

# Adapting to Digital Evolution: A Longitudinal Study of Web Navigation Patterns

ALEXANDRA NEAGU and DEMI TAO

A.I.Neagu@student.tudelft.nl  
Student Number: 5233194

Y.TAO-6@student.tudelft.nl  
Student Number: 5671078

**ACM Reference Format:**  
Alexandra Neagu and Demi Tao. 2024. Adapting to Digital Evolution: A Longitudinal Study of Web Navigation Patterns. 1, 1 (February 2024), 19 pages. <https://doi.org/10.1145/nnnnnnn.nnnnnnn>

## ABSTRACT

In an era marked by rapid technological evolution, this research examines the shifting landscape of web navigation patterns and its profound implications. As the web continually undergoes transformations in design [7], user behaviour, and technological infrastructure, understanding these changes becomes paramount for both researchers and practitioners in the field. As users engage with the web through diverse platforms and devices, the need to adapt and optimize navigation patterns becomes crucial for maintaining an effective and user-friendly online environment [10].

Despite the growing importance of this topic, existing research has predominantly concentrated on predicting crucial web navigation patterns [11, 24] and developing tools to facilitate the navigation process [2, 20]. Tracing the historical evolution of web navigation, the study employs a longitudinal controlled experiment, offering a nuanced understanding of how users navigate the internet. Anticipated outcomes underscore the significance of efficiency in navigation patterns, shedding light on their potential influence on the future of UI design. Key contributions include a contextual foundation for web navigation evolution, methodological insights into long-term pattern analysis, and implications for UI design trends.

## 1 INTRODUCTION

In the dynamic landscape of the internet, where technological advancements and user behaviours continually shape the way we interact with information, the study of web navigation patterns becomes increasingly crucial. This paper aims to unravel the intricate tapestry of evolving web navigation, delving into the nexus of web design, user experience, and technological progress.

Authors' address: Alexandra Neagu, A.I.Neagu@student.tudelft.nl; Demi Tao, Y.Tao-6@student.tudelft.nl.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from [permissions@acm.org](mailto:permissions@acm.org).  
© 2024 Association for Computing Machinery.  
XXXX-XXXX/2024/2-ART \$15.00  
<https://doi.org/10.1145/nnnnnnn.nnnnnnn>

### 1.1 Motivation

Efficient and intuitive web navigation is at the heart of a seamless user experience. The ability to find information quickly and effortlessly is paramount, influencing not only individual interactions but also shaping the broader realm of user interface (UI) design. As the digital realm evolves, propelled by technological innovations and shifting user preferences, understanding the dynamics of web navigation becomes imperative for designing interfaces that cater to the needs of the modern user.

### 1.2 Research Gap

Despite the ubiquity of web navigation in our daily digital experiences, a significant research gap persists in understanding how navigation patterns evolve over time. The rapid pace of technological advancements has outpaced the cadence of long-term research in this domain. The emergence of new navigation patterns, catalyzed by advancements in web technologies and changing user behaviours, presents a unique challenge. These patterns are so novel that they have yet to undergo comprehensive long-term study, creating an opportunity to bridge this research gap and gain insights into the future trajectories of web navigation.

### 1.3 Objective

This paper aims to fill this critical research void by undertaking a comprehensive exploration of evolving web navigation patterns. Through a systematic review and a longitudinal controlled experiment spanning a decade, we aspire to capture the nuanced changes in how users navigate the web, offering valuable insights into the implications for UI design and user interactions.

### 1.4 Research Question

Central to our inquiry are the following sub-questions:

- (1) How do web navigation patterns change over time?
- (2) What are the implications of these evolving patterns for user interactions?

### 1.5 Structure of the paper

The paper is structured as follows:

- The **Background** section provides a contextual foundation by tracing the historical evolution of web navigation patterns, offering insights into the challenges and advancements that have shaped the current landscape.
- The **Methodology** section elucidates the meticulous steps taken to conduct a systematic review of existing literature and the design of the longitudinal controlled experiment.
- The **Results** section, although containing placeholders, will focus on the anticipated outcomes, highlighting the importance of efficiency in navigation patterns and their potential influence on the future of UI design.

- The **Discussion** section, also with placeholders, will explore our opinions on the future of navigation patterns and their reciprocal influence on internet UI.
- The **Limitations** section critically examines the constraints inherent in our methodology, including demographic biases, simulated tasks, and the challenges of maintaining a longitudinal study over an extended period.
- The **Conclusions** section summarizes key findings and insights, offering a synthesis of the paper's contributions and outlining potential avenues for future research.

## 2 BACKGROUND

The process of web navigation comprises two primary stages. Initially, users need to locate a website related to their area of interest. Afterwards, they engage in the second stage, wherein they navigate through the chosen website to find specific information. During the first stage, global search tools, are typically employed to generate a list of potential websites [19]. In the second stage, users rely on a combination of local search tools and page-to-page browsing techniques [14]. At the local level, users have access to navigation tools encompassing functions provided by both the browser software and those integrated into the website by its developers. Commonly, web browsers offer a limited set of navigation tools, including back and forward buttons, history lists, bookmarks, colour coding to distinguish visited and unvisited links, the home button, and the URL field. These methods offer users various navigational choices, employing the self as the frame of reference. In this context, a pattern represents a regularity in behaviours that use these navigation tools.

Examining past navigation patterns provides a foundational understanding of the principles and challenges that have shaped the current landscape. In the early days of the web, navigation patterns were notably simpler compared to the sophisticated interfaces we encounter today. Websites often followed a linear structure, where users navigated through pages in a sequential order [2]. This approach lacked the branching and interconnectedness characteristic of modern websites. Many websites utilized hierarchical menus, presenting users with a tree-like structure where they could drill down into subcategories [9]. This method helped organize content but could become cumbersome as websites grew in complexity. Websites commonly featured sitemaps, providing users with an overview of the entire website's structure on a single page. Users could then click on specific sections to navigate directly to their areas of interest [20]. Examination of users' click-stream behaviour, encompassing metrics such as the number of pages visited, revisits, back actions, and distal jumps, revealed that the persistent visibility of a sitemap led to a reduced abandonment of information-seeking tasks, diminished reliance on the browser's back button and frequent navigational movements across the site hierarchy [6]. In a related study, Yip et. al (2004) [26] explored five distinct sitemap conditions, varying in terms of constancy of visibility, incorporation of hyperlinks, and a no-sitemap condition. Results derived from measures of task success, completion times, and the number of nodes visited indicated that constantly visible sitemaps notably enhanced performance, particularly for large websites. In the early days of

the Internet, some websites had text-only interfaces due to bandwidth limitations. Users again navigated through links presented in a linear or hierarchical format.

In the early 2000s, a notable surge in submit events points to the increasing prevalence of dynamic web pages and 'web applications'. The heightened occurrence of new window events indicates a transformation in web-client interaction, moving from singular-window hypertext navigation to a mode where users follow multiple paths concurrently. Additionally, certain browser windows persist for extended periods, dedicated to specific online services like news sites or email inboxes. Despite the similarities in navigation support to the early days of the web, new challenges emerge, such as backtracking and history inadequacies for dynamic pages. The conventional back button falters for users employing multiple windows or tabs due to each document area having its distinct history stack, imposing a new cognitive overhead on users [25].

In the early era of web design, frames were a prevalent technique used to structure web pages. Frames allowed web designers to divide a webpage into multiple independent sections or frames, each with its scrollable content. These frames operated as individual windows within a single browser window, enabling simultaneous display of content from different sources. For example, a webpage could have a navigation frame on the left containing links to different sections, and a larger frame on the right displaying the main content. This approach aimed to enhance the user experience by providing a persistent navigation menu while allowing the main content to change dynamically [16]. However, frames posed several challenges. Search engines often struggled to index content within frames accurately, leading to potential SEO issues [5]. Additionally, bookmarking and sharing specific content became cumbersome, as the URL in the browser's address bar remained static while the content within frames changed dynamically [18]. As web design evolved and new technologies emerged, frames fell out of favour due to these limitations and the advent of more flexible and SEO-friendly alternatives [1].

In their study, Weinreich et. al (2006) [25], examining the positions where users click on links revealed that scrolling, primarily vertical scrolling, is a common practice, even on pages mainly designated for navigation and those with brief visit durations. Nevertheless, the majority of chosen links are concentrated in the upper-left quarter of the browser window. Enhancing consistency with this established norm can be achieved by strategically placing the most crucial links within this region.

Lastly, it is also important to consider revisitation patterns in web navigation, as a big part of a user's presence on the Internet consists of reaccessing previously visited links. In their study, Tauscher et. al (1997) [23] found that users frequently revisit web pages, and there is a significant probability (58%) that the next page they visit has been previously seen, characterizing web browsing as a recurrent system. Despite this recurrence, users consistently integrate new pages into their browsing activities. Additionally, users tend to visit very few web pages frequently, with the majority visited only once or twice. Recency plays a pivotal role in revisits, as the last few pages visited contribute significantly to the recurrence distribution, emphasizing the frequent use of the 'Back' button. The analysis highlights local variations in vocabulary growth and navigation

activities across users and over time, suggesting evolving browsing behaviours.

The rapid expansion of online content necessitated more efficient navigation solutions, leading to the introduction of drop-down menus. These menus streamlined the user experience by enabling access to subcategories without the need for additional page loads. As the complexity and volume of website content continued to grow, there emerged a need for more advanced navigation systems. In response, MegaMenus were introduced, particularly suited for large websites with diverse content offerings. They represent a significant advancement in website navigation. Triggered by hovering over primary navigation options, these expansive panels display an array of lower-level links organized into relevant categories. This hierarchical approach offers users a comprehensive overview of available content, eliminating the need to navigate through multiple intermediate pages. Such a design not only optimizes space utilization but also provides a seamless browsing experience, especially beneficial when users lack a predefined path to their desired content [17].

In the latter part of the 2000s, smartphones marked a revolutionary shift in how people accessed and engaged with online content on their mobile devices. With the proliferation of advanced web browsers and user-friendly touchscreens, mobile devices became a primary gateway to the internet for a broad spectrum of users. This paradigm shift significantly expanded the reach and accessibility of online content, simplifying the process of conducting searches on mobile platforms. By 2015, the impact of this shift was evident, with Google reporting that ten countries, including major markets like the U.S., recorded more searches originating from smartphones than from desktop computers [8]. Specifically, in the United States, mobile devices accounted for more than half of all organic search engine visits. While desktops still command a substantial portion of search advertising expenditures, the momentum is clearly shifting towards mobile platforms. In fact, by 2018, mobile devices were responsible for approximately 63% of paid Google search clicks in the U.S., with mobile phones alone contributing to nearly 56% of the total clicks.

The contemporary digital landscape is characterized by users who frequently transition between various devices, including desktops, tablets, and smartphones. This dynamic underscores the importance of delivering a consistent and high-quality browsing experience across all platforms. However, the unique constraints associated with mobile devices, such as limited screen size and interaction mechanisms, present distinct challenges. Navigating websites on mobile devices often requires users to contend with a smaller visual field, necessitating strategies to enhance usability and minimize cognitive load. The need to memorize different parts of a webpage and establish connections between them can lead to increased user errors and navigation difficulties [13, 28]. To mitigate these challenges, adaptive strategies focusing on content restructuring, rearrangement, and visualization have been explored [27].

The industry's response to these challenges has been the development and adoption of responsive and mobile-first web design principles. These approaches prioritize adaptability, enabling websites to render effectively across a diverse range of devices and screen sizes. A notable outcome of this evolution is the widespread adoption of the hamburger icon, a minimalist symbol representing

hidden navigation options. While this icon has become a standard convention, many designers have opted to include the word "menu" alongside it to enhance user discoverability and comprehension [15].

In addition to the evolving landscape of device usage, mobile navigation behaviours exhibit distinct patterns compared to desktops. For instance, mobile search queries tend to be shorter, emphasizing the need for quick and concise information retrieval. Furthermore, usage patterns throughout the day differ, with desktop searches peaking during working hours, while mobile usage surges in the evenings. Notably, a majority of mobile queries are marked as important or urgent, indicating a prevalent inclination for mobile searches to address immediate needs. The impact of user contexts, especially location, is significant, with approximately 30% of mobile queries incorporating location markers [4, 22].

Amidst this transition, traditional search engines are no longer the sole option for information retrieval; mobile users and the younger generation are increasingly turning to social media platforms [21]. Notably, Generation Z, born between 1997 and 2012, exhibits a preference for searching on social platforms, particularly when exploring products. Additionally, the rise of AI chatbots, exemplified by ChatGPT, introduces a novel trend in leveraging generative AI for global navigation intentions. Virtual assistants, such as Siri or Google Assistant, have contributed to the substantial growth in voice search adoption. In the first quarter of 2019, 42% of the worldwide online population had engaged in voice search within a month [3]. This multifaceted evolution in navigation patterns underscores the dynamic nature of the contemporary digital landscape, where user expectations and technological advancements continually shape how we interact with information.

Anticipating ongoing changes, it is essential to recognize that navigation patterns will continue to evolve with advanced technology. Understanding the reasons and mechanisms behind these shifts holds value for future navigation designs. Researchers can stay abreast of the rapid pace of change and potentially predict future trends by unravelling the intricacies of how navigation patterns have transformed over time. This insight not only aids in adapting to current user behaviours but also provides a foundation for anticipating and shaping the navigation paradigms of the future.

### 3 METHODOLOGY

This section details the meticulous steps taken to conduct a systematic review of existing literature, and to gather, analyze, and interpret data, ensuring a rigorous exploration of user behaviours over a decade.

#### 3.1 Method

In this subsection, the research method is presented, encompassing the systematic search for relevant literature.

**3.1.1 Search criteria & filtering.** The *Google Scholar* and *Scopus* engines were used to search papers focused on the previously introduced web navigation patterns. Only studies in English were considered, as this is the language that the authors of this work are most familiar with and it is also the language that most of the

available papers were written in. In order to find relevant papers, the following queries were used:

- "web navigation patterns" OR "navigation patterns" OR "web navigation pattern" OR "navigation pattern"
  - For researching old patterns the filter "1995 - 2005" was set. This query returned 2500 results.
  - For researching more modern patterns the filter "2005 - 2023" was set. This query returned 11900 results.
- ("navigation patterns" OR "navigation pattern") AND ("internet" OR "human-computer interaction" OR "HCI")
  - For researching old patterns the filter "1995 - 2005" was set. This query returned 1750 results.
  - For researching more modern patterns the filter "2005 - 2023" was set. This query returned 7620 results.

The papers that were examined to determine if they were suitable or not were only from the first three pages of the returned results.

**3.1.2 Inclusion & exclusion criteria.** The following *inclusion criteria* were established for the selection of studies in this paper:

- *Topic Relevance:* Studies investigating web navigation patterns. Keywords were used to determine the relevance of the paper.
- *Language:* Studies published in English for comprehension and accessibility.
- *Publication Date:* Studies published from 1990 to the present focus on both relevant old navigation patterns and recent ones.

If a paper did not abide by all of these inclusion criteria, it was excluded.

After this process, the papers that were gathered were supplemented with other papers found through different means. Other relevant papers were found using the backward snowballing technique [12], by analyzing the *References* section of the papers deemed relevant from the search queries and choosing them based on the aforementioned process.

### 3.2 Controlled experiment

To conduct a comprehensive exploration of evolving web navigation patterns, this study will engage 40 participants from the United States, encompassing a balanced representation of 20 men and 20 women. The decision to focus on the USA aims to capture insights from a diverse and technologically advanced demographic, offering a nuanced perspective on web navigation behaviours within a specific cultural and technological context. Additionally, the gender balance seeks to account for potential variations in navigation preferences and patterns between male and female users.

The participants will belong to the 20-25 years age group. This age range represents a cohort that is heavily immersed in digital experiences, making them particularly insightful for studying evolving web navigation patterns. Participants within this age group are likely to exhibit a high degree of internet usage and a propensity to embrace and adapt to novel digital interfaces and technologies.

The experimental timeframe spans a decade, providing a longitudinal perspective on how web navigation evolves over time. Participants will be contacted every two years to reconduct the

study, ensuring that the research captures changing patterns and behaviours over the course of the experiment. Additionally, the user interface (UI) employed in the experiment will be modified at each encounter to adapt to the latest trends and technological advancements. This iterative approach allows for the observation of how participants navigate through evolving digital landscapes and how UI changes impact their behaviour.

### 3.3 Experiment Design

In this longitudinal study, the research strategy is a mixed-method strategy of qualitative and quantitative approaches. At every meeting point, the research consists of two parts and will last about an hour in total. The first part of the research is a quantitative observational study where participants will complete a navigation task, and the second part is a qualitative, semi-structured interview. This strategy was chosen to find both the statistical evidence and to gain a deeper understanding of the way of navigation of the participants. The observational study is used to answer subquestion one, and the interview is used to answer subquestion two.

**3.3.1 Observational Study.** The observational study is anticipated to encompass a duration of approximately 30 minutes, during which participants will be entrusted with a specific navigation task. For instance, they will be instructed to "retrieve information about air fryers and select the most suitable one to add to the shopping cart." This task is intricately divided into two sub-tasks to scrutinize participants' approaches to global navigation. The initial sub-task involves exploring how participants conduct internet searches independently, gauging their information retrieval skills. The subsequent sub-task introduces a purposefully designed website with a well-structured user interface, offering insights into their navigation strategies within a controlled digital environment.

Participants will be methodically assigned to two distinct groups, with one utilizing desktop computers and the other employing mobile devices. The desktop group will navigate using Google Chrome as their search engine, a choice mirrored by the mobile device group. In addition, the mobile devices will be equipped with social media applications, providing participants with the flexibility to incorporate social media as a means of global navigation.

To ensure unobtrusive observation, an observer will be discreetly positioned behind the participant, minimizing any potential impact on their behaviour. Simultaneously, a small camera strategically placed in front of the participant will capture their actions and reactions, serving as a supplementary data source in case any information is inadvertently overlooked by the observer. The recorded videos will be securely stored for further analysis, a facet that will be expounded upon in the subsequent section 3.5.

**3.3.2 Interview.** Following the observational study, a semi-structured interview, spanning approximately 30 minutes, will be conducted to delve into the intricacies of participants' navigation experiences. The objective is to unravel the underlying motivations behind their choice of specific navigation patterns and to unearth the challenges encountered during tasks. Confirmation of the interviewee's consent to the use of data and interview transcripts will be obtained.

Beyond individual experiences, these interviews are strategically designed to contribute to a broader understanding of the evolution of user interfaces and experiences over time. The insights gleaned hold the potential to shed light on the intricacies of navigational pattern design, offering valuable guidance for future research endeavours with an ambitious aim to forecast emerging trends in the dynamic landscape of user interaction and interface design.

The sample questions can be found in Appendix C.

The interview sessions will be meticulously recorded, and subsequent transcriptions will undergo a thorough cleaning and coding process. To ensure the utmost privacy and confidentiality, video recordings will be securely stored and safeguarded by password protection. Notably, these recordings will be expeditiously deleted upon the completion of the transcription process, further fortifying the protection of participant privacy.

### 3.4 Analysis

The study uses the integration of quantitative and qualitative methods for research design. The quantitative data obtained from the observational study provide statistical insights into user behaviours, offering measurable metrics such as task completion time, click-through rates, and error rates. This allowed for the identification of patterns, trends, and statistical associations within the dataset. Complementing this quantitative analysis, qualitative methods, including participant interviews, hope to enrich exploration by capturing the subjective experiences of users. The qualitative data will unearth nuanced aspects of navigation challenges, user preferences, and unanticipated issues that quantitative metrics alone might not reveal. The combination of both methods can provide a holistic perspective, enabling us to not only quantify the extent of navigational challenges but also understand the underlying reasons behind user behaviours. This synergistic approach intends to strengthen the validity of findings but also facilitates a richer interpretation of the complexities inherent in web navigation dynamics, contributing to more informed recommendations for user experience improvements. The methods used are shown in Table 1.

In the data analysis phase, a rigorous and methodical analytical approach will be applied to the quantitative dataset. Preliminary data cleaning procedures were executed to rectify any anomalies, ensuring the integrity of the dataset. Descriptive statistics, encompassing measures such as mean, median, and standard deviation, will be calculated to provide a succinct summary of key variables, including task completion time, click-through rates, and error rates. Comparative analyses will be conducted to discern disparities between distinct user groups, considering device usage, using desktop or mobile devices. Advanced statistical tests, including t-tests, will be applied to assess the statistical significance of observed differences. And post-hoc tests may be necessary to identify specific group differences. Correlation analyses are also instrumental in uncovering relationships between relevant variables. The Pearson correlation coefficient can be used to assess the strength and direction of relationships between two continuous variables, helping to identify potential associations between different aspects of web navigation. Last but not least, visualization techniques, including charts and heatmaps, will be used to facilitate the elucidation of complex

patterns. The findings, derived from these multifaceted analyses, hope to contribute to a nuanced and scientifically grounded understanding of the dynamics of web navigation, with implications for user experience optimization.

### 3.5 Human ethics

This experiment adheres to the highest ethical standards to ensure the well-being, privacy, and rights of the participating individuals. Prior to their involvement, participants will be provided with detailed information about the nature, purpose, and procedures of the study, enabling them to make informed decisions about their participation. Informed consent will be obtained, affirming participants' voluntary involvement in the experiment, with the understanding that they may withdraw at any stage without consequence.

To safeguard participant confidentiality, no sensitive data will be collected, and any personally identifiable information will be strictly protected. To make sure that this does not create a privacy risk in any published results, only aggregated results will be presented, making sure they are not identifiable to any specific participant. Additionally, the research team will employ robust cybersecurity measures to prevent unauthorized access to participant data. All collected data will be stored on offline local harddisks, protected by a strong password, and will not be uploaded anywhere or shared with any third parties. The research team will adhere to all relevant data protection laws and regulations. The data collected will be stored securely for a period of three months and then destroyed.

To minimize harm to participants, all interview questions are carefully structured to be neutral and free from any language that may suggest biased responses. There are no sensitive or offensive questions included. Participants also have the option to skip any question they feel uncomfortable answering, ensuring the survey is conducted in an ethical and professional manner.

Furthermore, the study will be conducted in accordance with the principles outlined by Human Research Ethics Committees (HREC), ensuring that the research design and procedures align with established ethical guidelines. Throughout the entire duration of the experiment, participants' rights, privacy, and dignity will be prioritized, reflecting a commitment to conducting research that is ethically responsible and respects the inherent value of each participant.

## 4 RESULTS

The first research question guiding the observational study seeks to unravel the temporal evolution of web navigation patterns. Foreseeing the emergence of novel patterns within both desktop and mobile device usage, the study posits a reciprocal influence between user behaviour and navigation design. Drawing upon practical insights and a thorough literature review, the study hypothesizes that users on mobile devices are inclined towards adopting voice search functionalities and social media platforms. The ongoing refinement of navigation patterns, tailored to users' evolving needs, is expected as a testament to the collective commitment to enhancing user experience satisfaction.

Complementing the observational phase, the interview component aims to unveil the intricacies of the mutual influences shaping

Measurements	Description	Type
Task Completion Time	Measure the time it takes for participants to complete specific tasks related to navigation. This can highlight the efficiency of the navigation system.	Quantitative
Click-through Rates	Track the number of clicks participants make to reach their intended destination. High click-through rates may indicate navigation difficulties.	Quantitative
Error Rates	Record instances where participants make errors or encounter issues while navigating. This can help identify problematic areas.	Quantitative
Path Analysis	Analyze the paths participants take through the website to identify common routes or unexpected detours.	Quantitative
Usability issues	Note instances where participants express frustration, confusion, or hesitation during the navigation process.	Qualitative
Click heatmaps	Generate heatmaps based on mouse movements and clicks to identify areas of interest or confusion.	Qualitative

Table 1. Observational Study Metrics

navigation behaviours. Fundamental to this exploration is the efficiency with which individuals procure the desired information. The study posits that navigation patterns optimizing the expeditious attainment of information are poised to ascend in popularity, subsequently delineating the trajectory of user interface design evolution.

As we anticipate navigating through a digital landscape characterized by perpetual evolution, understanding the underlying mechanisms of web navigation becomes imperative. The patterns discerned in this study are expected not only to enrich academic discourse but also to inform practitioners and designers, fostering the creation of user interfaces that seamlessly resonate with the needs and behaviours of their users.

5 DISCUSSION

The literature review revealed a notable trend wherein the availability of relevant papers in the field experienced a discernible decline, particularly in the years post-2020. This intriguing observation prompts us to reflect on potential factors contributing to this downturn. While the field of web navigation and user experience has historically been dynamic and responsive to technological advancements, a potential hypothesis emerges: a period of stagnation or deceleration in groundbreaking technological developments. The perceived scarcity of recent literature may indicate a lull in transformative innovations that traditionally stimulate a surge in research activities. Alternatively, it could be reflective of an underexplored niche within the broader domain, urging us to delve into this area and contribute insights that may reignite scholarly interest. Recognizing this apparent gap not only underscores the timeliness of our research but also underscores the need to scrutinize the evolving nature of web navigation patterns in an era that may be characterized by subtler, yet equally impactful, shifts in technology and user behaviour.

In the foreseeable future, the evolution of web navigation patterns is poised to be a dynamic process intricately tied to advancements in technology, user behaviours, and the ever-shifting landscape of web design. As users increasingly gravitate towards mobile devices

for internet access, the integration of voice search and social media platforms is anticipated to become more prevalent, shaping novel navigation patterns. This shift is not only a response to technological innovations but is also influenced by the symbiotic relationship between user preferences and the design of digital interfaces. As designers and developers focus on enhancing user experience satisfaction, bespoke navigation patterns tailored to individual needs are expected to emerge. The interview component of the study is designed to delve deeper into these mutual influences, providing invaluable insights into the intricate interplay between user behaviour and the evolving web design landscape. The efficiency with which users can access information will likely remain a central theme, and navigation patterns optimizing this efficiency are anticipated to rise in prominence, subsequently shaping the future of internet user interfaces. This reciprocal relationship between evolving navigation patterns and UI design is envisioned to continually redefine the digital experience, ultimately influencing how individuals interact with and navigate the vast expanse of the Internet.

6 LIMITATIONS

While our experimental design offers valuable insights into evolving web navigation patterns, it is essential to acknowledge certain limitations inherent to the methodology and scope of this study.

The selection of participants from the United States, aged 20-25, may introduce demographic biases. Different cultural contexts and age groups might exhibit distinct web navigation behaviours. Therefore, the generalizability of our findings may be limited to this specific demographic.

The tasks assigned during the experiment are inherently simulated scenarios, and participants may approach them differently than real-life tasks. The artificial nature of the tasks might influence the observed navigation patterns, potentially deviating from how users engage with the web in their daily lives.

The proposed 10-year timeframe for the study, with contact every two years, assumes a consistent and sustainable participation rate. External factors such as participant relocation, changes in technology adoption, or loss of interest may impact the continuity of the

study, potentially leading to sample attrition. Also, the longitudinal nature of this experiment inherently limits the feasibility of tracking a large number of participants over such an extended period. Consequently, the participant sample is relatively small, potentially compromising the statistical power and generalizability of the findings. The dynamics of web navigation may differ across diverse user groups, and our sample size constraints may further restrict the representation of the broader user population.

The dynamic nature of web technologies implies that the findings from this study may have a limited shelf life. As technology and user behaviours continue to evolve, the relevance of our results may diminish over time, necessitating periodic updates to maintain the study's validity.

Furthermore, as participants age over the course of the study, there is a potential bias towards established navigation habits. Older participants may exhibit a reluctance to adopt newly developed patterns, as they tend to adhere to familiar and habitual approaches. This age-related bias may impact the generalizability of our findings to younger, more adaptive user groups, potentially limiting the transferability of our results to a broader population.

Lastly, the study adheres to ethical standards; however, ethical considerations may vary across regions and institutions. While we strive for compliance, nuances in ethical guidelines may impact the study's ethical standing in certain contexts.

## 7 CONCLUSIONS

In conclusion, this study aspires to unravel the intricacies of evolving web navigation behaviours, seeking to provide valuable insights into the dynamic nature of web navigation patterns. Employing a longitudinal approach for data acquisition, we positioned ourselves to gain a more robust and nuanced understanding of the interplay between web design, user behaviour, and technology.

However, it is also essential to acknowledge the existence of certain limitations, which warrant consideration in the interpretation of results. Future research endeavours in this domain should address these limitations. By doing so, researchers can build upon the foundations laid by this study, further refining our comprehension of web navigation behaviours and expanding the knowledge base in user experience design.

## REFERENCES

- [1] [n.d.]. HTML5 differences from HTML4. <https://www.w3.org/TR/html5-diff/>
- [2] Bettina Berendt and Elke Brenstein. 2001. Visualizing individual differences in Web navigation: STRATDYN, a tool for analyzing navigation patterns. *Behavior Research Methods, Instruments, & Computers* 33, 2 (2001), 243–257.
- [3] Tiago Bianchi. 2023. Global Voice Search Region device 2019. <https://www.statista.com/statistics/1036727/global-voice-search-region-device/>
- [4] Karen Church and Nuria Oliver. 2011. Understanding mobile web and mobile search use in today's dynamic mobile landscape. In *Proceedings of the 13th international conference on human computer interaction with mobile devices and services*. 67–76.
- [5] Meng Cui and Songyun Hu. 2011. Search engine optimization research for website promotion. In *2011 International Conference of Information Technology, Computer Engineering and Management Sciences*, Vol. 4. IEEE, 100–103.
- [6] David R Danielson. 2002. Web navigation and the behavioral effects of constantly visible site maps. *Interacting with computers* 14, 5 (2002), 601–618.
- [7] P.M.E. "De Bra. "1999". "Design issues in adaptive web-site development". In *Proceedings of the Second Workshop on Adaptive Systems and User Modeling on the World Wide Web* ("Computing Science Reports"), P. Brusilovsky and P.M.E. De Bra (Eds.). "Technische Universiteit Eindhoven", "29–39". "conference; ASUMap;99; Conference date: 01-01-1999".
- [8] Jerry Dischler. 2015. Building for the next moment. <https://adwords.googleblog.com/2015/05/building-for-next-moment.html>
- [9] Emilia Djonov. 2007. Website hierarchy and the interaction between content organization, webpage and navigation design: A systemic functional hypermedia discourse analysis perspective. *Information Design Journal* 15, 2 (2007), 144–162.
- [10] Yizhu Gao, Ying Cui, Okan Bulut, Xiaoming Zhai, and Fu Chen. 2022. Examining adults' web navigation patterns in multi-layered hypertext environments. *Computers in Human Behavior* 129 (2022), 107142. <https://doi.org/10.1016/j.chb.2021.107142>
- [11] Malik Tahir Hassan, Khurum Nazir Junejo, and Asim Karim. 2009. Learning and predicting key web navigation patterns using bayesian models. In *International Conference on Computational Science and Its Applications*. Springer, 877–887.
- [12] Samireh Jalali and Claes Wohlin. 2012. Systematic literature studies: database searches vs. backward snowballing. In *Proceedings of the ACM-IEEE international symposium on Empirical software engineering and measurement*. 29–38.
- [13] Matt Jones, Gary Marsden, Norliza Mohd-Nasir, Kevin Boone, and George Buchanan. 1999. Improving Web interaction on small displays. *Computer Networks* 31, 11–16 (1999), 1129–1137.
- [14] Michael A Katz and Michael D Byrne. 2003. Effects of scent and breadth on use of site-specific search on e-commerce Web sites. *ACM Transactions on Computer-Human Interaction (TOCHI)* 10, 3 (2003), 198–220.
- [15] Nawaraj Khadka. 2021. *An usability and universal design investigation into hamburger menus*. Master's thesis. OsloMet-storbyuniversitetet.
- [16] Karl RPH Leung, Lucas Chi Kwong Hui, Siu-Ming Yiu, and Ricky WM Tang. 2000. Modeling web navigation by statechart. In *Proceedings 24th Annual International Computer Software and Applications Conference. COMPSAC2000*. IEEE, 41–47.
- [17] Samantha Naylor. 2016. Breadth and depth: A comparison of search performance in hierarchical and mega menus. (2016).
- [18] Jakob Nielsen. 1996. Why frames suck (most of the time). *Nielsen Norman Group* (Nov 1996). <https://www.nngroup.com/articles/why-frames-suck-most-of-the-time/>
- [19] Jakob Nielsen. 1999. *Designing Web Usability: The Practice of Simplicity*. New Riders Publishing, USA.
- [20] Chris J Pilgrim. 2012. Website navigation tools: a decade of design trends 2002 to 2011. In *Proceedings of the Thirteenth Australasian User Interface Conference-Volume 126*. 3–10.
- [21] Mark-Shane Scale. 2008. Facebook as a social search engine and the implications for libraries in the twenty-first century. *Library Hi Tech* 26, 4 (2008), 540–556.
- [22] Yang Song, Hao Ma, Hongning Wang, and Kuansan Wang. 2013. Exploring and exploiting user search behavior on mobile and tablet devices to improve search relevance. In *Proceedings of the 22nd international conference on World Wide Web*. 1201–1212.
- [23] Linda Tauscher and Saul Greenberg. 1997. Revisitation patterns in world wide web navigation. In *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems*. 399–406.
- [24] Yao-Te Wang and Anthony JT Lee. 2011. Mining Web navigation patterns with a path traversal graph. *Expert Systems with Applications* 38, 6 (2011), 7112–7122.
- [25] Harald Weinreich, Hartmut Obendorf, Eelco Herder, and Matthias Mayer. 2006. Off the beaten tracks: exploring three aspects of web navigation. In *Proceedings of the 15th international conference on World Wide Web*. 133–142.
- [26] April Yip. 2004. The effect of different types of site maps on user's performance in an information-searching task. In *Proceedings of the 13th international World Wide Web conference on Alternate track papers & posters*. 368–369.
- [27] Dongsong Zhang and Jianwei Lai. 2011. Can convenience and effectiveness converge in mobile web? A critique of the state-of-the-art adaptation techniques for web navigation on mobile handheld devices. *International Journal of Human-Computer Interaction* 27, 12 (2011), 1133–1160.
- [28] Martina Ziefle and Susanne Bay. 2006. How to overcome disorientation in mobile phone menus: A comparison of two different types of navigation aids. *Human-computer interaction* 21, 4 (2006), 393–433.

**Delft University of Technology**  
**ETHICS REVIEW CHECKLIST FOR HUMAN RESEARCH**  
**(Abbreviated version used for CS4270 Conversational Agents)**

**IMPORTANT NOTES ON PREPARING THIS CHECKLIST**

1. An HREC application should be submitted for every research study that involves human participants (as “Research Subjects”) carried out by TU Delft researchers and students.
2. Your HREC application should be submitted and approved **before** potential participants are approached to take part in your study
3. The Responsible Researcher (in your case a TA) must indicate their approval of the completeness and quality of the submission
4. There are various aspects of human research compliance which fall outside of the remit of the HREC, but which must be in place to obtain HREC approval. These often require input from internal or external experts such as [Faculty Data Stewards](#), [Faculty HSE advisors](#), the [TU Delft Privacy Team](#) or external [Medical research partners](#). For the conversational agents course, these are not necessary.
5. You can find more guidance on completing your HREC application (including tips for completing this checklist) [here](#). Please note this guidance is for the full checklist, which means this will contain additional items.
6. Please note that incomplete submissions (whether in terms of documentation or the information provided therein) will be returned for completion **prior to any assessment**

**I. Applicant Information**

<b>PROJECT TITLE:</b>	<b>A Longitudinal Study of Web Navigation Patterns</b>
<b>Name of Corresponding Researchers:</b>	<b>Alexandra Neagu, Demi Tao</b>
<b>E-mail Corresponding Researcher:</b>	<a href="mailto:A.I.Neagu@student.tudelft.nl">A.I.Neagu@student.tudelft.nl</a> , <a href="mailto:sdemitaoy@gmail.com">sdemitaoy@gmail.com</a>

**II. Research Overview**

***NOTE:** You can find more guidance on completing your HREC application (including tips for completing this checklist) [here](#)*

**a) Please summarise your research very briefly (100-200 words)**

What are you looking into, who is involved, how many participants there will be, how they will be recruited and what are they expected to do?

*Add your text here – (please avoid jargon and abbreviations)*

This research investigates the evolving web navigation patterns of individuals over a 10-year period, focusing on the interplay between web design, user behaviour, and technology. The study will engage 40 participants from the United States, evenly divided between genders and aged 20-25, a demographic known for its heavy internet use and adaptability to technological trends. Participants will navigate the internet using both desktop and mobile devices, with tasks varying in complexity. The experiment involves a one-hour session, with 30 minutes dedicated to navigation tasks and 30 minutes to individual interviews. Participants will be contacted every two years for follow-up sessions, during which the user interface will be adapted to reflect evolving design and technology. The study aims to provide valuable insights into the dynamic nature of web navigation patterns. Participants will be recruited through purposive sampling, and their involvement is voluntary, with



informed consent obtained. Data will be anonymized, treated confidentially, and used for research analysis, academic publications, and recommendations for web development.

### III. Risk Assessment and Mitigation Plan

*NOTE: You can find more guidance on completing your HREC application (including tips for completing this checklist) [here](#)*

Please complete the following table in full for all points to which your answer is “yes”. Bear in mind that the vast majority of projects involving human participants as “Research Subjects” also involve the collection of **Personally Identifiable Information (PII)** and/or **Personally Identifiable Research Data (PIRD)** which may pose potential risks to participants as detailed in Section G: Data Processing and Privacy below.

Note that this risk assessment plan is about potential risks of your study **to your participants**. This means that risks to you as a researcher (e.g. study validity) do not need to be described here.

To ensure alignment between your risk assessment, data management and what you agree with your “Research Subjects” you can use the last two columns in the table below to refer to specific points in your Data Management Plan (DMP) and Informed Consent Form (ICF) – **but this is not compulsory**.

			<i>If YES please complete the Risk Assessment and Mitigation Plan columns below.</i>	
ISSUE	Yes	No	RISK ASSESSMENT	MITIGATION PLAN
<b>C: Participants</b>				
7. Will the study involve participants who <b>may</b> be vulnerable and possibly (legally) unable to give informed consent? (e.g., children below the legal age for giving consent, people with learning difficulties, people living in care or nursing homes).		x		
8. Will the study involve participants who <b>may</b> be vulnerable under specific circumstances and in specific contexts, such as victims and witnesses of violence, including domestic violence; sex workers; members of minority groups, refugees, irregular migrants or dissidents?		x		
9. Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children, own students or employees of either TU Delft and/or a collaborating partner organisation)? <i>It is essential that you safeguard against possible adverse consequences of this situation (such as allowing a student's failure to participate to your satisfaction to affect your evaluation of their coursework).</i>		x		
10. Is there a high possibility of re-identification for your participants? (e.g., do they have a very specialist job of which there are only a small number in a given country, are they members of a small community, or employees from a partner company collaborating in the research? Or are they one of only a handful of (expert) participants in the study?		x		
<b>D: Recruiting Participants</b>				
11. Will your participants be recruited through your own, professional, channels such as conference attendance lists, or through specific network/s such as self-help groups				

			<i>If YES please complete the Risk Assessment and Mitigation Plan columns below.</i>	
<b>ISSUE</b>	<b>Yes</b>	<b>No</b>	<b>RISK ASSESSMENT</b>	<b>MITIGATION PLAN</b>
12. Will the participants be recruited or accessed in the longer term by a (legal or customary) gatekeeper? (e.g., an adult professional working with children; a community leader or family member who has this customary role – within or outside the EU; the data producer of a long-term cohort study)		x		
13. Will you be recruiting your participants through a crowd-sourcing service and/or involve a third-party data-gathering service, such as a survey platform?	x		Recruiting participants through external crowd-sourcing or survey platforms introduces potential risks related to confidentiality, data security, quality control, and ethical considerations. The use of such platforms may pose challenges in safeguarding participant information, ensuring data integrity, and adhering to ethical standards, necessitating careful attention to mitigate these concerns.	To address the identified risks, the research team will implement a comprehensive mitigation plan. This plan includes selecting secure and reputable platforms with established data security measures, employing encryption and anonymization protocols, providing clear participant guidelines to ensure data quality, and verifying the ethical compliance of external platforms. These measures aim to minimize the risks associated with recruiting participants through external services, promoting the highest standards of confidentiality, data security, and ethical conduct throughout the study.
14. Will you be offering any financial, or other, remuneration to participants, and might this induce or bias participation?		x		
<b>E: Subject Matter</b> <i>Research related to medical questions/health may require special attention. See also the website of the <a href="#">CCMO</a> before contacting the HREC.</i>				
16. Will drugs, placebos, or other substances (e.g., drinks, foods, food or drink constituents, dietary supplements) be administered to the study participants? <i>If yes see here to determine whether medical ethical approval is required</i>		x		
18. Does the study risk causing psychological stress or anxiety beyond that normally encountered by the participants in their lives outside research?		x		
19. Will the study involve discussion of personal sensitive data which could put participants at increased legal, financial, reputational, security or other risk? (e.g., financial data, location data, data relating to children or other vulnerable groups) <i>Definitions of sensitive personal data and special cases are provided on the TUD Privacy Team website.</i>		x		
20. Will the study involve disclosing commercially or professionally sensitive, or confidential information? (e.g., relating to decision-making processes or business strategies which might, for example, be of interest to competitors)		x		
<b>F: Research Methods</b>				
24. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g., covert observation of people in non-public places).		x		

ISSUE	Yes	No	RISK ASSESSMENT	MITIGATION PLAN
25. Will the study involve actively deceiving the participants? (For example, will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study).		X		
26. Is pain or more than mild discomfort likely to result from the study? And/or could your research activity cause an accident involving (non-) participants?		X		
27. Will the experiment involve the use of devices that are not 'CE' certified? <i>Only, if 'yes': continue with the following questions:</i>		X		
• Was the device built in-house?				
• Was it inspected by a safety expert at TU Delft? <i>If yes, please provide a signed device report</i>				
• If it was not built in-house and not CE-certified, was it inspected by some other, qualified authority in safety and approved? <i>If yes, please provide records of the inspection</i>				
28. Will your research involve face-to-face encounters with your participants and if so how will you assess and address Covid considerations?	X		Since the COVID-19 pandemic is over, the risk associated with face-to-face encounters has been significantly reduced. However, it's still important to consider general health guidelines.	When participants come in for the study general health and safety precautions such as appropriate social distancing will be put into place.
29. Will your research involve <b>either</b> : a) "big data", combined datasets, new data-gathering or new data-merging techniques which might lead to re-identification of your participants <b>and/or</b> b) artificial intelligence or algorithm training where, for example, biased datasets could lead to biased outcomes?		X		
<b>G: Data Processing and Privacy</b>				
30. Will the research involve collecting, processing and/or storing any directly identifiable PII (Personally Identifiable Information) including name or email address that will be used for administrative purposes only? (eg: obtaining Informed Consent or disbursing remuneration)	X		We have to obtain consent from our participants to let them participate in our experiment, which means we will collect, process and store PII.	To mitigate the risks attached to this, we will store the consent only locally/physically, not share it with anyone outside of the researchers and delete/destroy the data as soon as the research is finished.
31. Will the research involve collecting, processing and/or storing any directly or indirectly identifiable PIRD (Personally Identifiable Research Data) including videos, pictures, IP address, gender, age etc	X		Some data is collected: age, and gender.	This data is necessary for the experiment and determining relations between factors, all is stored securely and anonymously
32. Will this research involve collecting data from the internet, social media and/or publicly available datasets which have been originally contributed by human participants		X		
33. Will your research findings be published in one or more forms in the public domain, e.g., Master thesis, journal publication, conference presentation or wider public dissemination?		X		
34. Will your research data be archived for re-use and/or teaching in an open, private or semi-open archive?		X		



## H: More on Informed Consent and Data Management

**NOTE:** You can find more guidance on completing your HREC application (including tips for preparing your Informed Consent materials) [here](#)

### A HREC FORM

Your research involves human participants as “Research Subjects” if you are recruiting them or actively involving or influencing, manipulating or directing them in any way in your research activities. This means you must seek informed consent and agree/ implement appropriate safeguards regardless of whether you are collecting any PIRD.

Where you are also collecting PIRD, and using Informed Consent as the legal basis for your research, you need to also make sure that your IC materials are clear on any related risks and the mitigating measures you will take – including through responsible data management.

## IV. Signature/s

*Please note that by signing this checklist list as the sole, or Responsible, researcher you are providing approval of the completeness and quality of the submission, as well as confirming alignment between GDPR, Data Management and Informed Consent requirements.*

Name of Corresponding Researchers: Alexandra Neagu, Demi Tao

Signature of Corresponding Researcher:

 Tao Yiwei

Date: 2024.01.10

## V. Completing your HREC application

Please use the following list to check that you have provided all relevant documentation

### Required:

- **Always:** This completed HREC checklist
- **Always:** A complete Informed Consent form (including Participant Information) and/or Opening Statement (for online consent)

# Informed consent form template for research with human participants

Author: HREC, Joost Groot Kormelink ([HREC@tudelft.nl](mailto:HREC@tudelft.nl)) based on examples provided by [UK Data Services](#), adapted by Alexandra Neagu ([A.I.Neagu@student.tudelft.nl](mailto:A.I.Neagu@student.tudelft.nl)), Demi Tao ([sdemitaoy@gmail.com](mailto:sdemitaoy@gmail.com))

Last edited: 10 January 2024.

---

## Consent Form for the Longitudinal Study of Web Navigation Patterns

*Please tick the appropriate boxes*

**Yes    No**

### **Taking part in the study**

I have read and understood the study information dated \_\_\_\_\_, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

☐    ☐

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.

☐    ☐

I understand that taking part in the study involves:

☐    ☐

- Engaging in web navigation tasks using both desktop and mobile devices, including the use of voice assistants and social media platforms.
- Allowing the research team to observe and analyse my navigation patterns and interactions during the experiment.
- Participating in a one-hour session, with approximately 30 minutes dedicated to the actual navigation tasks and 30 minutes for an individual interview afterward.
- Answering questions during the interview about my experience, difficulties encountered, and providing feedback on the user interface.
- Agreeing to be contacted every two years for a period of 10 years to participate in subsequent sessions, during which the user interface may be modified to adapt to changes in web design and technology.
- Understanding that my data will be anonymized and treated with strict confidentiality, and any personal information will be securely protected.
- Recognizing that my participation is voluntary, and I have the right to withdraw from the study at any time without facing any consequences.
- Acknowledging that the research team is committed to conducting the study ethically and in accordance with established human research ethics guidelines.

OPTIONAL (delete if not needed):

### **Risks associated with participating in the study**

I understand that taking part in the study involves the following risks:

☐    ☐

- **Minimal Physical Risks:** The experiment poses minimal physical risks as it primarily involves engaging in web navigation tasks on desktop and mobile devices. Participants are not exposed to any physical harm during the study.
- **Potential for Mild Discomfort:** There is a possibility of experiencing mild discomfort during the interview portion of the session, where participants may be asked about their experiences and potential difficulties encountered during the navigation tasks.
- **Data Security Risks:** While extensive measures will be in place to protect participant data, including anonymization and secure storage, there is a minimal risk of a data breach. Every effort will be made to mitigate this risk through robust cybersecurity measures.
- **Minimal Emotional Discomfort:** Participants may experience minimal emotional discomfort related to the tasks or questions asked during the study. However, the research team will prioritize the well-being of participants and provide support as needed.



- Longitudinal Engagement: Engaging in the study over a 10-year period involves a commitment to periodic follow-ups. While efforts will be made to minimize inconvenience, participants may experience a sense of obligation or fatigue from the continued engagement.

### Use of the information in the study

I understand that the information I provide will be used for:

☐ ☐

- Research Analysis: The data collected during the experiment, including web navigation patterns, interaction behaviours, and interview responses, will be used for in-depth research analysis. This analysis aims to explore and understand evolving web navigation patterns over a 10-year period.
- Publication and Academic Purposes: Aggregated and anonymized findings may be used for academic publications, presentations, or conference materials. The results will contribute to the broader understanding of web navigation trends and inform academic discussions in relevant fields.
- Recommendations for Web Development: Insights drawn from the study may be used to provide recommendations for web developers and designers to enhance user experiences. This may include suggestions on adapting to changing navigation patterns and optimizing user interfaces.
- Longitudinal Study Updates: Information provided during the study may be used to contact participants every two years for subsequent sessions, allowing the research team to track changes in web navigation patterns over time. The findings from each session will contribute to the longitudinal aspect of the study.
- Statistical and Aggregated Reporting: Data may be used for statistical analyses and aggregated reporting, helping to identify trends and patterns at a broader level. Any reporting will ensure the anonymity of individual participants, protecting their privacy.

I understand that personal information collected about me that can identify me, such as [e.g. my name or where I live], will not be shared beyond the study team.

☐ ☐

### Future use and reuse of the information by others

I give permission for the resulting data that I provide to be archived in the researchers' database so it can be used for the current research.

☐ ☐

### Signatures

\_\_\_\_\_  
Name of participant [printed]

\_\_\_\_\_

Signature

Date

*For participants unable to sign their name, mark the box instead of sign*

## B CONSENT FORM

I have witnessed the accurate reading of the consent form with the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

\_\_\_\_\_  
Name of witness [printed]

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

\_\_\_\_\_  
Researcher name [printed]

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

Study contact details for further information:

- Alexandra Neagu, +31648738980, [A.I.Neagu@student.tudelft.nl](mailto:A.I.Neagu@student.tudelft.nl)
- Demi Tao, +31626103831, [sdemitaoy@gmail.com](mailto:sdemitaoy@gmail.com)

## C INTERVIEW PROTOCOL

Sample questions would be:

- How would you describe your overall experience with navigating through the website?
- Were there any aspects of the navigation that you found particularly easy or challenging?
- Can you explain how you understood the navigation structure of the website?
- Were there specific terms, labels, or icons that were unclear or confusing to you?
- Were there any difficulties along the way?
- Were there alternative paths or features you considered using for the task?
- Were there any moments where you felt the navigation slowed you down?
- Do you have any preferences regarding the placement of navigation elements, such as menus or buttons?
- Were your expectations about the website's navigation met during your interaction?
- Did you find any part of the navigation mentally taxing or confusing?
- Were there moments where you had to stop and think about how to proceed?
- Were there particular points where you felt uncertain about your actions?
- If you could change one thing about the navigation, what would it be?
- Are there specific features or enhancements you would suggest to improve the navigation experience?
- Did you find the navigation accessible and user-friendly? Why or why not?
- How did you feel about the visual design of navigation elements? Did it aid or hinder your understanding?
- Were there any specific visual cues or indicators you found helpful or confusing?
- What aspects of the navigation contributed most to your overall satisfaction or dissatisfaction?