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A Comparative Eye Tracking Study of Usability—Towards Sustainable Web Design

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Abstract: Websites are one of the most frequently used communication environments, and creating sustainable web designs should be an objective for all companies. Ensuring high usability is proving to be one of the main contributors to sustainable web design, reducing usage time, eliminating frustration and increasing satisfaction and retention. The present paper studies the usability of different website landing pages, seeking to identify the elements, structures and designs that increase usability. The study analyzed the behavior of 22 participants during their interaction with five different landing pages while they performed three tasks on the webpage and freely viewed each page for one minute. The stimuli were represented by five different banking websites, each of them presenting the task content in a different mode (text, image, symbol, graph, etc.); the data obtained from the eye tracker (fixations location, order and duration, saccades, revisits of the same element, etc.), together with the data from the applied survey lead to interesting conclusions: the top, center and right sides of the webpage attract the most attention; the use of pictures depicting persons increase visibility; the scanpaths follow a vertical and horizontal direction; numerical data should be presented through graphs or tables. Even if a user's past experience influences their experience on a website, we show that the design of the webpage itself has a greater influence on webpage usability.

Keywords: sustainable web design; web usability; neuromarketing; eye tracking; scanpaths; ANOVA technique



Citation: Țichindelean, M.; Țichindelean, M.T.; Cetină, I.; Orzan, G. A Comparative Eye Tracking Study of Usability—Towards Sustainable Web Design. *Sustainability* **2021**, *13*, 10415. <https://doi.org/10.3390/su131810415>

Academic Editors:
Juan Sánchez-Fernández,
Luis-Alberto Casado-Aranda and
Iris Vermeir

Received: 27 June 2021
Accepted: 13 September 2021
Published: 18 September 2021

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1. Introduction

During a time when a great part of our activity takes place online, ensuring the quality of user-interface interaction becomes vital for keeping consumers satisfied. It has been shown that consumers often become loyal to certain brands, not only because of the intrinsic qualities of their product or service but also thanks to the unique and pleasant interaction and communication choices that the company makes. Secondly, when designing a website, its impact on the consumer should not be the only concern; but consideration should also be given to its impact on the environment.

As high usability will ensure high consumer satisfaction and low environmental impact, the present study analyzes five different landing pages, seeking to identify the elements, formats, and structures of information that increase the usability of the landing page of a website. While the first part of the paper presents a detailed literature review about sustainable web design and neuromarketing, the second part aims at obtaining relevant results about the way information should be structured on a webpage by combining traditional research methods such as survey (questionnaire) with neuromarketing (eye tracking). This study involved 22 subjects who visualized five different webpages while performing three different identification tasks on each of them; additionally, each website was freely viewed by the participants for one minute. During the four interactions of the participants with the websites, the eye tracking device mounted on the laptop recorded

the visual gaze of the users, offering information such as fixation location, order and duration, saccades, revisits of the same element, etc. Moreover, each participant in the study completed a set of questions, offering more details about their general experience with the online environment, as well as specific opinions about each studied website and the tasks performed there. This setup of the study allowed the researchers to analyze the subjects' online behavior so that each of the following research objectives could be fulfilled: (1) Identify elements memorized by the users following the free-viewing of the websites and their correlation with the elements registered by the eye tracker as being viewed (heat map); (2) Determining the order in which subjects visualize different bits of information on the landing pages of a website while performing a task; (3) Establishing the relationship between the measured and perceived difficulty for fulfilling a task, in the case of different website structures and designs and (4) Determining the variance (ANOVA) of the measured difficulty of fulfilling a task for different structures and design of the landing page. A set of valuable conclusions were obtained within the presented research, on a general level; thereby, showing that the design of a website influences, to a great extent, the usability of a website and the user experience.

2. Sustainable Web Design, User Experience and Consumers' Perception

When accessing the internet, we find ourselves in what seems like an endless pool of information, facilitated by numerous websites trying to sell something, convince people about a concept or offer new perspectives over a primary aspect of our lives. We rarely (or maybe never) stop and ask ourselves, "What is the environmental impact of all this information"?

Starting from the 17th century, when sustainability was referred to in relation to deforestation [1], the notion of sustainability has been widely present and seems to vary in terms of definition, content and approach; still, the three main pillars of sustainability remain standing in all approaches and theorizations of the notion: social, economic and environmental pillars [2,3].

Furthermore, sustainable development was, as early as 1987, defined by the Brundtland Commission of the United Nations to be a process that "meets the needs of the present without compromising the ability of future generations to meet their own needs" [4] (p. 15). Since a big part of our daily activity takes place online, it is vital to consider and talk about sustainable web design and how it can contribute to the environmental—but also to the social—pillar of sustainability.

A very up-to-date example of the impact of the online environment and its functionality is the high usage of internet services during the COVID-19 pandemic when the internet traffic grew up to 20% within one week of the pandemic [5]. While most businesses were closed for face-to-face activity, so was the worldwide education system; thus, all courses and seminars were moved online. While many higher education institutions lacked the resources for full-online teaching, this period highlighted more than ever the acute need for a stable e-education infrastructure. While a usable web design of the e-learning platform will ensure smooth usage, monitoring users' behavior allows for anticipation and prevention of bottlenecks of the web environment, equipment and infrastructure [6]. Fedushko et al. show that by establishing correct and comprehensive service level agreements, e-learning platforms can predict online behavior and customer expectations. This further allows for better monitoring techniques and user behavior analysis, leading to higher customer satisfaction and lower resource usage [7]. Therefore, it can be seen how, in the case of e-learning, the interface and technical infrastructure of a website/platform can affect, in addition to the environment, a whole social group and its educational development.

Let us take another example and look at 14 December 2020, when all Google services turned off for about 2 h, globally. Because of internal storage issues, millions of users had problems accessing productivity, utility, or information resources, such as Gmail, YouTube, Google Drive, Google Docs, Google Calendar and Google Play. This was a period when, due to the COVID-19 pandemic, a big part of daily activities switched online; thus, it is clear that

an event like this cuts sustainability to a much lower level. Why? Leaving aside frustration, the time and energy consumption needed for data restoration appear as a cost for the environment. What is still reassuring, in this case, is that Google is one of the relatively few companies that embraced carbon neutrality (since 2017) using 100% renewable energy sources [8]. Unfortunately, not all online presences have the same sustainable drive as Google. In 2013, the internet carbon footprint was evaluated to be 830 million tons of CO₂ per year, a figure comparable to the entire aviation business [9]. Another study estimated that communication technology would use 14% of global electricity by 2040, up from just under 4% in 2020 [10]. In his last book, Garry McGovern [11] evaluates how many trees would need to be planted in order to counteract the environmental impact of the world wide web, reaching the conclusion that 1.6 billion trees would cover for the pollution generated by email spam; meanwhile, to offset the pollution caused by yearly e-commerce returns in the US, 1.5 billion trees would have to be planted and to compensate for the pollution generated by the approximately 1.9 trillion yearly Google searches, 16 million trees would be needed. We, therefore, have indisputable evidence for the necessity of a sustainable worldwide web.

The central solution to limit the environmental impact of the internet is to adopt a sustainable web design approach. Tom Greenwood [12] (p. 5) defines sustainable web design as “an approach to designing web services that prioritize the health of our home planet. At its core is a focus on reducing carbon emissions and energy consumption”. The emphasis of this definition on reduced carbon emissions clearly indicates how efficient and clean web design can contribute to the stop of global warming, goal number 13 of the 17th Sustainable Developmental Goals defined by the United Nations [13]. Tim Frick [14] presents sustainable web design as a set of environmental principles applied to any digital product, service, or media by energy use reduction and green ingredient inclusion. The following four-category framework for sustainable design ensures lower energy consumption and lower carbon emission, thus fitting the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, proposed by the Council of the European Union in 2007 [15].

- Sustainable components, such as green housing, green workplaces, energy-efficient frameworks, Agile workflows—where multiple team members communicate and brainstorm solutions;
- Increased findability, content and search engine optimization (SEO)—reducing meaningless content, easy-to-find information, data with clear purpose and utility, the inclusion of tools such as search buttons;
- Web performance optimization—fast loading websites consume less energy while keeping users happy;
- Design and user experience (UX)—the focus of the present paper—creating enjoyable online experiences, removing information overload, keeping things simple, easily apprehensible, ensuring valuable information, generating high conversion rates and positive brand perception.

Detailed research, interviewing users, testing and retesting, are the key elements for obtaining a good web design to increase consumer satisfaction and trust, website visits and conversions or purchases [16–19]. However, what is good web design? How can we evaluate it? Keeping in mind the sustainability goal, companies strive to create high usability and a rich user experience for their website visitors. Usability is defined by the International Organization for Standardization (ISO) as the “extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” [20] (p. 2). When referring to the use of a website, usability measures the ease to use that website, the design of the task-based interaction, or how intuitive and easy it is for consumers to reach their goal on the website. Palmer [21] demonstrates through a series of three studies that website usability and success are usually associated with download speed, layout organization, information sequencing, type and amount of content, interactivity, customization degree and

responsiveness (e.g., feedback opportunities and FAQs). Regarding aesthetics, Sonderegger and Sauer [22] used a computer simulation of a mobile phone and analyzed how the visual appearance of the phone influenced perceived usability, performance and attractiveness. Even if (aside from one aspect) the phones were identical, the participants using the highly appealing phone found it more usable than the case of the non-appealing one. Furthermore, the task completion time was lower in the case of the appealing mobile device, underlining the impact that a pleasing design can have over UX as a usability component.

User experience (UX), on the other hand, is a holistic view of human-computer interaction. This dimension embeds usability as a component and broadens out, considering elements such as cognition and emotional involvement; therefore, it is a more hedonic view of how users' satisfaction is reached [23]. Starting in 1995, when Norman and colleagues introduced the term UX [24], and continuing with Alben [25], the field of UX became of interest for marketers and web designers, presenting itself as a challenge—as it is influenced not only by technical, objective factors (usability) but also by situational factors such as the emotional state of the user.

Lee and Kozar [17] propose ten dimensions to be measured when evaluating the usability of a website and UX, similar to those proposed by Shackel [26]:

- Consistency (consistent design and structure throughout the whole website);
- Navigability (ease of accessing information, presences of search features);
- Supportability (easy to receive personalized support from provider);
- Learnability (frequent usage makes the website easier to use);
- Simplicity (succinct, easy to understand content and structure);
- Interactivity (presence of animations, video, etc., or possibility to contact other consumers or providers);
- Telepresence (the existence of emotional involvement while using the website);
- Credibility (clear information about security features);
- Content relevance (accurate, in-depth and up-to-date information);
- Readability (easy-to-understand words, appropriate formatting, pleasant use of colors and structures).

We conclude that UX combines the physical and technical aspects of a website with the cognitive processes that occur while the user interacts with the website. A qualitative UX will positively impact memory and website familiarity; these aspects have been shown to be in close relation with consumer satisfaction and loyalty [27]. The notion of UX can also be related to the term “online atmospherics”—the design of a website that seeks to create positive cognition and affect, having as the final objective, to obtain positive responses from consumers [28,29]. Without getting into technical details, we have to mention the gold standard of approaching web design, meaning progressive enhancement. This is a web design method that does not build around the browser but around the content and the way it contributes to UX. As it fits with HTML, CSS or JavaScript, progressive enhancement allows adaptation according to the users' needs, starting, in a layered manner, from the context in which the user accesses the webpage [30].

In a world filled with information, as an individual is targeted by thousands of marketing messages every day, it is vital to know how to differentiate yourself in the mind of the consumer, creating, through UX, a favorable perception about the business presented [31,32]. Perception can be defined as “the process through which a person receives, selects, organizes and interprets stimuli from the environment while assigning them a meaning” [33] (p. 58). An essential part of the perceptual process is represented by perceptual selection—what consumers choose to see and interpret. As the sensation—part of the perceptual selection process is influenced by both internal factors (attitude, expectations, motives, etc.) and external factors (color, shape, movement, light, etc.)—it is vital that when opting for web design styles, one takes into consideration both categories, while also keeping in mind the objective of sustainability.

In terms of internal influences, it is important not to forget that users access a website to satisfy their needs; no matter if they are searching for information, a product, or a service,

they come on a platform with an open heart, hoping that it will match their expectations. It is not recommended to try to trick visitors into buying something they do not need; thus, we refer to an ethical approach to web design [34]; providers should avoid asking for credit card information for free trials or adding hidden costs or essential information in small fonts hoping that the user will not notice. UX is about the appearance, comfort and trust developed between the consumer, website and provider; therefore, website design should be simple, direct and easy to use [16].

Structural elements (external influences), such as a good choice of fonts and typography, colors, imagery, or information position on the page—even if not directly related to the buying decision process—will contribute to high usability by creating a pleasant and memorable experience [35,36]. Still, the sustainability issue should not be forgotten. For example, blue pixels consume up to 25% more energy to be displayed than red or green; using Google Maps in night mode reduces screen power usage by 63 percent [12]. When choosing between black background—white text or vice versa, consider that while black text on a white background will be easier to the eye, the black background may consume lower energy. For OLED screens, the use of black light does not activate any pixels; therefore, no energy is consumed, but this is not the same for LCD screens, where displaying a black background might consume even more energy than a light one [13]. Color can influence a consumer's perception, disposition, purchase intent, perception over a brand or brand personality [37–39]. In terms of online atmospherics, color can influence perception over website loading time [40], can attract attention and impact memory over the viewed item, or reversely, a bad choice of colors can distract the attention of users from the main information [41]. Generally speaking, long-wavelength colors like red or orange are usually associated with arousal and excitement, while browns can be connected to the idea of nature and earth, green with the feeling of security, and blue with qualities like sanitary [38].

Closely related to color is imagery in the online environment, a tool that can increase users' attention and memory but, when wrongly managed, can prove unsustainable. As images occupy a large amount of data in the website's background, the benefit versus cost of using images and videos on the website should be evaluated. PNG and GIF files are recommended for showing graphs; JPGs are a good choice for photos, while logos should be exposed through vector images. Another critical aspect of imagery use and sustainable web design is running all visuals through an online compressor tool like Smush.it or Image Optimizer; this will reduce file size without affecting quality too much. In terms of impact, the correct use of images in relation to the content of the text presented showed an increase in consumer attitude towards the website and brand [42]. Font-wise, it is important to make the web page look neat and pleasant; the recommendation is not to use more than two different fonts to keep the design sustainable; always evaluate the loading time that each font needs. For online use (not print), fonts like Georgia or Verdana are recommended [14]. Furthermore, using fonts pre-installed on the devices where the website is expected to be viewed more often will require less server use [12].

Other external characteristics that affect sensation and can impact UX and consumer perception of the website are:

- The size of the content—larger is easier to see but has more energy cost;
- Intensity—brightness, color intensity, intrusiveness of ads (ads that users have to interact with to get to the desired content) or repetition (frequency intensity);
- Movement—videos or motion pictures—attract attention but consume more energy and data than static information;
- Position—not only how, but where information is presented might make a difference—in the US, it has been shown that the best place to display important information is on the top left side [43].

3. Neuromarketing and Web Design

Whether we are at home, at the office, on the street or in the car, we are constantly exposed to marketing stimuli [44]. A poster of a Guns N' Roses concert spotted on the street, a radio ad for a weekend in Greece heard while taking a shower, the smell of a freshly baked croissant coming from the bakery on the street corner, a free sample of the newly-released mint ice cream received in the cake shop or the feel of ripe mango in the supermarket. These are all ways through which businesses are targeting each of the human senses, what Aristotle, thousands of years ago, was referring to as *visus/sight*, *auditus/hearing*, *odoratus/smell*, *gustus/taste* and *tactus/touch* [45]. The way each consumer reacts to these inputs, their preferences, thoughts, emotions and their behaviors are elements of interest for marketing researchers. Self-report research techniques (surveys, interviews, etc.) used for measuring consumer behavior have limited value as one will be subjective when talking about thoughts and emotions, elusive when discussing taboo subjects, present behavior in a socially acceptable way or may not be able to express the actual feelings that they have [46]. Obtaining clear and objective information is where neuromarketing, as a relatively new and innovative research technique, proves extremely valuable. Neuromarketing “asks” the body and brain how they feel about a particular marketing stimulus, thus, being able to complete the gaps of expressed behavior with an objective measurement of impact [47–49].

While it can be very hard for individuals to objectively evaluate their emotions, it is crucial not to lose emotions from our sight when evaluating consumer behavior. The consumer is very often considered and approached as *homo economicus*, having the ability to make rational decisions; this approach is profoundly wrong and undesirable. Many theoreticians and practitioners underline the way that rationality and emotions—defined by Damasio as chances that appear in the body and brain states as a result of exposure to stimuli [50,51]—weave together to make us what we are. Daniel Kahneman [52] presents this wonderful partnership between rational and emotional, or conscious and unconscious, as System 1 and System 2. System 1, or fast-thinking (present in animals), is represented by all the reactions and activities that happen spontaneously, involuntarily, quickly and with little or no effort. System 2, or slow-thinking, appeals to conscious, learned and complex mental processes for a problem to be solved. While System 1 generates intuitions, feelings and impressions, it needs System 2 to transform these into beliefs, organized ideas or voluntary actions. In terms of timing, System 1 acts first, gathering information from the environment and providing information for making fast decisions. As System 1 is represented by the intuitive and emotional reactions, it is impossible to even consider that decisions can be made only rationally by directly involving System 2. The weight that each system brings to a decision depends on several aspects, including the hot/cold states that Lowenstein and colleagues [53] discuss. In cold states, cognitive, rational thinking will prevail, while under hot states, when the need is acute, the emotional aspects will weigh heavier, thus guiding the decision-making process.

Rene Descartes argued that the rationale behavior is the first the first marker of existence. Antonio Damasio [50] contradicted this approach, justifying that the existence of emotions makes us behave at our best. Emotions should not be removed from the decision-making process, but first and foremost, we should never desire this. Damasio [54] considers that the brain is responsible for the body and mind homeostasis and that, by using emotions and feelings, the brain manages to restore an equilibrium state in the body whenever things get complicated, and decisions are tough. Damasio reached this conclusion through several hands-on experiences with patients who had their cerebral prefrontal cortex damaged from various medical conditions and, even if the general capacities of the patients remained unchanged, they became incapable of feeling emotions. The main impact of this was that they were incapable of making decisions anymore; the instinct, the intuition, that gut feeling was gone, leaving them with only the rational analysis at disposal for choosing the best options. The result? Endless self-debate taking into consideration cost-benefit criteria, resulting in poor decisions, affecting their personal and social life [55–57]. These studies,

together with other revealing research of the brain, undergone by Damasio and colleagues, lead to the well-known Somatic Marker hypothesis, where emotions are considered vital in guiding the decision-making process [50,58]. The somatic marker hypothesis has a major role in the way individuals take risks, therefore, how their decision-making process works. Pleasant emotions, which correlate with dopamine release, are higher when positive outcomes are unexpected; therefore, when the risks are higher. People are motivated by the desired reward to take risks; thus, without somatic states (emotions and moods), consumers would stick to a narrow set of choices, without assuming any risk (monetary, time related, socially related, etc.) for achieving better results and higher satisfaction [59].

Analyzing the emotions triggered by specific stimuli is easier by using neuromarketing. In order to correctly define neuromarketing, we must first discuss neurosciences, neuroeconomy and consumer neurosciences. While the first seeks to understand human behavior in general, through the study of the brain [60], neuroeconomy and consumer neurosciences bring consumer behavior to the center of the analysis by studying psychological processes such as perception, memory, attention and arousal [61]. Concerning the previous notions, neuromarketing can be treated as a niche of consumer neurosciences, focusing exclusively on studying consumer behaviors that arise from the interaction between individuals and markets or marketing stimuli [62,63].

Pioneer neuromarketing studies can be found as early as 1979 [64] when the effect of watching an advertisement was studied by measuring pupil dilation or changes in consumer's brain waves; however, until 2002, when professor Smidts first used the term "neuromarketing", these studies did not belong to a specific field of research [65]. Seeking to increase marketing effectiveness [66] and offer a deeper understanding of the relationship between individuals, businesses, and markets through the study of the brain [63], neuromarketing utilizes several research techniques. Studying either the metabolic or electric reaction of the brain or other behaviors and conducts of the consumer [49,67–71], the most well-known and frequently used techniques are:

- fMRI (functional magnetic resonance imaging)—a scanner that combines magnetic and radio waves, used for the study of the brain's reaction to stimuli;
- EEG (electroencephalography)—a helmet that measures how the brain's electrical currents change when the subject is facing a marketing stimulus;
- MEG (magnetoencephalography)—a detector that measures the magnetic fields created by the brain during interaction with a marketing stimulus;
- fNIRS (functional near-infrared spectroscopy)—one of the latest neuromarketing techniques, taking the form of a set of electrodes that records the changes of the hemoglobin concentration present in the brain;
- The eye tracker—a fixed or mobile camera that records the individual's eye movement, establishing where, when, and in which order certain elements of a visual stimulus (static or dynamic) are viewed. Metrics such as time elapsed until first fixation, duration of fixation, saccades (visual paths between two fixations), order of the fixations, pupil dilation modification as a result of positive or negative arousal, etc., can be produced by the eye tracker, allowing researchers to understand in more detail what catches the eye. The eye tracker can generate both quantitative data (performance of key objects) and qualitative data (usability issues), thus being a perfect tool for the study of web design [68].

Even if the saccades of the eyes were known in ophthalmology as early as 1879, when Lois Javal [72] observed the way the eye moves during the reading process, the eye tracker was only used in 1947 to study the eye movements of pilots during their flight [73]. Later on, based on data from experiments using visual cues, the scanpath theory was developed [74,75], which suggests that actively looking at stimuli, together with visual perception, is cognitively controlled by the individual—using visual memory while focusing on specific details of the visual stimulus. In terms of fixations, or the static sequence of a scanpath, Dario Salvucci and Joseph Goldberg [76] propose five different algorithms for identifying and measuring fixations, offering a standardized method for

analysis that is valuable for the field. As eye tracking proved to offer valuable information about the physical and mental state of an individual, several domains resorted very early to this practice in order to obtain answers. Holzman and his colleagues [77] studied the eye movements in patients with schizophrenia, identifying certain differences compared to the eye movement of healthy people, thus establishing new diagnostic criteria for the field. Jacob [78] uses the eye tracker, seeking to identify how eye movements can be used as an input in human-computer communication, proposing ways to facilitate this interaction in both directions. Consumer behavior was early studied offline, as well as online. Lohse [79] analyzed how people scan yellow page advertisements, sharing valuable evidence regarding the positions and formats that attract visual attention, thus contributing to advertising efficiency. Online, Granka et al. [80] gather information via eye trackers to understand how consumers use search engines and what makes them choose certain ones from the long list of results, concluding that usually only the first two results are accessed. The previously mentioned works are some of the most well-known in the field. Still, many eye tracking researchers have contributed to the current state of knowledge in the field. As it would be impossible to mention all of them, we chose to present a set of practical commercial applications of the eye tracker, offering several examples for each category:

- Advertising creation and testing [73,81–88]—understanding where the consumer looks when viewing an advertisement, the order in which different elements are viewed or finding out what type of emotions are produced by a particular message, are essential in order to create or refine ads;
- Packaging [89,90]—colors, shapes, and unique differentiation elements can make a product memorable; neuromarketing provides valuable techniques to study how the package of the product impacts the consumer and influences their buying decision;
- Pricing [91,92]—psychological prices, absolute and differential thresholds in price adjustment, or different psychological concepts that stand at the basis of the consumer's price evaluation process can be studied through neuromarketing techniques, offering a positioning advantage for a company;
- Retail [93–95]—merchandising aspects (e.g., shelf position of the product), as well as environmental aspects of the shopping space (e.g., lightning, scents, colors), can be studied in store, thanks to gadgets such as eye tracking glasses or EEG helmets;
- Product development [96,97]—additional to the verbalized opinion of consumers regarding the use of certain products, neuromarketing research offers data about the psychological and neural connections that the brain makes regarding a potential new product;
- Website/app design—aspects such as information position, dynamic, format, or content can majorly impact the time that consumers spend on a website and the perception that they form about the business. Neuromarketing techniques open a new door to understanding how the users perceive these aspects and what can be done to improve the usability of the website/app.

Over time, many academics and practitioners got involved in developing web design, and neuromarketing became a widely used research method in the field. As the present paper focuses on the study of web design sustainability, usability and UX, the following section summarizes the results of several research papers that applied neuromarketing techniques—especially eye tracking—to the study of web design.

Pan and his team [98] combined the traditional survey method with neuromarketing, namely the eye tracker, to study behavior patterns in webpage viewing and their determinants. The study showed that demographic elements, such as gender and stimulus design, are the main influencers of the user's viewing pattern. Lee and his colleagues [99] used the fMRI and the EEG to test how the brain's reactions differ when viewing a good or bad web design. As twenty-five subjects viewed and categorized fifty websites as having a "good" or "bad" design, the researchers concomitantly studied the subjects' brain reactions. The fMRI results showed that the perceived quality of the design was associated with

activations of the frontal and occipital lobes, while the EEG showed that the brain had a faster and more intense reaction to bad designs rather than good ones.

The relation between user's age and web design was studied by Djamasbi and colleagues [100]: based on the evaluation of 50 web pages performed by 98 generation Y individuals, six websites (the three most liked and three most disliked) were used as stimuli for an eye tracking study. The data obtained by the eye tracker (e.g., visual fixations), combined with the verbalized perceptions offered by the participants during the surveys, and interviews following the experiment, showed that the use of large pictures, the presence of a search feature, and the use of celebrities were actions that contributed to increasing the attractiveness of a webpage for generation Y consumers. Another study of the relation between age and web design preference has been conducted by Jenifer Bergstrom and her colleagues [101], who studied how elderly users interact with certain web pages. The study involved 37 users in an eye tracking study, where particular metrics of pre-established areas of interest (AOIs) were measured (duration until first fixation, fixation duration). The heat maps and metrics indicated that elderly users focus more on the center part of the webpage, while young users look more frequently in the peripheral area. Moreover, the upper side of the website is much later viewed by elderly users compared to young ones. Seeking to study the impact of personal traits on web utilization, Hernandez and team [102] researched the attention of users with the use of an eye tracker by analyzing how individuals who only read from left to right interact with a web page, compared with those who can read in both directions. The research showed that users who can read from both sides have better spatial attention, while those who only read from left to right have better attention to details. These studies provide helpful information regarding the ideal web design according to the personal characteristics of the target group.

In terms of web characteristics and user behavior, Cyr and her team [103] studied the relation between color and satisfaction, loyalty, and trust and added the culture variable by comparing this correlation for three different cultures (Japanese, Canadian and German). Ninety subjects from the countries mentioned above viewed one e-commerce website. By combining perceptions measured through the eye tracker with perceptions expressed by the participants through follow-up discussions, the researchers concluded that the colors used in web design influence the trust and satisfaction related to the website.

Seeking to evaluate the usefulness of neuromarketing research for the field of web design, Lee & Seo [104] conducted a study where they tested and compared bio-signals usability research (electroencephalogram, electrocardiogram) versus traditional usability testing (satisfaction interviews, performance measurements, participator evaluations). Within the study, ten subjects evaluated four automotive company websites. The results showed that the used neuromarketing techniques provided similar conclusions to the traditional usability tests, indicating that, besides being reliable, neuromarketing is valuable for completing the traditional usability tests with information about emotions and feelings that specific web designs may trigger. Similar results were obtained by Pablo Loyola and his colleagues [105] when they used an eye tracker to record fixations and pupil dilation during a subjects' (23 persons) interaction with a website. Seeking to better define the web elements that attract most of the users' attention, the information provided by the eye tracker proved not to be sufficient if used alone but showed a 14% accuracy increase in defining the key elements of attraction when compiled with data obtained through traditional research methods.

In terms of users' cognitive load and website design, several neuromarketing studies showed how the structure and format of a webpage could influence the way users interact with the content and the final result of their interaction. Wang et al. [106] tested how simple and complex tasks were performed on simple versus complex website structures. The researchers used the eye tracker to record the interaction of the 42 subjects with the websites, and, based on the result obtained from the ANOVA statistical test, they concluded that the website complexity influences usability at a lower rate than the complexity of the task. While no statistical differences were shown in the analysis of simple versus complex

websites, more fixations and longer duration of fixations were identified when the task carried out by the subjects was a complex one, no matter the complexity of the website. In the same area of interest, Zlokazova et al. [107] compared how an airline web page's structure impacted web usability. While being eye tracked, the subjects (23) firstly used a website that presented two-way flights on the same page; secondly, a webpage that presented each route on a separate, subsequent page was used. The study showed that the two-page structure allowed users to complete the task faster but presented a higher number of errors due to a higher cognitive load.

4. Methodology

Past research of the authors [108] proved that a business's website is a top choice for marketing communication. As usability and UX are key concepts that contribute to website sustainability, the present paper aims to evaluate the usability of five different website structures and designs by analyzing users' attention while they perform tasks on the landing pages of the considered websites. The main source of inspiration for the present study was the work of Munoz-Leiva [88], who tested how tourism advertisement banners are seen in different online environments, thus different layouts and design, conducting three neuromarketing studies with 15 participants each, where subjects had to solve a task (find certain information) on a blog, website and Facebook page of a touristic business.

The present research seeks to compare different design styles, layouts and formats of the same type of business website. By establishing the key attractors and the measured and perceived difficulty of performing the tasks, the purpose of the research is to identify the elements, formats, and structures of information that increase the usability of the landing page of a website. Derived from the purpose of the research, following the results of other research papers, a set of objectives and hypotheses were established.

Various studies, such as Bucher and Schumacher [109], show that visual attention to information and memorization are highly influenced by layout and design. Matzen and her colleagues showed that a subject devotes a large part of their attention to text, and specifically, to the titles of each section [110]. Laeng et al. [91] and Pieters and Wedel [111] showed that pictures are the most viewed. Bonnardel et al. [112] show that colors have a determinant influence on how the users interact with a website. Having this in mind, we propose the following objective and hypothesis:

- Objective 1—Identify the elements registered by the eye tracker as being viewed (heat map) and memorized by the users following the free-viewing of the websites.

Hypothesis 1 (H1). *Information layout and design influence the extent to which information is viewed and memorized by the subjects.*

In terms of page scanning directions, Pinto et al. [113] and Connor et al. [114] showed that top-down scanning patterns are identified for goal-oriented (task-solving) web visualizations. Furthermore, Hung and Wang [115] argued that scanpaths within their eye tracking study were mainly vertical and horizontal. Buscher et al. [116] considered that users usually look at the top side of the screen in the first moments of their encounter with the website. Considering these aspects, the following objective and hypothesis were established.

- Objective 2—Determining the order in which subjects visualize different information on the landing pages of a website while performing a task.

Hypothesis 2 (H2). *A pattern of visualization can be established.*

Even if it was not applied on website design, we considered useful the method used by Andrzejewska and Stolińska [117] in their research, where the subjective difficulty of the tasks that the subjects had to perform while being eye tracked was compared to the time needed for each task to be completed. In the end, the two variables had a direct correlation. As our research model defined the eye tracking time of each task for each participant to be

the measured task difficulty, we decided to correlate this dimension with the perceived difficulty of the task expressed by the participants.

- Objective 3—Establishing a relationship between the measured and perceived difficulty for fulfilling a task, in the case of different website structures and designs

Hypothesis 3 (H3). *The relationship between the measured and perceived difficulty of carrying out the task is a negative one.*

- Goldberg and Helfman [118] and Wang et al. [106] used ANOVA techniques for analyzing timed completion of the task and perceived website complexity. Starting from their analysis approach, the following objective was developed. Objective 4—Determining the variance (ANOVA) of the measured difficulty of fulfilling a task for different structures and design of the landing page.

We consider that a longer sequence of fixations and saccades before the completion of the task, therefore a longer duration, indicates a higher difficulty for completing the task. Different studies indicate that the scanpath format, as well as task completion duration, are influenced by the structure of the webpage. Goldberg et al. [119] suggest that important information should be placed on the top and left sides of the portal, as well as that different scanpath directions (vertical/horizontal) occur, depending on the columns position. Bojko's [120] comparative analysis of two versions of the American Society of Clinical Oncology (ASCO) website proved, through the reduced time needed for a task to be fulfilled, that the new, improved design of the website was far more usable, proving again the influence of design over visual attention. Pan et al. [98] showed that the complexity of the webpage, therefore the way information is structured, impacts the scanpath structure and the extent to which it differs from one individual to another. Zlokazova et al. [107] compared two different designs for an airline webpage, showing that a two-page structure of the booking feature proved to perform faster but with more errors.

Hypothesis 4.1 (H4.1). *The measured difficulty as a result of carrying out a task differs significantly depending on the landing page structure and design.*

Various studies [118,121–123] showed that information that is new and unfamiliar will be either fixated for a longer time or will need more fixations in order to be understood; having this in mind, the following hypothesis was established.

Hypothesis 4.2 (H4.2). *Each subsequent task will be performed faster as a result of the learning process.*

A randomly created, non-representative sample of 22 subjects (21–36 years old), 11 male and 11 female, was selected for the study. Taking into consideration the samples used in different other eye-tracking studies [73,89,91,105,107], we have established a minimum of 20 participants to the study; out of the 50 invitations sent to students and graduates of Bucharest University of Economic Studies, Romania, 22 participants showed up for the study. Data were collected by applying a combined research method: a survey (questionnaire) and neuromarketing (eye tracking).

The implementation phase of the research: an initial information session regarding the purpose and structure of the study was performed by the researchers; following the information session, each participant signed the consent form for participating in the study. The first research step consisted of each subject completing a questionnaire, self-evaluating their online consumption behavior. The second research stage was performed on a laptop with an SMI REDn Scientific System mounted eye tracker. While each participant followed the calibration dots moving on the screen, the eye tracker was calibrated for each subject individually, assuring the correctness of gaze recording.

Researchers like Danaher and Mullarkey [124] consider that screening a website having a task in mind makes it less probable for information to be memorized, thus generating a constant debate whether to set up tasks for participants within eye tracking

studies or to choose a free-viewing approach. We decided to undergo both options: (1) we have established three tasks to be performed by the participants so that we can compare which of the design options (picture/symbol/text) perform better and (2) offer participants the chance to free-view the webpages for a fixed duration of one minute, so that the memorized elements can be evaluated.

The eye tracker recorded the subjects' gaze while each of them fulfilled three tasks on five different website landing pages; the duration needed for each task to be fulfilled was recorded and considered to be the overall task completion time, based on Bojko [120] and Andrzejewska and Stolińska [125].

Each participant evaluated the difficulty level for fulfilling the first, second and third tasks (perceived difficulty). In addition, 1 min of free-viewing was performed by each subject for each website. Following the 1 min free-viewing, the subjects completed a complex questionnaire, expressing their perception and experience over the five different websites. Each task consisted of identifying a certain section on the webpage (exchange rate, shopping bankcard, mobile banking). For comparison reasons, the content of the task was chosen so that each webpage would present the information under a different format (text, image, symbol, table, etc.).

Seeking to compare the usability of different layouts, the study used five different web pages from the same service category (banking); the web pages used were not designed for this study, but the actual landing pages of five of the most popular banks in Romania were used. Besides their popularity, these five banking web pages were chosen so that the three elements contained by the tasks (exchange rate, shopping card and mobile banking) were displayed differently (text/picture/symbol) so that a comparison of each format attractiveness and usability could be made. The authors consider the results to be valuable for web design development, no matter the field of activity.

5. Results and Discussion

Objective 1—Identifying the elements memorized by users following the free-viewing of the websites and their correlation with the elements registered by the eye tracker as being viewed (heat map)

After a 1-min free-viewing of the landing page of each studied website, the subjects made a list of elements and information that stood out during their interaction with the page, which they memorized. As the eye tracker recorded each subject's eye gaze during the 1-min free-viewing of the webpages, a heat map showing the most viewed elements of each webpage was created (as shown in Figure 1). Moreover, using the eye tracker software, an AOI (areas of interest) map was generated so that metrics such as visualization sequence, number of visualizations (attention), or average fixation (milliseconds) could be analyzed against the mentioning frequency (memory) of the elements memorized by subjects; this data was analyzed for the specific information of each website. After completing the eye tracker data with the information obtained through the final questionnaire, a set of results, valid regardless of the considered webpage, were obtained.



Figure 1. Heat Map BRD bank website in free-viewing conditions.

- By comparing the frequently mentioned elements as being memorized by the subjects with the heat map generated by the eye tracker for each task performance on each of the five websites, it can be concluded that most of the memorized information was recorded as the eye tracker as being intensely viewed. This confirms the results of Laeng and his colleagues [91], who showed that a long stare at an element directly correlates with a higher preference, therefore a greater chance for the visualized element to be memorized.
- In situations where subjects have previously interacted with the web page, their experience facilitates the revision and mentioning of already known elements. Some of the memorized elements would have a higher mention rate, even if they were not intensely viewed, while other memorized information has a low mentioning rate as it is considered redundant, being mentioned within another task. From the analysis of heat maps, it can be noticed that the already known elements (exchange rate, shopping card or internet banking) represent, in most cases, anchor elements that guide the scanpaths towards new areas of the page. These results are in line with the ones obtained in other studies [126,127], suggesting that the use of familiar information alongside new elements of a web design facilitates the visual search, thus increasing the chances for a wider area of the webpage to be visualized. A particular case can be identified for website E, where, due to the multitude of buttons and well-highlighted sections, there is an intense view and increased attention on most sections, not only the ones previously viewed. As we are now referring to free-viewing, where the number of fixations and memorized bits of information are an indicator about web design appropriateness, this information could be highly useful when considering the choice of section structure and use of buttons on a website in order to create an increased interaction between the user and the website.
- Considering that the images (promotional banners) placed at the top of the pages were one of the most efficient elements in terms of mentioning and memorizing, it can be concluded that the information transmitted through images, in a visual form, needs a shorter viewing time in order to be memorized. Findings regarding the impact of pictures and their visibility are contrasting: several studies performed on different webpages, analyzing the eye movement and scanpaths during free-

viewing or while performing a task sustain that text information is more attractive than pictures/video/graphical information [119,128–131]. The results obtained within the present study are in line with the other half of research, which considers pictures as having better visual performance on websites and in offline communications. Laeng et al. showed that while eye tracking the visual attention of consumers looking at different wine bottles, the pictures depicted by the wine labels were the ones viewed the most [91]. Pieters and Wedel [111] showed through their study that pictures always performed better and were more attractive to the users, while Wu et al. [132] argue that in situations when more images are present, the most conspicuous of them will be the ones attracting visual attention.

- Even if the subjects mentioned different specific elements of the image content, most often, the image itself and the title/main subject are mentioned. This result is sustained by the results of Matzen et al. [110], who show that most of the time, users read the title of a text section first and for the longest period (about 70% of the viewing time).
- As stated by Bonnardel et al. [112], colors have a determinant influence on how the users interact with a website. Our results proved that intense colors attract attention and increase the chances of information being memorized. It was possible to observe this aspect specifically mentioned or deduced by analyzing the color used to present the memorized information. On the other hand, the excessive use of colors seems to be annoying for the user; proving the theoretical point of view of Greenwoond [12], using different fonts and text sizes increases the user's attention and the chance that this information will be stored. As in the case of colors, the excessive use of different fonts proved to be tiring for the users.
- While Le Meur and Liu [133] claim through their study that scanpaths follow a horizontal, rather than vertical, direction under free-viewing conditions, the present study cannot incline for a majority of the vertical or horizontal direction, but for a majority of both compared to chaotically or diagonal scanning. Thus, the viewing scanpaths templates usually respect a vertical and horizontal direction, following the page layout through different boxes and sections. In the case where six separate box-shaped sections are used to present the information, the focus falls on the first three boxes presented in the first line. The information in the first, being mentioned to a greater extent. This conclusion indicates that a structured way to present the information on a website, avoiding excessive text and sections, will ensure a full visual cover of the content.
- In line with Li et al. [134], the findings suggest that a combination between text and picture attract viewer's attention to a greater extent compared to pictures or text alone. In several situations, it was noticed that attention is directed more often to the images that accompany each section of information, thus guiding the gaze and indicating the differentiation of the sections;
- Analyzing the position of the memorized items on the web pages, it can be concluded that the essential information should be placed in the center, top, and right side of the web page. While the center and upper side of the page proved to be intensely viewed within other studies, we note a difference represented by the left-right attention. As Buscher et al. [116], Goldberg et al. [119], and Durgin et al. [95] showed, besides the upper and center areas, the left side of the screen is viewed sooner and for a longer period of time compared to the right side of the screen. As Djamasbi [135] had similar results, the right side of the webpage being viewed before the left side, we consider that this difference is also due to the structure of the information on the studied webpages, some sections and panels attract the sight to the right area.
- Using intuitive images, graphics, buttons or icons for the described product or service leads to increased attention and a higher understanding of the information. This finding is supported by Linderman and Fried [136]. However, graphics should be wisely chosen; childish pictures risk creating an unprofessional perception of the business.

- In accordance with Miniukovich et al. [137], who propose structuring text by using bullets rather than continuous prose, it was observed that if the information is presented in text form, subjects went through this information only if the text was structured in a list format and not as a block of compact text. In the cases where the information was presented mainly through text, it can be noticed that only the titles of the sections were viewed, a fact demonstrated by Matzen et al. [110]. While the language used does not have to be very technical or specialized, it is observed that unique information (e.g., live chat, live shop, investments in gold, personalized names) attracts attention and is retained to a greater extent, indicating that presenting information in unexpected ways makes it more probable to be visualized and easier to be memorized. This is not surprising, as the literature gives credit to unique and unexpected forms of presentation for being able to be memorized for a longer period of time [138,139].

By taking into consideration the results obtained, namely that information presented in strong colors, positioned on the top or right sides of the screen, the information presented with a picture or alongside it, or text arranged using bullet points rather than continuous writing will attract the most user attention, it can be stated that hypothesis H1 is confirmed, with information layout and design influencing the extent to which information is viewed and memorized by the subjects.

Objective 2—Determining the order in which subjects visualize different information on the landing pages of a website while performing a task.

While performing each of the three tasks on the five different webpages, the attention of each subject was driven by different information/design elements. Using the eye tracker software, an Areas of Interest (AOI) map was generated, information such as the viewing order, duration of each fixation, revisits of the elements, etc., being centralized. A scanpath map of the first ten elements viewed by the subjects (Figure 2) was created based on this information. Below, the scan path map obtained for the website of BRD bank stands as an example of the maps created for each website and each task in particular.



Figure 2. Scan path map showing the first 10 viewed elements on the website of BRD bank.

By analyzing the top 10 elements viewed for each of the five websites during the tasks, a series of conclusions can be drawn, indicating the ideal ways for information presentation:

- On a general level, the structure of the information sections, the position of buttons and images and the use of colors for highlighting certain information prove to be the elements that guide the scanning paths of the consumers. A general valid model regarding the visualization order cannot be established. Similar to the previous objective, these results are in line with the ones obtained by Bucher and Schumacher [109], indicating that through the chosen web design elements, the visual attention of the user can be guided so that he or she will interact the most with the webpage. As we are now referring to the gaze analysis under free-viewing conditions, these findings are in line with the results of Pinto et al. [113] and Connor et al. [114], who showed that while top-down scanning patterns are identified for goal-oriented web visualization, bottom-up scanning of the webpage is more frequent when the user freely scans the content of the page. In this case, the colors, contrasts and other visual characteristics of the website are the ones guiding the sight. In terms of scanning direction, users tend to scan the webpage vertically, top-down, shifting their attention to highlighted elements once these enter their visual field. While we cannot define a certain scanning pattern, a vertical tendency of the gaze was discovered, contradicting the findings of Goldberg et al. [119]. Not having a compelling result and taking into consideration the results of Hung and Wang [115], where scanpaths within the eye tracking study were mainly vertical and horizontal, we can conclude that the arrangement of the sections, images, text and other information remain the main determinant of the direction of the user's visual gaze. The top and right sides of the displayed webpage proved to receive more attention from users compared to other areas; the lower area of the webpage is least interacted with. While the results about the top and right sides of the webpage were previously discussed, the fact that the lower side of the website is less seldom viewed was shown by Buscher et al. [116] as well. When textual information is presented as part of an image or in its immediate vicinity, the text receives more attention from users than when it is presented separately. This aspect was concluded by Beymer et al. [140] as well, with the mention that once the user gets to see the text, the image that accompanies it will slow down the reading process, demanding more attention for both the text and image to be understood. We can therefore conclude that designing sections by using colors, symbols, borders, or images seem to increase the attractiveness and attention gathered by information from low-visibility sections of the webpage; The logo of the website is reviewed almost every time among the first ten items viewed, as the subjects seek to be sure that they are performing the task on the correct page. This comes as natural behavior, as Buscher et al. [116] stated that it is normal for the user to firstly look at the upper side of the page (header, logo) for a quick check about the presumed content of the page encountered.
- Most of the time, the same elements were identified as being visualized in each of the three tasks, indicating that the subjects used these elements as anchors, guiding them within the page. This finding could be valuable for personalized online services: in an ideal case where the regular activity of a customer on the website is known, his visual behavior on the webpage would be easy to predict.
- In most cases, the viewing format (scan path) is simplified within task 2 and task 3, compared to task 1, becoming more linear, this being the result of familiarization with the information; In line with other researches from the field [90–93], this result does not imply a shorter duration for the task fulfillment (this will be studied in the next section) but indicates less chaotic viewing path, with a shorter number of saccades and longer fixations.
- Images depicting persons attracting users' attention are viewed among the first ten elements each time. This was demonstrated by several other researchers [141–143]. Pictures with human faces have a higher memorization rate. Similar to the case of the

texts, the title of the main images is always viewed first within the first task and a bit later within the subsequent tasks.

By looking at the results obtained within the current objective and comparing them to the ones from the previous objective, similar visual behaviors can be identified; this leads us to an important conclusion, namely that there are no major differences in visual behavior when the user is scanning the website having a task in mind or in a free-view format.

The proposed hypothesis of the present objective was that a visualization pattern could be established for the moment users scan a webpage having a task in mind. Using the viewing sequence of the AOIs produced by the eye tracking software, the first 10 scanpaths were identified for each of the five studied websites. A general vertical tendency of the gaze was discovered, one that becomes more linear within each subsequent task. Furthermore, we can conclude that the visual path depends on the position of the information sections, images and buttons; thus, for the same layout, a similar visual route will be approached by users. As we cannot define a general visualization pattern independent of the page layout, we consider Hypothesis H2 to be only partly confirmed.

Objective 3—Identifying the relationship between the perceived and measured difficulty for completing a task in the case of different website structures and designs.

The difficulty for completing each task on the five web pages was measured by the eye tracker (duration in seconds until the fulfillment of the task) and expressed by the participants (perceived difficulty level on a 1 to 5 Likert scale—1-very difficult; 5-very easy). The duration was considered to be the objective task difficulty, while the expressed perception was considered the subjective difficulty of the task [125]. The following section will analyze the relationship between the two variables by calculating Pearson and Spearman correlation coefficients, seeking to find out to what extent the perceived level of difficulty is congruent with the measured one. Given that both scales are metric—proportional scale for measured difficulty (duration) and interval scale for perceived difficulty, both correlation coefficients can be calculated.

Eighteen correlations were performed, three computations calculating the correlation at a general level without considering the website difference, and fifteen computations for each task on each of the five banking websites. Each computation followed the same steps: the initial values of the measured and perceived difficulty were standardized, and all the values that were not included in the 0.99 confidence interval around the mean were excluded from further computation; for the new N, the Pearson and Spearman correlation coefficients were calculated, together with their significance levels.

In the following part, an example of the correlation computation process will be presented, namely the case of perceived and measured difficulty for the first task at a general level (all websites).

The descriptive statistics for the two variables, for all the considered websites (22 subjects \times 5 websites = N = 110), are presented in Table 1.

Table 1. Descriptive statistics for measured and perceived difficulty in fulfilling task 1 overall.

	Mean	Standard Deviation	N
Duration Task 1 (T1)	0.1368	0.15753	110
Perceived difficulty T1	3.47	1.261	110

At a general level, the average duration needed for task 1 to be completed was 0.1388 s, with a standard deviation of 0.15753, while the average perceived difficulty for performing this task was 3.47. By standardizing the two variables, two observations that exceeded three standard deviations (are not included in the confidence interval of 0.99 around the mean) were identified. By excluding these observations from the analysis, the values from Table 2 were obtained for the two correlation coefficients.

Table 2. Pearson and Spearman correlation between perceived difficulty and measured difficulty in fulfilling task 1 overall.

		Pearson Correlation		Spearman Correlation	
		Duration T1	Perceived Difficulty T1	Duration T1	Perceived Difficulty T1
Duration T1	Correlation coefficient	1	−0.496 **	1.000	−0.516 **
	Significance level		0.000		0.000
	N	108	108	108	108
Perceived difficulty T1	Correlation coefficient	−0.496 **	1	−0.516 **	1.000
	Significance level	0.000		0.000	
	N	108	108	108	108

** Correlation significant at 0.01 level.

Based on the values obtained for the correlation coefficients, it can be seen that, at a general level, there is a negative correlation of medium intensity between the perceived difficulty and the measured difficulty of performing task 1 (Pearson = −0.496; Spearman = −0.516); statistical significant for a 0.01 level. Therefore, it can be concluded that when the perceived difficulty decreases, the measured difficulty (the time required to complete the task) decreases as well. In other words, the perceived level of difficulty is consistent with its measured level, subjects correctly assessing the task difficulty.

Following the same computation process, the Pearson and Spearman correlation coefficients were calculated for each task and each website. Out of the eighteen computations, seventeen cases indicate the existence of a medium or high-intensity negative correlation between the two variables; given that the scale for perceived difficulty was defined as (1-very difficult; 5-very easy), the negative values of the correlations indicate that the perceived level of difficulty is consistent with its measured level, with subjects correctly assessing the ease of performing tasks for each website. The only exception appears in task 3, for website A, where the ambiguity of the information needed to be identified made it hard for the subjects to be sure if the task was performed completely or correctly.

There are more examples in the literature where the relation between measured (objective) and perceived (subjective) difficulty of a task within an eye tracking study was analyzed. On one side, there are researchers that indicate that a correlation between the two types of difficulty cannot always be identified [144]; or that, even when modest correlations are established, the perceived difficulty was influenced not only by the measured difficulty but by the users' cognitive abilities and online search experience [145]. On the other side, several researchers present strong correlations between the two types of difficulty [125,146], some other objective measurements of the visual gaze like the deviation from the optimal path visual linearity being identified to correlate with the perceived difficulty as well [147]. The results of the present paper are in line with the second half of researchers, showing a correlation between the measured (objective) and perceived (subjective) difficulty of a task, suggesting that users' perceptions regarding the usability of a website for a given purpose can be considered valid and taken into consideration when aiming for website design improvements.

Given the obtained results, it is considered that Hypothesis H3 is confirmed, the relationship between the perceived difficulty of carrying out the task and the measured difficulty being a negative one.

Objective 4—Determining the variance (ANOVA) of the measured difficulty of fulfilling a task for different structures and design of the landing page.

As each participant in the study fulfilled the proposed tasks on the websites, the eye tracker recorded their gaze but also the time spent since the first contact with the page until the end of the task.

The average durations recorded for each task on each of the studied websites are presented in Table 3.

Table 3. Average durations for fulfilling the tasks on each website.

Website	Task	Average Duration (Seconds)	Std. Dev.
A	Task 1	0.205	0.234
	Task 2	0.210	0.267
	Task 3	0.285	0.108
B	Task 1	0.139	0.211
	Task 2	0.525	0.412
	Task 3	0.130	0.101
C	Task 1	0.124	0.094
	Task 2	0.192	0.157
	Task 3	0.410	0.324
D	Task 1	0.137	0.071
	Task 2	0.463	0.529
	Task 3	0.344	0.273
E	Task 1	0.077	0.029
	Task 2	0.397	0.254
	Task 3	0.412	0.310

The relationship between the measured and perceived difficulty is a negative one, meaning that a task that needed a longer duration of time to be fulfilled was also perceived as tasks with a high difficulty level. Taking this information into consideration, the next step of the research focused only on the measured difficulty (duration), seeking to determine the variance of the measured difficulty levels for fulfilling the three tasks on the five websites. Thus, in computing the ANOVA values for each case, the measured difficulty (duration) was considered to be the dependent variable (Y), while the five websites constitute the considered factors (X); the measured difficulty variable was noted on a proportional scale, while the five website pages were recorded on a nominal scale.

The same computation process was respected for each of the three tasks. The following part presents the data for the first task that was undertaken by the subjects on the webpages; for the sake of simplicity, for the other two tasks, only the conclusions will be presented.

Firstly, the two hypotheses of the ANOVA technique were tested: the Kolmogorov Smirnov and Shapiro-Wilk tests were used to test (1) if the dependent variables follow a normal distribution within each factor category (Tables 4 and 5), while the Levene statistical test was used to test if (2) the variation of the dependent variable within each category of the considered factor is a homogeneous one (Table 6).

Table 4. Kolmogorov-Smirnov and Shapiro-Wilk tests for the measured difficulty (duration) of completing the task.

Web Site	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df.	Sig.	Statistic	Df.	Sig.
Task duration	A	0.292	22	0.000	0.513	22
	B	0.203	22	0.019	0.831	22
	C	0.218	22	0.008	0.848	22
	D	0.341	22	0.000	0.666	22
	E	0.292	22	0.000	0.711	22

As the dependent variable (duration) does not follow a normal distribution for any of the factor categories (significance level < 0.05), the outliers were excluded from the computation, and the two tests were performed again. The new results are presented below.

Table 5. Kolmogorov-Smirnov and Shapiro-Wilk tests for the measured difficulty (duration) of completing the task after eliminating the outliers.

Web Site	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df.	Sig.	Statistic	Df.	Sig.
Task duration	A	0.113	21	0.200 *	0.945	21
	B	0.203	22	0.019	0.831	22
	C	0.206	18	0.043	0.870	18
	D	0.174	18	0.158	0.921	18
	E	0.150	19	0.200 *	0.918	19

* This is a lower bound of the true significance.

Category B has a significance level = $0.019 < 0.005$, the dependent variable (duration) did not have a normal distribution. Given that website C is approaching a normal distribution (significance level = 0.043), we will consider this category in the following computations. In the case of categories A, D and E, the time-dependent variable follows a normal distribution.

Table 6. Levene statistical test—homogeneity of duration variation within each studied website.

		Levene Statistic	df1	df2	Sig.
Task duration	Based on Mean	21.819	4	93	0.000
	Based on Median	12.375	4	93	0.000
	Based on Median, with adjusted df	12.375	4	29.456	0.000
	Based on trimmed mean	20.229	4	93	0.000

For each calculation method, the Levene test is statistically significant (significance level < 0.05), thus the null hypothesis and the two hypotheses specific for ANOVA techniques were fulfilled.

Following the elimination of category B, the Kolmogorov-Smirnov and Shapiro-Wilk tests (Table 7) and the Levene statistical test (Table 8) were performed again.

Table 7. Kolmogorov-Smirnov and Shapiro-Wilk tests for the measured difficulty (duration) of completing the task after eliminating category B.

Web Site	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df.	Sig.	Statistic	Df.	Sig.
Task duration	A	0.113	21	0.200 *	0.945	21
	C	0.206	18	0.043	0.870	18
	D	0.174	18	0.158	0.921	18
	E	0.150	19	0.200 *	0.918	19

* This is a lower bound of the true significance.

Table 8. Levene statistical test—homogeneity of duration variation within each studied bank after eliminating category B.

		Levene Statistic	Df1	Df2	Sig.
Task duration	Based on Mean	1.433	3	72	0.240
	Based on Median	0.995	3	72	0.400
	Based on Median, with adjusted df	0.995	3	60.582	0.401
	Based on trimmed mean	1.323	3	72	0.274

As the two hypotheses of the ANOVA technique were fulfilled, the analysis was performed; the results of the one-factor-dependent ANOVA technique are presented in Table 9.

Table 9. ANOVA analysis for the measured difficulty (duration) of completing the task according to each category.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	0.236	3	0.079	7.129	0.000
Within Groups	0.793	72	0.011		
Total	1.029	75			

The F value = 7.129 > 1 (ratio between the systematic and non-systematic variation of Y) indicates a greater variation of the dependent variable between categories than the variation of the dependent variable within the categories; it can thus be stated that the dependent variable (duration of the task) differs depending on the categories of the factor considered, meaning that the structure and design of the webpages influence the duration of the task fulfillment.

The final step of the computation was to develop contrast tests (Table 10) in order to verify the pairs of websites where a statistically significant difference is present for the dependent variable.

Table 10. Contrast tests: duration for fulfillment of the task on the website pages taken two-by-two.

		Contrast	Contrast Value	Standard Error	T	Df.	Sig.
Duration of the task	Assuming equal variations	1 = A–C	0.0269	0.03372	0.798	72	0.427
		2 = A–D	−0.0787	0.03372	−2.333	72	0.022
		3 = A–E	−0.1106	0.03323	−3.326	72	0.001
		4 = C–D	−0.1056	0.03499	−3.017	72	0.004
		5 = C–E	−0.1375	0.03452	−3.981	72	0.000
		6 = D–E	−0.0319	0.03452	−0.924	72	0.359
	Assuming unequal variation	1 = A–C	0.0269	0.02797	0.962	36.574	0.342
		2 = A–D	−0.0787	0.03296	−2.387	32.306	0.023
		3 = A–E	−0.1106	0.03525	−3.136	31.830	0.004
		4 = C–D	−0.1056	0.03327	−3.173	31.617	0.003
		5 = C–E	−0.1375	0.03554	−3.868	31.452	0.001
		6 = D–E	−0.0319	0.03958	−0.806	34.824	0.426

The values above clearly indicate that the duration for fulfilling the task significantly differs between website A and D, A and E, C and D, C and E; concluding that between each of the websites in these pairs there are significant design differences that lead to different duration of task fulfillment.

The same steps as presented before were taken into computing the ANOVA values for each of the three tasks. At least four pairs of websites with statistically significant differences being obtained for each task, thus indicating that the measured difficulty (duration) and, in a strong, negative correlation, the perceived difficulty of performing the tasks, are influenced by the design of the webpage. The results of the three ANOVA techniques provided valuable information for identifying the information position and formats that lead to the lowest difficulty (both measured and perceived) of each task, thus concluding:

- From the analysis of the exchange rate format, presented on the websites as a table, graph, or a symbol, it can be concluded that for numerical information, the tabular format, followed by a combination between graphical and numeric format are the ones that make it the easiest for users to identify the information. The fact that these formats were the easiest to identify within the page, even if their position was at the bottom side of the webpage, proves the usefulness of the format. The third option in presenting numerical information on a webpage is to signal that section through an intuitive symbol (preferably a large one, positioned in the center of the webpage). These results are not surprising, as similar information can be identified in the studies of Tufte [148], who show that reading and understanding the information from a tabular form is easier compared to a narrative form. Resnick et al. [149] demonstrate that the tabular form of information needs a lower time to be scanned compared to a list. Smerecnik et al. [150] recommend the graphical form, followed by the tabular form for presenting numerical information; if we are to compare between different graphical formats, Goldberg and Helfman [151] indicate that the linear graphs are easier and faster to read and comprehend.

A set of results supported by several other researchers [67,111,132,134] was obtained from the analysis of the shopping bank card, presented on the website either as a picture, a text section, or a title. Thus, it can be concluded that presenting information as a picture (preferably in the main carousel of the website) is preferred to the option of using text sections or blocks of text for presenting the product/service on the landing page of a website. In terms of position, when the searched information was placed on the upper or right sides of the webpages, the time needed for the section to be identified was shorter, a finding supported by other studies as well [95,116,119,135]. From the analysis of the mobile banking section, presented on the websites as text, text with symbol or text with login button for mobile banking, it can be concluded that for the information referring to different tools, the use of symbols and buttons are making it easier for the user to identify the needed information on the landing page of a website. While Scholz et al. [152] define a symbol as a graphical image depicting a concept or idea, Detheridge and Detheridge [153] confirm our results by proposing three different approaches for making information more accessible: (1) by text simplification, (2) by replacing parts of the text or associating it with pictures and meaningful pictorials or (3) by replacing the whole text with pictures or videos. Thus, showing that the use of symbols makes information easier to identify and understand. Given the results previously presented, Hypothesis H4.1 is confirmed, the measured difficulty of carrying out a task differs significantly depending on the landing page structure and design.

As the specific theory refers to the impact of memory and learning process on usability and UX, the authors re-examined the values obtained for the measured and perceived difficulty for fulfilling the tasks and seeking to identify if the task difficulty decreases as the users move from one task to the other. The values for both variables (measured difficulty and perceived difficulty) have a heterogeneous variation, with a frequent increase of difficulty for Task 2 or 3 compared to Task 1. Thus, in line with other studies [118,121–123],

past experience proved to simplify the visualization format. Therefore, Hypothesis H4.2 is rejected, the learning process and memory not helping the users perform each subsequent task faster, only in a more linear way. Together with previous conclusions, this result proves once again that the ease of finding information on a website, implicitly the usability and UX, are strongly influenced by the layout and design of the webpage.

6. Conclusions and Recommendations

The purpose of the current paper was to identify the elements, formats and structures of information that increase the usability of the landing page of a website; thus, being able to make several recommendations regarding layout and information structure that eases the users' experience on a webpage. While the first sections of the paper present theoretical aspects about sustainable web design and ways to reach this goal, but also about neuromarketing and its application in marketing, the second part of the paper presents the results of an eye tracking study. Carried out as a combination between neuromarketing (eye tracking) study and survey (questionnaire), the study analyzed the online behavior of 22 subjects. The study used five banking webpages as stimuli and proposed to the subject three tasks to be performed (identifying three types of information on each website). Additionally, one minute free-viewing of each website was performed by each subject. During these four interactions of the subjects with the webpages, an eye tracker recorded their gaze and offered the researchers information like fixation location and duration, saccades or revisits of the same elements. The subjects' perceptions about the five websites content, layout and design were expressed by answering the questionnaire. By using both subjective (expressed) and objective (measured) variables of visual attention, the researchers could draw a series of conclusions regarding the impact of web design on user experience.

In terms of methodological approach, the main difference between the present study and other similar research is that the subject had both free-viewing and task-solving interactions with the stimuli; thus, allowing the researchers to compare visual behaviors for each scenario. Given that the order of the stimuli was of no importance, the webpages were not randomized but shown to the participants in the same order; this allowed for the comparison of visual behavior under a standardized stimulus input.

While many diverse outcomes were obtained from the analyzed data, several main ideas can be underlined, together with their practical implication in web design. Thus, one of the main outcomes was that we confirmed the results of other studies [64,79,86,98,106,107,120], showing that the structure of information and layout proved to influence usability more than users' experience with the website. Regarding the best approaches to attract attention, the following results are useful for web developers, as they can contribute to one of the two possible objectives: (1) design the webpage so that the user finds the needed information as easy as possible, spending a short time on the webpage for fulfilling a task or (2) ensure a pleasant experience, thus a longer stay on the webpage and full visual coverage of the content, for explorative visits of the webpage. Thus, in terms of position and layout, several results present preferable approaches: the top and right sides of the webpage proved to receive most of the attention, and the main carousel (upper side) is usually the first to be visualized. The information presented here had a higher memorization rate. The least viewed area of the website is the lower part. This information is valuable when considering where to position certain data on a website, as it shows where the users will look first and where it would be ideal to position information that is vital to be seen and remembered.

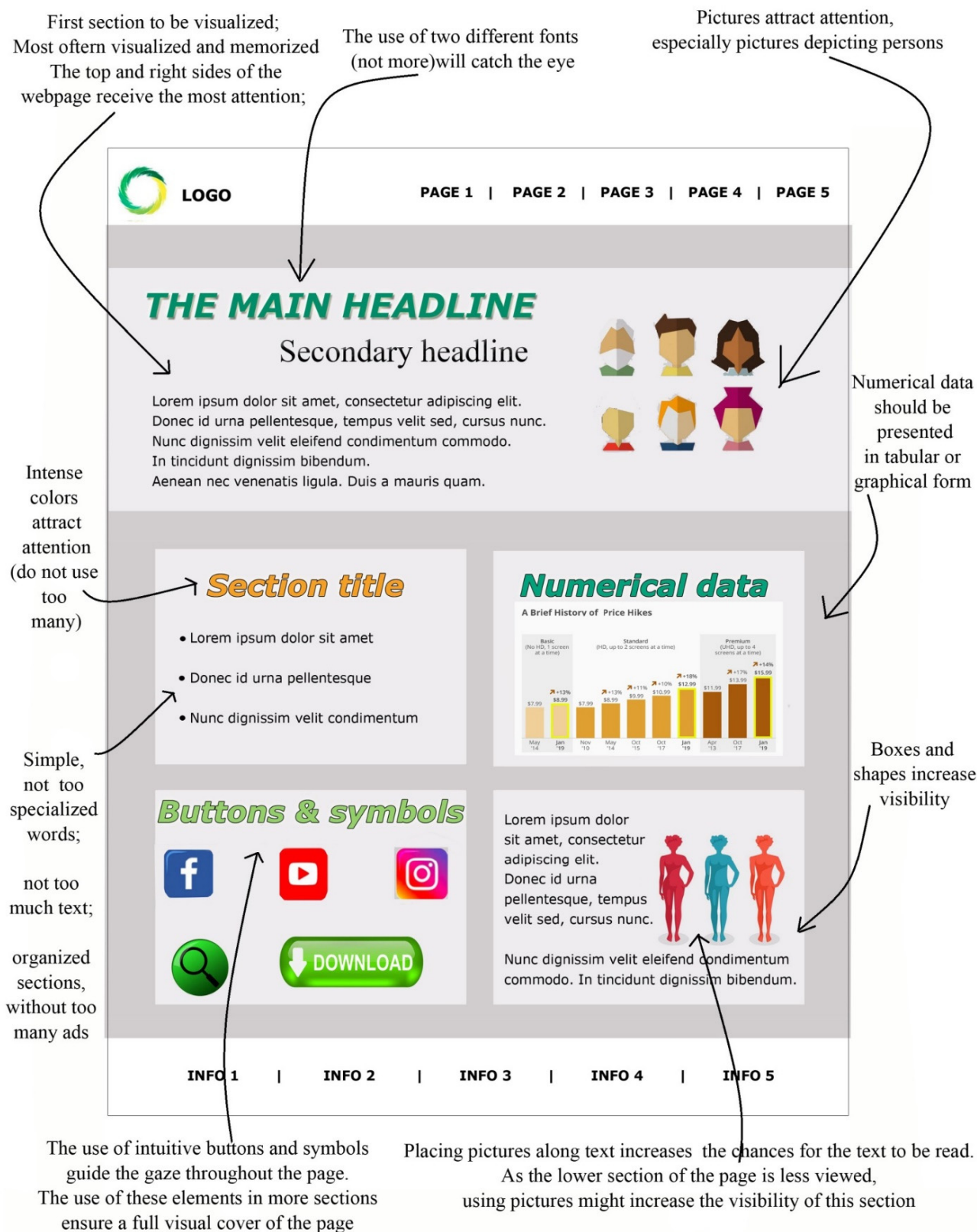
Besides position, several tips on how to attract and retain attention resulted from the research. In terms of font and color use, the use of two different fronts within a section proved to attract attention. Using intense colors can have the same impact. Displaying too many types of fonts of too many different colors can become tiring and annoying for the user.

When comparing pictures, text, tables and graphics as forms to present information on a website, the most efficient option was the picture, as they are viewed earlier, for a

longer period of time and allow better memorization compared to text. Of all picture types, the ones depicting persons seem to catch the eye the most. It is evident that many types of information must be put in words; in this case, the present study showed that text has a better chance to be read when it is not very long, does not use specialized words or when a picture is shown beside the text. In terms of numerical data, the tabular or graphical choice would be the best, as it offers the user an easier to comprehend format.

The appearance of the content itself is not the only important factor; the main structure of the webpage had a great influence on the users' behavior on the website. In order to make information visually pleasing, either easy to find or interesting to read until the end, chaotic page arrangement should be avoided. Thus, the use of boxes for delimitating types of information/services proved to guide the viewer in a vertical and horizontal way, increasing predictability of what type of information will be present in each box. Similarly, the use of buttons and suggestive symbols attract attention and guide the view throughout the webpage, increasing full visual coverage. Even if the lower section of the webpage proved to be very seldom or only shortly viewed, the use of pictures, buttons or symbols in this area decreases the chances for the information presented in this area to be ignored.

The following section presents these conclusions in a visual form (Figure 3), proposing a webpage layout that might prove useful, no matter the field of activity.



- The box-structured layout proved to be useful, guiding the gaze on a vertical and horizontal (not chaotic) scanpath
- The structure of the information and layout proved to influence usability more than the user's experience with the web

Figure 3. Recommendation for landing page layout and structure.

Author Contributions: Conceptualization, M.T.T., M.T., I.C. and G.O.; methodology M.T., G.O. and I.C.; software, M.T.T.; validation, M.T., G.O. and I.C.; formal analysis, M.T.T. and M.T.; funding acquisition M.T.; investigation, M.T.T. and I.C.; resources, I.C.; writing—original draft preparation, M.T.T., M.T. and I.C.; writing—review and editing, M.T.T., M.T., I.C. and G.O.; visualization, M.T.T.; supervision G.O. All authors have read and agreed to the published version of the manuscript.

Funding: Project financed by Lucian Blaga University of Sibiu & Hasso Plattner Foundation research grants LBUS-IRG-2020-06.

Institutional Review Board Statement: Ethical review and approval were waived for this study, due to the fact that the researchers did not manipulate the subjects, their choices or their usual state in any way; following their consent, their voluntary and uninfluenced behavior was externally observed.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Other analysis of the data used in the present study is openly available at: <https://doi.org/10.2478/sbe-2019-0034> and <https://doi.org/10.24818/18423264/53.4.19.08> (accessed on 8 March 2021).

Conflicts of Interest: The authors declare no conflict of interest.

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