the previous evaluations, pages that are optimized according to SEO-measures are clearly more likely to convey information than unimproved pages. To further refine and confirm this finding test, subjects were asked to evaluate the attainment of the characteristics of presented information as defined in ISO 9241-12 (ISO 9241-12:1998: Presentation of information, 1998). The evaluation was based on the grading system used in Austrian schools (1 = very good, 2 = good; 3 = satisfying, 4 = sufficient, 5 = insufficient). The following chart (figure 7) summarizes the scenario-specific results and compares optimized and unchanged page versions:
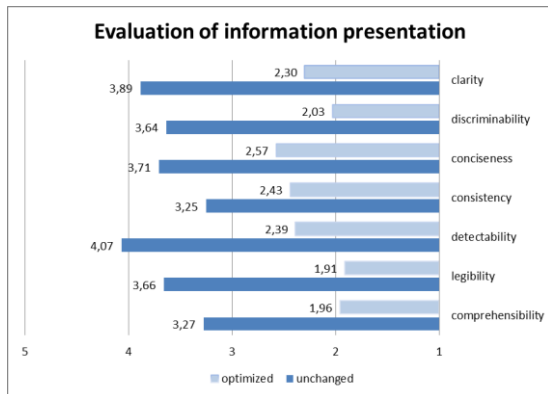

Figure 7: Evaluation of information presentation.

As figure 7 clearly shows, optimized pages were significantly better marked (average mark: 2,2) than unchanged, original page versions (average mark: 3,6).

Hence, optimized website are not only more adequate to convey information, but are also

perceived as considerably better in terms of information presentation.

5.2.2 Eye Tracking Analysis Results

The eye tracking analysis was an important part of the conducted usability evaluation study and allowed drawing inferences from recorded saccades and fixations about user behaviour. Thus, it was possible to analyse which parts of a webpage were looked at for how long, which, in turn, gave indication of the way the presented content was perceived.

The following comparison of heat-maps from an optimized and an unchanged page clearly shows why optimized pages are better in terms of conveying information and information presentation:

Figure 8: Heat-map comparison of an unchanged (left) and optimized (right) page.

Figure 8 visualizes that the test subjects' focus when looking at the unchanged page is limited to the upper third. That means that more than half of the page was not part of the user focus and the possibility of information placed there being conveyed was low. The heat-map of the optimized page on the other hand had a much broader focus area: especially lists and headings were focussed. Hence, content was much more likely to be conveyed.

Eye movement analyses also showed why optimized pages are more likely to convey content than unoptimized ones. To visualize this, the first ten seconds of eye movement of the test subjects from group A and B - each of scenario one - are compared. The following figure clearly shows that it was pretty hard for subject group A to identify relevant page areas in the early seconds:
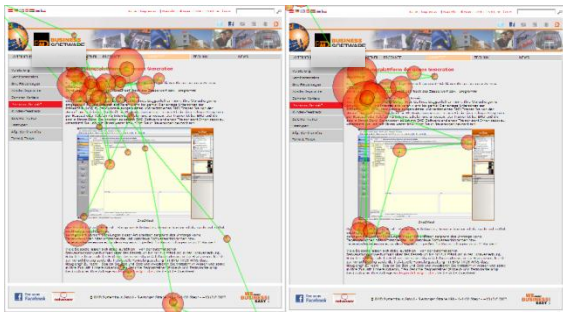
Figure 9: Eye movement on unchanged page (group A).

Subject group B on the other hand had a much narrower focus and was able to identify relevant content right from the start:
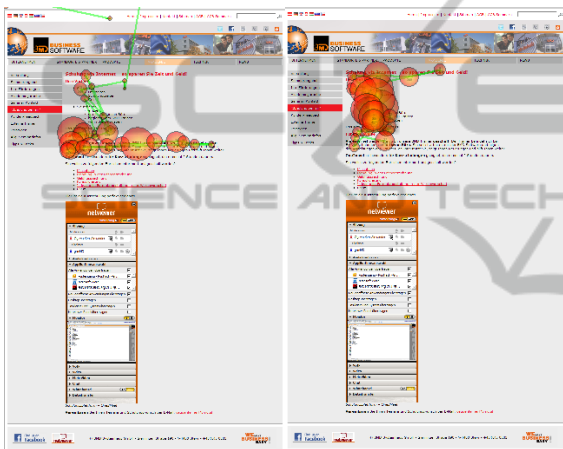

Figure 10: Eye movement on optimized page (group B).

Summarizing, eye tracking results confirm the findings of the scenario-specific questionnaire and clearly show that SEO-methods positively influence websites in terms of information conveyance and presentation.

5.2.3 Evaluation of General Questionnaires

As previously mentioned, in addition to the scenario-specific questionnaire, a questionnaire containing general questions was handed out after the subject groups had completed the four scenarios. Test subjects had to evaluate the following seven questions based on a seven-level grading system, whereby 1 stood for very easy respectively very satisfied and 7 stood for not easy at all respectively not satisfied at all:

- How clear was the site presentation?
- How difficult was it to focus on information research?
- How easy was it to work with the text?

- How fast could you finish your task?
- How would you describe page handling?
- How satisfied were you in terms of text quality?
- How easy was it to find information?

The following chart visualizes the results of this questionnaire and compares optimized and unchanged page versions:
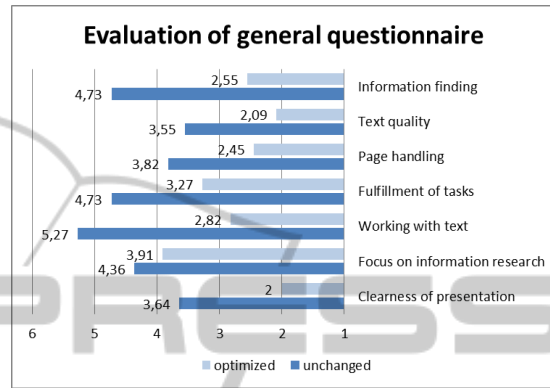

Figure 11: Evaluation of general questionnaire results.

Hence, not only the applied scenario-specific questionnaires, but also the general questionnaire clearly shows that optimized pages are perceived as more usable in terms of information finding, page handling, text quality, clearness of presentation and pleasantness of working with them.

6 CONCLUSIONS

Usability and Findability are two key factors for every website and can make the difference between success and failure. Hence, not only usability measures but also SEO-methods should be applied to improve a website's overall performance.

In the course of this study, a range of theory-based usability requirements and recommendations as well as SEO-standards and methods were introduced in a first step. In a second step, SEO-methods, presented in section three, were assigned to the web usability guidelines and its effects described in section two. Thereby, it could be ascertained that these two areas are closely connected, and SEO-methods positively influence website usability.

By conducting a theory-driven usability evaluation study the effects of SEO-methods on website usability could be further analysed.
Hence, the main findings of this paper are:

- SEO-methods positively influence website usability and potential SEO-problems also

have negative effects on usability.

- Decisive contradictions between SEO-methods and usability could not be found.
- The usability evaluation study conducted clearly showed that SEO-methods improve effectiveness and efficiency of task accomplishment.
- Websites optimized according to SEO-methods are perceived as more usable in terms of information presentation, information conveyance and user satisfaction.

In conclusion, the theory-based findings could be confirmed by the results of the usability evaluation study conducted and a positive correlation between search engine optimization and website usability could be found.

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