Using Web Analytics and Usability Testing to Optimize Usability for Data Dashboards: A case study.

TzuNing Huang (s2425246)

Faculty of Behavioural, Management and Social Science (BMS), University of Twente

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Dr. Joyce Karreman

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Abstract

Delivering information online in an optimum way is becoming increasingly crucial for governmental organizations to effectively communicate with their target audiences. One practical way of relaying information over the web is through the use of data dashboards, which allow complex data to be visualized and interpreted. Moreover, it was found that the usability of the dashboards themselves play a substantial role in how effective they actually are. Recent web analytics tools have emerged with the purpose of improving data dashboards, through assessing user behavior and pain points. However, web analytics results come with their own potential of misinterpretation, which is a considerable limitation. This research proposes that we can supplement web analytics with usability testing, which can provide us with the missing qualitative insights into user challenges and suggestions. Furthermore, research on the combined use of both is currently insufficient. Thus, this paper will address how usability testing can complement web analytics with the purpose of improving data dashboards, by taking Kennispunt Twente as a case study. At the end of the paper concrete improvement points are listed, gathered through the combined method of web analytics and usability testing.

Keywords: data dashboards, web analytics, usability testing, usability

Introduction

In the Information Age, delivering an optimal online experience is crucial for governmental organizations to effectively communicate with their target audiences. Over time, the internet has become an indispensable tool, especially for such organizations, to reach audiences, provide information, and conduct interactive operational transactions (Cebi, 2013). Therefore, websites have become essential channels for information and service delivery between governmental organizations, citizens, and other stakeholders (Elling et al., 2007).

A critical way of effectively disseminating information through websites is the use of data dashboards. As stated by Abd-Elfattah et al. (2014), data dashboards have become indispensable for displaying, visualizing, and analyzing complex data, offering real-time insights for better decision-making. In short, they are visual representations of data that offer an in-depth, quick view of key metrics and data points. Data dashboards manage to enhance comprehension by making use of colors and high data-to-ink ratios, while also being designed to align with human cognition principles (Abd-Elfattah et al., 2014). Franklin et al. (2017) further emphasize that effective visualizations through such dashboards can support better detection, interpretation, understanding, and evaluation of information for real-time decision-making. Thus, the usability of data dashboards plays a decisive role in how information is effectively presented and understood online.

This study concentrates on usability in the context of data dashboards, as illustrated through a case study of Kennispunt Twente, a non-profit government-related research organization. This organization serves the fourteen municipalities in the Twente region and SamenTwente in the Netherlands. It utilizes data dashboards to provide high-quality management information to help administration, management, and policy officers make informed decisions and develop effective policies for the region. The dashboards of Kennispunt Twente fall under the category of information websites, as defined by Cebi (2013). Therefore, thorough evaluation is needed to ensure and enhance the dashboards' quality (Elling et al., 2007). According to Young et al. (2021), many city administrations use dashboards to present local government data via open data portals. Thus, the

usability of dashboards is critical in making sure that users can quickly and easily access relevant information and therefore contribute to informed decisions.

With the aim of optimizing usability, it is essential to understand user behavior and identify the data dashboards' pain points. As suggested by Palomino et al. (2021), web analytics have emerged as a significant tool in achieving this goal, as it is increasingly being employed to assess user behavior on websites. It comprises the process of monitoring, gathering, analyzing, and reporting web data with the aim of comprehending and enhancing web usage (Beri & Singh, 2013). Specifically in relation to data dashboards, web analytics can help identify the most frequently used areas of the dashboard, areas that cause confusion or errors, and patterns in user navigation.

However, to gain a comprehensive understanding of user behavior and experience, it might be beneficial to further supplement web analytics with usability testing. Since web analytics can only offer quantitative data about user interactions (Palomino et al., 2021), usability testing is able to provide the lacking qualitative insights into user challenges, preferences, and suggestions for improvement (Barnum, 2020). This combination of methods might be able to offer a thorough understanding of user behavior and experience, thus improving the usability of data dashboards.

While there is a significant amount of literature available on web analytics and usability testing individually, research on the combined use of these methods is currently insufficient. Therefore, the aim of this study is to review the research and work conducted to improve usability in data dashboards by using web analytics and usability testing. This research used the Kennispunt Twente case study to test if these methods can be employed synergistically to inform data-driven design decisions for the dashboards. The findings would contribute to an understanding of how dashboards can be effectively designed and implemented to improve user interactions and decision-making processes. Specifically, this research aimed to answer the following question: How can usability testing complement web analytics findings to enhance the usability of the data dashboards?

Theoretical Framework

Definition of Usability

It is critical to develop a precise definition of "usability" for the context of this study since the term carries various meanings within the fields of software and product design. Over the years, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) have published several formal definitions of usability.

Namely, ISO/IEC 9126 (1991) presented usability as a cluster of features that affect the required effort and user evaluation of a product. This was refined by ISO 9241-11 (1998), which defined usability as the effectiveness, efficiency, and satisfaction with which users can achieve specific goals. However, due to the limitations posed by its abstract nature (Seffah et al., 2006), this definition underwent a comprehensive review, leading to its revised version in 2018. The revised definition extended the scope to systems as well as services, considered broader outcomes, reframed efficiency, and broadened satisfaction considerations (ISO, 2018).

Among the variant definitions, ISO/IEC 9126-1 (2001) describes usability as a software quality attribute with five components: understandability, learnability, operability, attractiveness, and compliance. In contrast, the Institute of Electrical and Electronics Engineers (IEEE) focuses on user-friendliness (IEEE, 610.12, 1990). As per IEEE 610.12 (1990), usability is defined as the simplicity with which a user is able to get the hang of operation, data entry, and result interpretations of a system or constituent (IEEE, 1990).

Given these variant definitions, the operational definition of usability followed in this paper is ISO 9241-11 (2018) definition.

Web Analytics

Web analytics is a vital method for understanding user behavior and improving the usability of websites. It involves the measurement, acquisition, analysis, and reporting of data gathered from the internet (Bekavac & Garbin Praničević, 2015). This process typically incorporates various metrics, data acquisition techniques, data transformation, and report generation to aid decision-making processes (Bekavac & Garbin Praničević, 2015).

The use of web analytics has grown in recent years, with organizations employing these methods to evaluate user behavior on websites (Palomino et al., 2021). It allows for the collection and transformation of information about user interactions into quantitative data for analysis. This process offers valuable insights into user behavior and the technical aspects of user access (Palomino et al., 2021).

Prior to the discussion of broad applications in web analytics, a comprehensive understanding of the specific metrics involved is necessary. There are several metrics that can be used in web analytics, such as page views, time on site, bounce rate, exit rate, and so on (Beri & Singh, 2013). To specify, 'page view 'referred to the total number of pages viewed or refreshed in the raw browser used by the user; 'Average time on page 'was the average amount of time that the user spent on a certain page. 'Bounce rate 'indicated the percentage of single-page sessions in which the user exited the site without interacting with the page, whereas 'exit rate 'depicts the percentage of exits from the site that have taken place from a particular page (Google, n.d.). Simply put, bounce rate gives apprehension about the first and only page in a user's journey, whereas exit rate provides insights about the last page in a user's journey. Each of these metrics provides unique insights into a website's usability, design, or structure and can guide improvements to boost conversion rates and overall user satisfaction (Beri & Singh, 2013).

Building upon these metrics, web analytics has found extensive use in a multitude of areas. These include traffic monitoring, e-commerce optimization, digital marketing, and information architecture (Palomino et al., 2021). Notably, Google Analytics is recognized for its comprehensive and powerful features for tracking website activity and user behavior (Palomino et al., 2021). Its user-friendly interface, coupled with powerful data reporting functionalities, has been proven for its efficacy in recording and interpreting web traffic and user behavior within website content (Fang, 2007; Palomino et al., 2021). As a result, Google Analytics has proven to be an instrumental tool in guiding usability decisions.

Specifically, a feature found in Google Analytics, known as "user flow" or event tracking, has demonstrated efficacy in guiding decisions to improve website usability and functionality (Vecchione et al., 2016). User Flow represents the sequence of actions that a user takes within a system in order to achieve a specific goal, thus offering a more comprehensive perspective of a user journey throughout data dashboards (Takahashi, 2016). By gaining an understanding of users 'journeys, improving the website's structure and content becomes beneficial in meeting user requirements and preferences (Takahashi, 2016).

However, despite its numerous applications and insights, web analytics is not without limitations. A key limitation of web analytics is its potential for misinterpretation due to a lack of qualitative understanding of the data (Palomino et al., 2021). For instance, consider the web analytics metric 'bounce rate,' which measures the proportion of users leaving a website after viewing a single page. A high bounce rate might be prematurely interpreted as a bad user experience, whereas it could imply that users found exactly what they were searching for on the first page. Therefore, it could be essential to consider the qualitative context in web analytics to accurately interpret user behavior and website performance.

Ultimately, though the misinterpretation of data poses a potential limitation, the insights that can be gained from Web Analytics are highly valuable. With the attainment of an adequate understanding and interpretation of data, insightful conclusions can be drawn through the processes of Web Analytics that may not have been known before. Consequently, the resulting knowledge can play a key role in designing websites that effectively aligns with users' specific needs and preferences.

Usability Testing

Usability testing is an essential aspect of the development process, as it aims to help developers create more user-friendly products (Lewis, 2012). This evaluation method is able to measure how well users can use a specific interactive system and ensure the products meet the needs of end-users (Zhang & Adipat, 2005; Niranjanamurthy et al., 2014). In addition, it can mitigate any

negative consequences arising from end-users 'usage (Bastien, 2010). A well-designed usability test elicits user feedback on the ease of use and enjoyment of an application, as well as evaluates the levels of task performance achieved by users (Zhang & Adipat, 2005).

Usability evaluations utilize both expert-based and user-based methods, with usability testing as the primary method for user-based methods (Sauer et al., 2020). It involves individuals interacting with a product while being observed by evaluators, which allows for the collection of quantitative and objective data on user behavior, such as efficiency, effectiveness, errors, and usage problems (Sauer et al., 2020). Although usability itself cannot be directly measured, it can be evaluated through various measurable parameters, including subjective user experiences and objective performance (Haaksma et al., 2018).

While measures of perceived usability are standard practice in usability tests, affective aspects, such as fun and pleasure, have recently gained importance in product usage (Sonderegger et al., 2016). Usability testing studies are widely recognized as an effective means to understand users' goals, motivations, and engagement with a product (Barnum, 2020). The combination of various usability testing methods can help identify areas for improvement and increase overall user satisfaction (Niranjanamurthy et al., 2014).

The standard guideline for usability testing stipulates that participants should be provided with specific tasks embedded within realistic scenarios (Barnum, 2020). This setup enables researchers to observe users' methods for achieving their goals (Barnum, 2020). During a usability test, observers watch participants perform specific tasks with the product in a specific test environment (Lewis, 2012). Usability testing can be applied to various types of prototypes and products, including low-fidelity, high-fidelity, mixed-fidelity prototypes, products under development, predecessor products, or competitive products (Lewis, 2012). Common goals for usability testing include efficiency, effectiveness, engagement, error tolerance, and ease of learning (Barnum, 2020). Performance measures in usability testing are divided into indicators of effectiveness and efficiency, where

effectiveness refers to the successful completion of a task and efficiency concerns the ease with which tasks are carried out (Sonderegger et al., 2016).

Additionally, one popular guideline for usability testing is Nielsen's principle, which suggests that 85% of usability problems can be identified by testing with only five users (Chow et al., 2014). Nevertheless, this principle has significant limitations based on unique contexts and individual user differences (Chow et al., 2014).

Further, there are multiple classifications for the types of usability testing. Based on Zhang & Adipat (2005), there are two major methodologies employed in usability testing: laboratory experiments and field studies. Laboratory experiments involve human participants accomplishing specific tasks using a mobile application in a controlled setting, while field studies allow users to interact with mobile applications in real-world environments (Zhang & Adipat, 2005). The selection of an appropriate methodology depends on the objectives and usability attributes of the study (Zhang & Adipat, 2005).

On the other hand, Barnum (2020) stated that there are two types of test design which are formative and summative evaluation. Formative usability testing focuses more on qualitative data, while summative usability testing emphasizes quantitative data. Formative evaluation, typically used for products in development, involves the think-aloud protocol, where users share their thoughts while working through tasks (Barnum, 2020). Summative evaluation aims to establish benchmarking metrics for effectiveness, efficiency, and satisfaction by presenting users with tasks or scenarios without the think-aloud protocol (Barnum, 2020). This approach allows participants to move through tasks as realistically as possible, providing metrics for time on task, completion rates, and other measures (Barnum, 2020).

Summary of Theoretical Framework

The theoretical framework for this study starts with the definition of usability. This research has adopted the ISO 9241-11 (2018) definition of usability. The decision was driven by the broad scope of this definition, accounting for effectiveness, efficiency, satisfaction, and the context of use

while taking both individual and organizational outcomes into consideration. Adopting this contemporary standard would direct the analysis and evaluation of usability in the context of this research, giving a comprehensive, up-to-date, and standard-compliant perspective.

With a clear understanding of usability, the framework introduces the concept and application of web analytics. Web analytics is a critical instrument for comprehending user behavior, optimizing online experiences, and addressing usability issues (Bekavac & Garbin Praničević, 2015). Among the various web analytics tools available, this research uses Google Analytics due to its proven efficacy for tracking and reporting information about user behavior (Palomino et al., 2021). However, considering the potential for misinterpretation due to a lack of qualitative understanding, this research explores a complementary approach to enrich the quantitative insights of web analytics.

In response to this limitation, this study implements summative usability testing. Since summative usability focuses on quantitative data, which allows more data-driven decisions, post-test interviews are used to gain more qualitative data. The selection of this testing method helps to reduce any potential language confusion during the testing process, as the interface language of the data dashboards is Dutch while post-test interviews are conducted in English. Moreover, this approach operates perfectly in accordance with the requirements of the ISO 9241-11 standard of usability, which ensures the validity and reliability of this research in evaluating usability.

Methodology

This research aimed to enhance the usability of the data dashboards featured on the Twente Social Domain Monitor website, managed by Kennispunt Twente. To achieve this objective, the research methodology would combine both Web Analytics and Usability Testing to test how usability testing can complement web analytics findings.

Consequently, the methodology of this paper is divided into three main parts: Materials, Web Analytics, and Usability Testing. First, the Materials section is primarily focused upon the common or principal testing material applied in both subsequent approaches, hence describing the primary material. Second, the Web Analytics approach describes the corresponding secondary

materials, procedure, and data analysis executed. Conversely, the following section describes the Usability Testing approach in which the complementary participants, secondary materials, procedure, and data analysis are discussed.

Materials

The main material for this research was the Twente Social Domain Monitor website (TMSD) managed by Kennispunt Twente. Particularly its three data dashboards: "Inwoners met ondersteuning" (residents with support), "Achtergronden" (backgrounds), and "Aanbieders" (providers). These data dashboards displayed a wealth of data relating to youth care, youth protection, and youth probation under the Youth Act, as well as support services like domestic assistance, daytime activities, individual guidance, and resources under the Social Support Act (Wmo) across all municipalities in the Twente region. To access these dashboards, users need to navigate through the Thema's page (Home page), proceed to the general information section, and then arrive at the respective data dashboards as shown in Figure 1.

Figure 1
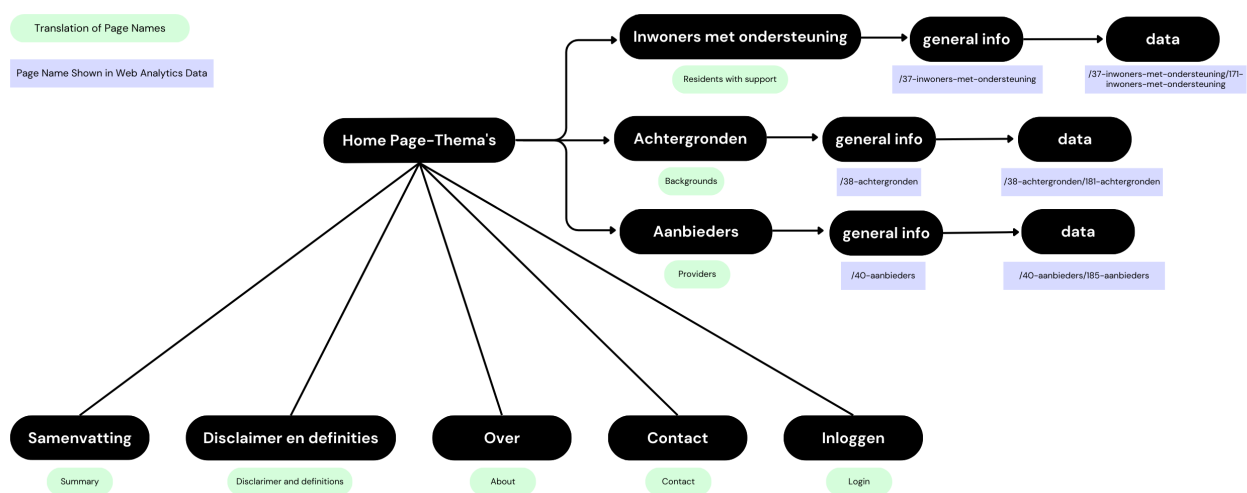
Navigation Flow of Twentse Monitor Sociaal Domain

In addition, as showcased in Figure 1, the website hosts several other pages: *Samenvatting* (Summary), *Disclaimer en definities* (Disclaimer and Definitions), *Over* (About), *Contact*, and *Inloggen* (Login). While the Contact and Login pages are straightforward in their purpose, the other

sections serve to deepen the user's comprehension of the data dashboards. The *Samenvatting* page provides an overview of the TMSD, which indicates the usage of youth assistance, protection, probation under the Youth Act, and domestic support under the Social Support Act (Who). The *Disclaimer en definities* page addresses the sources of data for the TMSD, thus adding credibility to the information presented. Lastly, the *Over* page offers details regarding the TMSD's creation and overall purpose, offering users valuable context about the dashboards' content and intent.

These sections contextualize the presented data, explaining the purpose and content of the dashboards. These sections thereby support users in effectively understanding and interacting with the data dashboards, enhancing their experience in navigating and interpreting the data presented. Given their importance to overall usability, this research will include an analysis of these sections alongside the examination of the three primary data dashboards.

Web Analytics

Secondary Materials

The main used for web analytics for data collection in this study was Google Analytics.

Procedure

data was compiled over a period of three months, from 1st of February to 1st of May in 2023. Insights gained from the analysis informed the design of tasks for the subsequent usability testing phase.

Data Analysis

The collected data from Google Analytics was divided into three categories for analysis: Overview of User Engagement, User Interaction Metrics, and User Flow. Firstly, the overview of user engagement included the numbers of total users, new users, total sessions, sessions per user, average duration per user, and the overall bounce rate in terms of new visitors and returning visitors. It provided an indication of the size of the website's audience and the frequency of user interactions. Secondly, user interaction metrics contained page views, average time on page, bounce Rate, and exit rate, all of which provided information about how users engaged with the website.

Thirdly, user flow was analyzed individually through the interpretation of data revealed by Google Analytics as a means to evaluate user behavior patterns.

Usability Testing

Participants

Through the process of convenience sampling, usability testing engaged a total of nine participants, aged between 21 and 25 years old. The gender distribution was 22% female and 78% male. It's noteworthy to mention that all participants demonstrated proficiency in reading Dutch, which was a critical requirement for this study. Moreover, none of these participants had previous experience with the data dashboards, thus offering the perspective of first-time users.

Secondary Materials

The data collection for the usability testing phase of this study did not rely on any specialized software. The participants' interactions with the dashboards were captured using screen recording technology, providing quantitative data on user interactions with the dashboards. In addition, manual note-taking was used for recording observations and metrics.

After the completion of tasks, post-test interviews were conducted. The interviews were transcribed and then coded into four main themes: General Experience, Difficulties, Positive Feedback, and Recommendations. Both manual notetaking and post-test interviews served to collect qualitative data.

Procedure

The procedure for the usability testing started with a brief session where the purpose of the study was explained to the participants. During this stage, informed consent was obtained from each participant through oral agreement. Participants were assured that their participation was voluntary, their responses would remain confidential, and they could withdraw at any time without any repercussions.

After the agreement, participants were asked to execute six specifically designed tasks. These tasks were formulated based on the findings from the web analytics stage, which ensured they were data-driven and contextually relevant. The tasks are shown in the following table:

Table 1

Tasks of usability testing

Task Number	Tasks Questions
1	Find the specific percentage of the share of residents with youth care at Hengelo in 2021.
2	Imagine you are looking for more detailed background information related to Wmo support at different age groups. Locate this information on the website.
3	What is the most common provider of youth care at Almelo in 2021 and what is the number of indications of it?
4	Tell me what is OZJT/Samen14 about?
5	What is the specific percentage of women with support from age 65 to 74 at 2020?
6	Go to the *Disclaimer en definities page*. Based on the information available on this page, explain what this page is about.

The tasks were designed to take approximately 5–15 minutes to complete, depending on participants' individual pace and understanding. After completing the tasks, a post-test interview was conducted to gain deeper insights into participants' experiences and perceptions. These interview questions have been outlined below. Notably, the interviews lasted approximately 15–30 minutes. Participants' recorded responses were then recorded and transcribed. The interview questions included:

1. How would you describe your overall experience with the website?

2. Which tasks were easy to complete, and why do you think they are hard to complete?

3. Which tasks were difficult to complete, and why do you think they were hard to complete?

4. What content or features on the website helped you in completing the task?

5. What content or features on the website hinder you from completing the tasks?

6. How do you feel about the navigation of the website?

7. How confident do you feel that you would be able to find the information you need using this website?

8. What do you think about the data presented on the website? Is it easy to understand?

9. How clear do you think the information provided on the website is? Were there any pages or sections that you found confusing?

10. What improvements would you suggest to make the website more user-friendly?

After this pos-test interview, participants' answer were recorded and transcribed for further analysis.

Data Analysis

Upon completion of the usability testing, the metrics analyzed effectiveness, efficiency, and satisfaction. Firstly, *Success Rates* provided an indication of the overall effectiveness of the website's design and layout in facilitating user navigation and information retrieval.

Secondly, *Completion Time* for each task and *Average Page Views* per task were measured to provide insight into the data dashboards' efficiency. The shorter the task completion time, the more efficient the website is considered. Besides, average page views represented the average number of pages that participants viewed in order to complete each task. A lower number of page views often indicates a more intuitive and user-friendly website design, as users can locate the information they need with fewer navigational steps. This metric was important in understanding whether users could quickly find the information they were looking for or complete their intended actions.

Lastly, *Insights from Post-test Interviews* provided qualitative insights on user satisfaction. Participants' comments and feedback were analyzed to identify common themes and recurring issues. The post-test interviews were coded into four themes: General Experience, Difficulties, Positive Feedback, and Recommendations. This analysis provided deeper insight into user satisfaction and potential areas for improvement that quantitative metrics alone might not fully capture.

Results

This section presents the findings obtained from the research methodology employed, which included both web analytics and usability testing. The results are divided into two distinct parts: Web Analytics Results and Usability Testing Results.

Results from Google Analytics

Overview of User Engagement

The website attracted a total of 99 visitors, out of which 90 were new visitors, indicating a high proportion of first-time visitors during the data collection period, as shown in Figure 2. The site facilitated 142 sessions, with an average of 1.43 sessions per user. This suggests that a fair number of users were engaged enough to return to the website.

Figure 2

Audience & User Engagement Overview
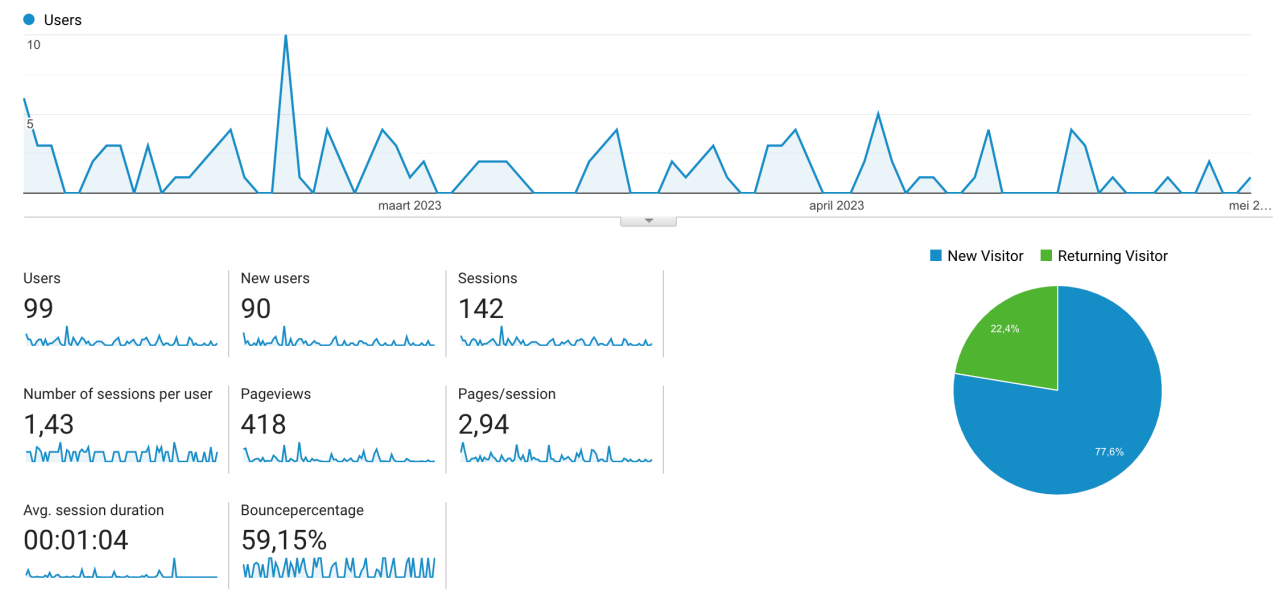
The average session duration was calculated at 1 minute and 4 seconds, highlighting the time users spent on the website during their visits. When this metric was split between new and returning visitors, it was found that new visitors spent an average of 55 seconds, while returning visitors spent a longer average duration of 1 minute and 21 seconds.

The overall bounce rate, which represents the percentage of sessions where a user leaves the site after viewing only a single page, was found to be 59.15%. When dissected further, the bounce rate for new visitors was slightly higher at 60%, compared to 57.69% for returning visitors.

User Interaction Metrics

These metrics provided data on how users interacted with the website and offered valuable inputs for the usability test. Specifically, the data helped identify problematic areas of the website and guided the development of tasks to assess these issues during usability testing.

Table 2 presents a summary of user interaction metrics for all pages of the site. To make the page identifiers more manageable, the page names simplified the terms: *'Home', 'Support', 'Background', 'Provider', 'Summary', 'About'* and *'Disclaimer'*.

Table 2

Site Content for All Pages

Page	Pageviews ↓	Unique pageviews	Avg. time on page	Entry points	Bouncepercentage	Exit rate
	418 % of total:100,00% (418)	304 % of total:100,00% (304)	00:00:33 Avg. for data display:00:00:33(0,00%)	142 % of total:100,00% (142)	59,15% Avg. for data display:59,15%(0,00%)	33,97% Avg. for data display:33,97% (0,00%)
1. /home	165 (39,47%)	97 (31,91%)	00:00:19	79 (55,63%)	59,49%	36,36%
2. /37-inwoners-met-ondersteuning/171-inwoners-met-ondersteuning	50 (11,96%)	40 (13,16%)	00:01:23	15 (10,56%)	46,67%	28,00%
3. /40-aanbieders/185-aanbieders	48 (11,48%)	44 (14,47%)	00:01:04	20 (14,08%)	90,00%	66,67%
4. /samenvatting	39 (9,33%)	30 (9,87%)	00:00:47	14 (9,86%)	50,00%	35,90%
5. /37-inwoners-met-ondersteuning	27 (6,46%)	21 (6,91%)	00:00:08	4 (2,82%)	0,00%	14,81%
6. /38-achtergronden/181-achtergronden	23 (5,50%)	21 (6,91%)	00:01:17	1 (0,70%)	0,00%	26,09%
7. /40-aanbieders	17 (4,07%)	13 (4,28%)	00:00:04	2 (1,41%)	0,00%	0,00%
8. /38-achtergronden	16 (3,83%)	12 (3,95%)	00:00:04	2 (1,41%)	50,00%	12,50%
9. /disclaimer-en-definities	16 (3,83%)	11 (3,62%)	00:00:18	3 (2,11%)	66,67%	25,00%
10. /over	12 (2,87%)	10 (3,29%)	00:00:07	2 (1,41%)	100,00%	33,33%

The most visited page was the *Home* page (39.47% of total views), followed by the *Support* page (11.96%), and the *Provider* page (11.96%). In terms of average time on page, users typically spend about 33 seconds per page. The *Support* page had the highest average time at 1 minute and 23 seconds, followed by the *Provider* page at 1 minute and 4 seconds. Users spent the least time on the *Provider* and *Background* pages, at 4 seconds each.

The overall bounce rate for the website was relatively high, at 59.15%. The *Home* page had a bounce rate of 59.49%, whereas the *Support* page had a slightly lower bounce rate of 46.67%. Both the *Summary* page and the *Background* page had a bounce rate of 50.00%. The *Disclaimer* page had a bounce rate of 66.67%, and the *About* page had the highest bounce rate of 100.00%. The *Provider* page experienced a particularly high bounce rate of 90%. Conversely, there was no bounce rate (0.00%) recorded for the Support, *Background*, and *Provider* pages.

The total exit rate for the website was 33.97%. The *Provider* page had the highest exit rate at 66.67%, meaning most users ended their browsing here. This was followed by *Home* at 36.36%, *Summary* page at 35.90%, and *Background* page at 26.09%. The *Provider* page interestingly, also had an exit rate of 0.00%, indicating users always navigated elsewhere on the site after viewing this page.

User Flow

The User Flow graph provided an insightful perspective on the navigation behavior of visitors on the website. Figure 3 shows that users of this website typically engage in a sequence of up to four interaction steps.

Figure 3

User Flow graph

From a total of 142 visits, significant drop-off rates were observed at various stages of interaction: 60.56% at the starting pages, 28.57% at the first interaction, 20% at the second, and 21.87% at the third.

Focusing on the starting pages, the *Home* page was the entry point for 55.63% of users, while it had a high drop-off rate of 62%. The *Provider* page, accessed by 14.08% of users, showed a higher 90% drop-off rate. The *Support* page, visited by 10.56% of users, had a 46.7% drop-off rate. Meanwhile, 9.86% of users began on the *Summary* page with a 50% drop-off rate. The *Support* page saw a 0% drop-off rate, with only 2.81% of user visits.

For the first interaction, 39.44% of users progressed beyond the starting page. Among these, 28.57% went to the *Home* page, with a 25% drop-off rate. 17.86% navigated to the *Support* page (20% drop-off rate), while another 17.86% moved to another section of the *Support* page with a higher 40% drop-off rate.

Moving to the second interaction, 71.43% of users continued, with a 20% drop-off rate. The *Home* page remained popular, attracting 27.5% of users. The *Support* page saw 22.5% of users, with a 22.2% drop-off rate.

In the third interaction, 80% of users proceeded from the second interaction. The *Home* page was the most visited, attracting 25% of users with a 12.5% drop-off rate. Both the *Background* and *Provider* pages each had 12.5% of users with high drop-off rates of 50%.

Results of Usability Testing

Usability testing aimed to measure three core aspects of usability: effectiveness, efficiency, and satisfaction. Effectiveness was evaluated based on task success rates; efficiency was accessed by analyzing task completion times and page views; and satisfaction was measured through post-test interviews.

Effectiveness

Results from the usability testing revealed various success rates for the assigned tasks, as presented in Figure 4. Task 3 had the lowest success rate of 22.22%, while Task 1 had a slightly

higher success rate at 33.33%, followed by Task 2 at 55.56%. Tasks 1 and 3 required participants to find specific information on data dashboards, highlighting the challenges participants faced when searching for information on data dashboards. These comparatively lower success rates indicate concern regarding the effectiveness of the data dashboards for information retrieval.

Contrarily, tasks 5 had a high success rate of 88.89%, while tasks 4 and 6 had perfect completion rates of 100%. As tasks 4 and 6 were related to content understanding from the *About* and *Disclaimer* pages respectively, it reflected that participants found the content intelligible and accessible, a positive attribute contributing to the website's effectiveness.

Figure 4
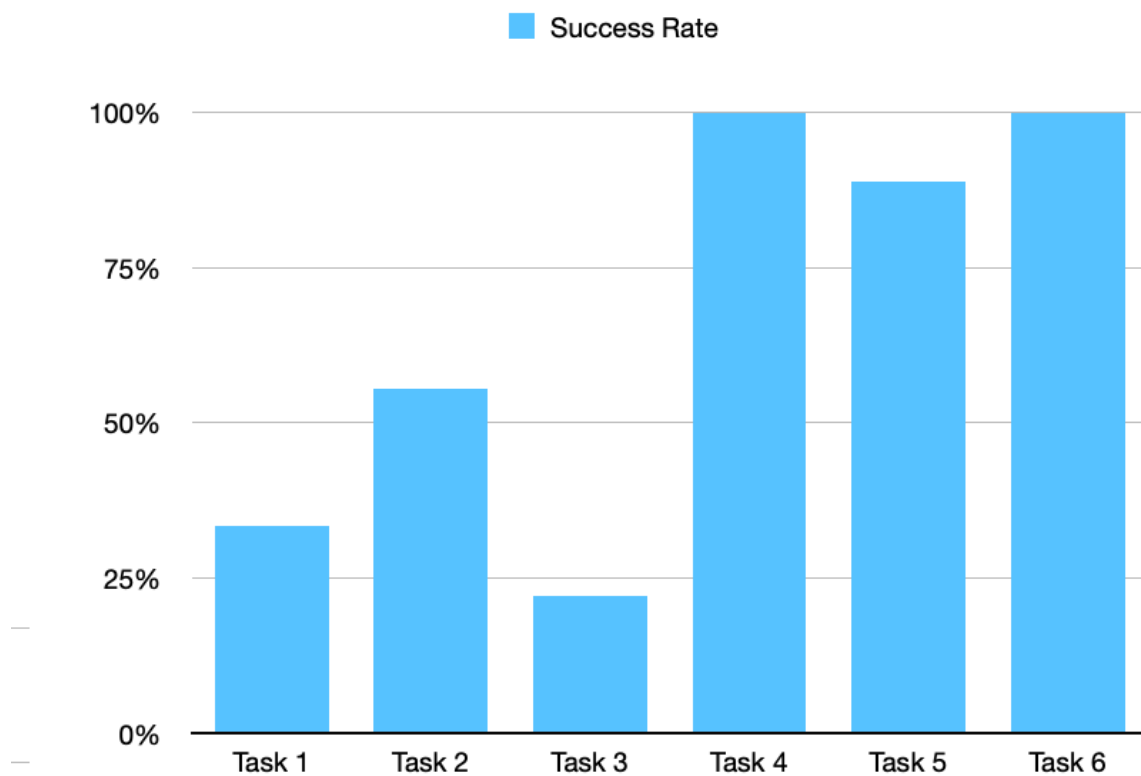
Success Rate for all the tasks

Efficiency

Efficiency was analyzed by examining the completion time for each task and the average number of page views per task. As shown in Figure 5, task 5 took the longest, with an average of 2 minutes and 19 seconds, while Task 4 was completed the quickest, in an average of 49 seconds. Task 3 took an average of 1 minute and 30 seconds. Tasks 1 and 2 had similar average time spent of 1 minute and 45 seconds, and 1 minute and 45 seconds, respectively.

More specifically, Task 5, which involved navigating to the *Background* page, presented the least efficiency, indicating users struggled to locate the information on this page. Moreover, Tasks 1 and 2 also displayed a higher time requirement, which reflects the potential for optimization to enhance user efficiency.

Figure 5
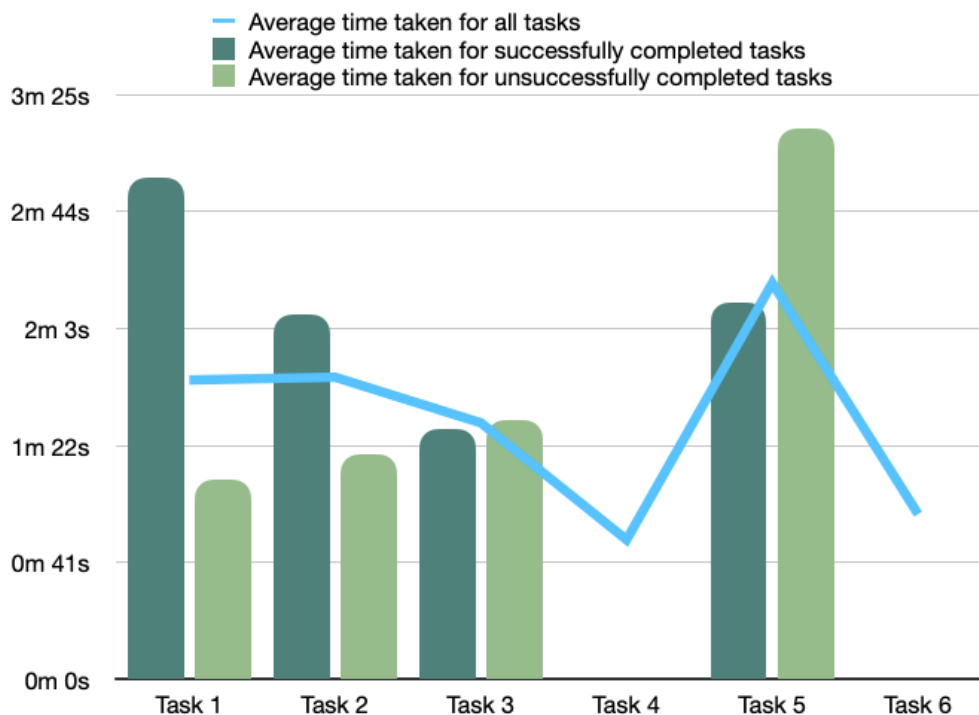
Tasks Completion Times

Figure 5 also demonstrated the difference between the completion times of successful and unsuccessful tasks. It showed that Task 5 took longer on average when unsuccessful (3 minutes and

13 seconds) than when successful (2 minutes and 12 seconds). Besides, task 3 had similar completion times for completing successfully and unsuccessfully, with 1 minute and 28 seconds, and 1 minute and 31 seconds. In contrast, tasks like Tasks 1 and 2 took less time when unsuccessful compared to when they were successful.

Additionally, average page views per task were analyzed, as displayed in Figure 6. Task 5 had the highest average with 6.33 page views, while Task 6 had the fewest with just 2 page views on average. The other tasks ranged between 3 and 3.67 in average page views. These suggest that the task 5 had the lowest efficiency, while task 6 had the highest efficiency.

Figure 6

Average Page Views per Tasks
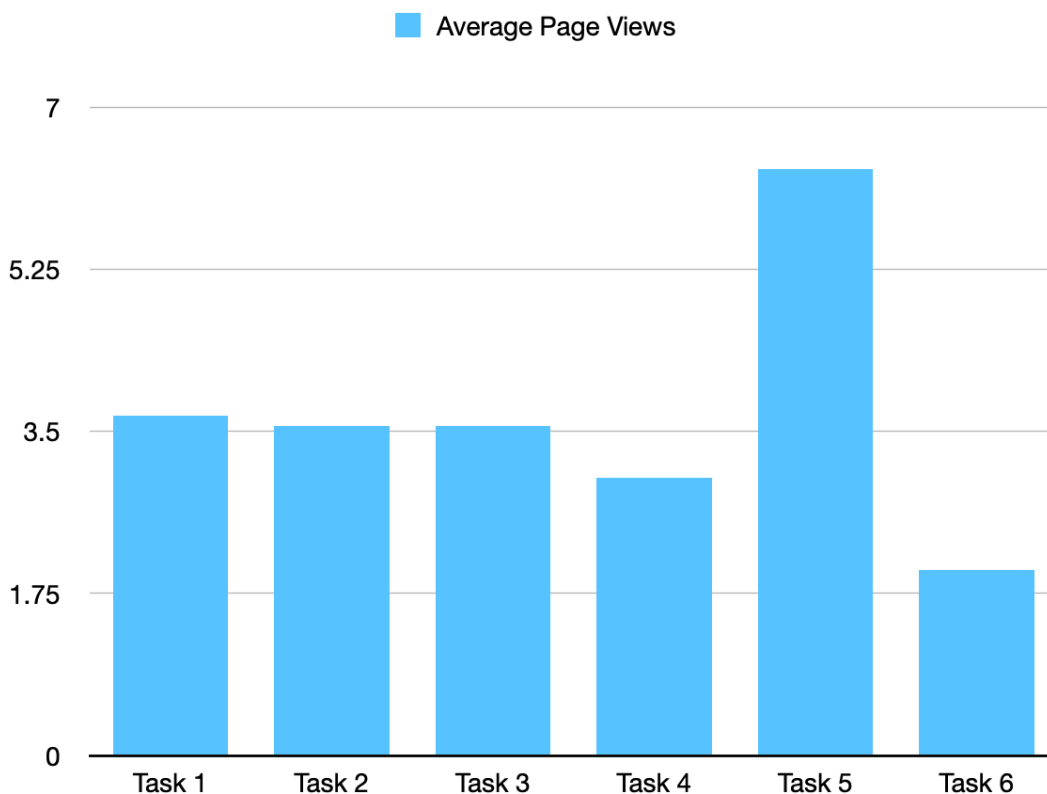
The minimum and maximum page views for successfully completed tasks were also analyzed, as illustrated in Figure 7. Task 1 had the largest range with a minimum of 2 and a maximum of 13, while Task 6 had the smallest range with both minimum and maximum values being equal to 2.

Figure 7

Comparison of Minimum and Maximum Page Views for Successfully completed Tasks
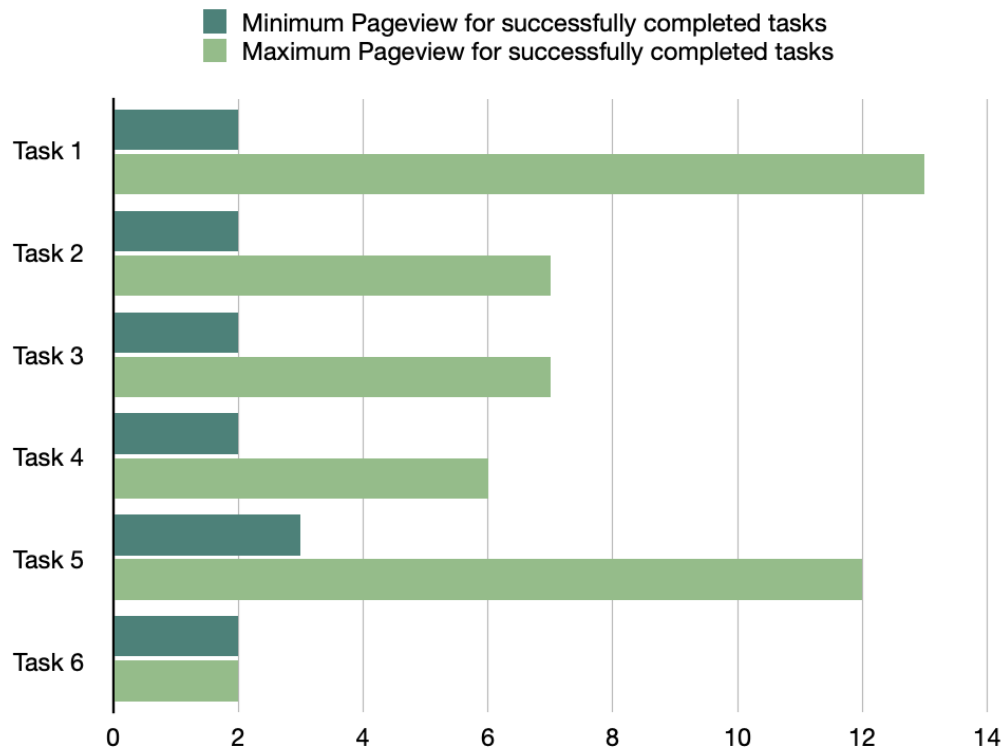
Satisfaction

The satisfaction aspect of usability testing was analyzed by gaining direct feedback from participants through post-test interviews. The general experience varied across participants, ranging from expressing difficulty and confusion to asserting that the website was clear and easy to use.

Several participants expressed concerns about the complexity and navigability of the website and data dashboards. For instance, Participant 1 mentioned that "The website feels complicated. It feels like information is scattered everywhere instead of on a specific page," and Participant 7 stated, "Pretty bad to be honest, I found it very difficult to navigate and locate information." Such feedback suggests users' struggles in locating specific information and highlights a need for improved site navigation and information structure. More specifically, the comments regarding the confusing homepage and data dashboards buttons were consistent across most participants, accentuating the

issues with the accessibility of the data dashboards. They were unsure about the purpose and content of these buttons, and this confusion decreased the efficiency of completing task 5, which required accessing the data dashboards on the *Background* page. Furthermore, difficulties with understanding data filters were a notable concern that caused many participants to fail Task 3, and the issue of long loading times for data dashboards, averaging 8.25 seconds, negatively impacted the overall user experience.

On the contrary, positive feedback was also received. For instance, Participant 2 commented, "I think it's easy to find some specific information and everything is clear," and Participant 4 noted, "The information is clear, but sometimes I don't know where to look." This feedback suggests that while the information on the site is clear once accessed, finding the required information can be challenging. Moreover, there were participants who found the data dashboards clear and intuitive. Several participants stated that the data visualization was easy to understand. In addition, participants also like the drop-down menu and navigation bars.

It is also significant to note that some participants had a more balanced experience. Participant 3 said, "Overall, I was able to find all the information, but it took a bit of time," implying that while they eventually found the information, the process was more time-consuming than expected. Similarly, Participant 5 enjoyed their experience despite a few difficulties with categorization: "Pretty nice experience despite some struggles finding the specific task requested because I wasn't sure what information went in what category".

Overall, while there were positive aspects about the user experience, the general feedback suggested the need for improved navigation, better categorization, and a more intuitive design to make information easily discoverable. This feedback forms a crucial foundation for enhancing user satisfaction. Accordingly, several actionable recommendations have been proposed. They include renaming the homepage for greater clarity, improving the accessibility and presentation of the data dashboards, and enhancing navigability through the addition of a search bar and better visibility of

the homepage icon. Implementing these changes aims to address user feedback and ultimately enhance satisfaction levels during website interactions.

<p align="center">**Discussion & Conclusion**</p>

Main Findings

The main finding of this research is that usability testing can effectively complement web analytics to enhance the usability of data dashboards by providing a deeper understanding of user behavior and highlighting specific areas for improvement.

Web analytics provided a comprehensive view of user engagement, revealing valuable patterns such as the pages that received the most traffic, the time users spent on each page, the bounce rates for each page, and so on. It demonstrated that the *Home* and *Support* pages were frequently visited while having high drop-off rates; the *Provider* and *Background* pages were less engaging and had high exit rates; and the *About* and *Disclaimer* pages had extremely high bounce rates. This data hinted at potential usability issues, but it did not explain the reasons for these behaviors.

This is where usability testing played a significant role. It complemented the web analytics findings by providing qualitative insights into user behavior. It indicated specific areas of the dashboard that were challenging for users and identified potential improvements. For instance, tasks related to finding specific information on the data dashboards (Tasks 1 and 3) had low success rates and took longer to complete, indicating that information retrieval from the dashboards was challenging for users. On the other hand, tasks related to understanding content from the *About* and *Disclaimer* pages had high success rates, demonstrating that the content on these pages was intelligible and accessible.

Participant feedback from the post-test interviews further validated these findings. Users expressed difficulties with the complexity and navigability of the website and the data dashboards. However, they also appreciated the clarity of the information once they were able to find it, highlighting the need for better navigation and information structure.

To answer the research question "How can usability testing complement web analytics findings to enhance the usability of the data dashboards?", this research has demonstrated that a combination of usability testing and web analytics offers a comprehensive method for assessing and improving dashboard usability. While web analytics provides an overview of user behavior, usability testing delves deeper into user experiences, shedding light on the reasons behind the behaviors captured in web analytics. To demonstrate, usability testing provided a more detailed insight into user experiences and difficulties and contributed to clarifying why specific patterns occurred in the web analytics data. For example, the web analytics data identified possible difficulties for data dashboards by displaying high bounce rates and low page views. The explanations of these data were clarified with the implementation of usability testing. During the usability testing, most of the participants struggled with task 5, which had the longest average completion time, revealing a specific pain point: the unclear information provided by the Data Dashboards buttons. Similarly, the web analytics suggested users had difficulties navigating the website, as reflected by the high drop-off rate at various stages of user flow. This was supported by the post-test interviews, when participants repeatedly commented on their difficulties navigating the website and finding the information required.

All in all, the combination of these results provides a thorough understanding of user behavior and areas for enhancement. It emphasizes the importance of improving site navigation, enhancing the accessibility of data dashboards, and optimizing the information structure to make information easily discoverable. These improvements, based on both web analytics and usability testing findings, could significantly enhance the usability of the data dashboards.

Discussion

The findings from this research can be contextualized within the established theoretical framework, which incorporates the concepts of usability, web analytics, and usability testing.

The chosen definition of usability from ISO 9241-11 (2018), which includes effectiveness, efficiency, satisfaction, and the context of use, has been reflected in the evaluation of the web-based

systems in this study. The analysis revealed usability features within the dashboards that correspond to this definition. For example, effectiveness was observable in the success rate of the usability testing tasks. Since users can either fail or complete a task, it was easy to assess whether the dashboards were effective in helping the user achieve his tasks. Effectiveness focuses on achieving the end result. However, the process through which the users got to their end result is also relevant. This is what is also referred to as efficiency, and it was evident in the ease with which users could navigate and use the dashboards themselves. Lastly, satisfaction was determined by user feedback during post-test interviews, reflecting their perceptions of the system's functionality and design.

The application of web analytics, specifically Google Analytics, in this study has provided valuable insights into user behavior and the technical aspects of user access (Bekavac & Garbin Praničević, 2015; Palomino et al., 2021). Metrics such as page views, time on site, bounce rate, and exit rate were utilized to infer the usability of the website. However, the study also identified the limitations of relying solely on these metrics. As discussed in the theoretical framework, the data from web analytics can be misleading without the proper qualitative understanding (Palomino et al., 2021), which was confirmed in this study. For example, high bounce rates were observed for the *About* and *Disclaimer* pages, but through the post-test interviews, it was identified that users found exactly what they were looking for on those pages. This reinforces the argument made in this research that considering the qualitative context in web analytics is vital for accurate interpretation.

Usability testing is instrumental in identifying areas for improvement and enhancing overall user satisfaction (Barnum, 2020; Sauer et al., 2020). As part of the study, participants were observed while interacting with the data dashboards. Both efficiency and effectiveness, as defined in the theoretical framework, were evaluated during the testing (Sonderegger et al., 2016). Participants' task completion (effectiveness) and the ease with which tasks were carried out (efficiency) provided invaluable data that pointed out specific areas for improvement. The post-test interviews also allowed for the capture of more qualitative data, adding depth to the understanding of user experience and satisfaction.

The study's findings also endorse the theoretical framework's view of the usability testing method's type and design. The summative usability testing was effective in providing quantitative data, while the post-test interviews gave insights into qualitative aspects (Barnum, 2020). The combination of these methods ensured a more holistic understanding of the user experience, consistent with the ISO 9241-11 (2018) standard of usability.

Practical Implementation

This research illuminates important aspects of usability and web analytics that can be practically implemented for improving the design and function of digital platforms, particularly focusing on data dashboards. The case study elucidates how these principles can be applied, providing specific recommendations.

Firstly, the study identifies the need for clear navigational cues within data dashboards. Highlighting the active page in the navigation bar can mitigate user confusion and the redundant viewing of the same page. This minor adjustment can contribute significantly to usability by orienting users and helping them track their progress through the dashboards.

Secondly, the study recommends more descriptive labels for homepage elements. For instance, changing the 'theme' label to 'data,' 'statistics,' or 'data dashboards' can facilitate quicker user access to desired information.

Thirdly, the study revealed ambiguity in accessing general information on data dashboards. To resolve this, it is recommended to integrate general information directly on the homepage and provide a direct link to the data dashboards. This modification promotes simplicity and usability by reducing the cognitive load associated with navigating through additional pages.

The fourth recommendation relates to improving user interaction with data filters on data dashboards. The study suggests the use of pop-up instructions to guide users in using data filters effectively.

Finally, this study identified long loading times as a technical issue affecting the user experience. An average loading time of 8.25 seconds exceeds the 2-second threshold generally

recommended for optimal user satisfaction (Beri & Singh, 2013). Therefore, resolving this issue through technical enhancements is vital to improving usability.

These practical implementations serve as a guideline for enhancing the usability of data dashboards, by employing principles of web analytics and usability testing. However, it is vital to recognize that these recommendations are subject to the specific context of the case study and should be adapted based on unique platform requirements and user behaviors.

Limitation & Future Work

Despite those insights, the study has several limitations. The usability testing involved a relatively small number of participants. Even though the Nielsen principle suggests that testing with only five users can uncover about 85% of usability issues, it does not account for the individual differences and specific contexts that may only become noticeable with a larger group of users (Chow et al., 2014). Moreover, Nielsen's principle primarily emphasizes qualitative data (Chow et al., 2014). In contrast, summative usability testing, which was implemented in this research, was oriented more towards quantitative data, although it was supplemented with post-test interviews. Thus, it may not completely align with Nielsen's qualitative-focused approach.

Moreover, all of the participants in the usability testing were not actual end-users which means they were experiencing the website for the first time during the study. As it does not completely take into account the experiences and possible difficulties of regular users, who could engage with the site differently owing to their previous experience with the dashboard, this might restrict the insights collected.

Future research should focus on addressing these issues and exploring deeper into the possibilities of web analytics and usability testing for comprehending and enhancing usability. This could consist of conducting longitudinal research to monitor user adaptations over time as well as testing with a larger and more varied participant sample that includes actual end users. Further, to create a more comprehensive picture, future research should explore the use of a variety of usability testing methods, such as formative testing or hybrid methodologies that combine qualitative and

quantitative data. This would provide a broader view of usability issues and potential improvements. Additionally, investigations into alternative web analytics tools could be undertaken, and a subsequent round of usability testing could be carried out after implementing design modifications based on this study's findings. Continued analysis of user interaction data might produce even more thorough insights.

Conclusion

To conclude, the combination of quantitative data from web analytics with qualitative insights from usability testing enables the creation of data-driven, user-centered design recommendations, therefore improving the usability of the data dashboards. Web analytics provided valuable quantitative data, highlighting potential issues in data dashboard usage. This analytic information served as an excellent foundation for designing specific tasks for usability testing. On the other hand, usability can provide deeper insights into user behavior and perception, thus enabling usability improvements that are user-oriented.

This combination approach has proven to be effective in identifying and addressing usability flaws and creating more user-friendly and efficient data dashboards. Future work on enhancing the data dashboards should continuously employ and refine this combined approach, harnessing the power of web analytics and the profound insights of usability testing to ensure optimal usability.

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Appendix A

Literature Study Log

Literature study log: CRAAP form

#	Author(s)	Year	Title	Source	Data Accessed	Currency (1-5)	Relevance (1-5)	Authority (1-5)	Accuracy (1-5)	Purpose (1-5)	Notes	Summary
1	Beri, B., & Singh, P.	2013	"Web analytics: Increasing website's usability and conversion rate"	International Journal of Computer Applications	29.03.2023	3	4	2	4	4	Talk about how to use web analytics to increase usability. Give me general information about web analytics and what metrics to use.	This paper provides the metrics to analysis website' usability。It also talked about the general information of web analytics (definition & purpose)
2	Palomino, F., Paz, F., & Moquillaza, A.	2021	"Web Analytics for User Experience: A Systematic Literature Review"	International Conference on Human-Computer Interaction	29.03.2023	5	5	4	5	5	Discuss what is web analytics and its imitations. Mentioned that web analytics can be use for detecting potential problems!	A literature review of web analytic for UX, a comprehensive concept of how web analytics help to increase user experience.
3	Vecchione, A., Brown, D., Allen, E., & Baschnagel, A.	2016	"Tracking user behavior with Google Analytics events on an academic library web site"	Journal of Web Librarianship	29.03.2023	3	2	3	4	4	Show the way to report and analysis Google Analytics event tracking.	Discuss the way to track user behavior by using google analytics, providing information of how to report and analysis user flow.
4	Bastien, J. C.	2010	"Usability testing: a review of some methodological and technical aspects of the method"	International journal of medical informatics	11.04.2023	2	4	4	4	3	About why usability testing important and the methods of usability testing.	Discuss difference types of usability testing.
5	Chow, A. S., Bridges, M., & Commander, P.	2014	"The Website Design and Usability of US Academic and Public Libraries: Findings from a Nationwide Study"	Reference & User Services Quarterly	21.04.2023	3	5	4	4	4	Talk about information seeking and website usability: highly relevant for my case	Testing the website design and usability
6	Elling, S., Lentz, L., & De Jong, M.	2007	"Website evaluation questionnaire: development of a research-based tool for evaluating informational websites"	Electronic Government: 6th International Conference, EGOV 2007	21.04.2023	2	3	3	3	3	Discuss about data dashboards and governmental website for citizen (which match with mine research)	This paper focused on evaluating the quality of e-government website.
7	Lewis, J. R.	2012	"Usability testing"	Handbook of human factors and ergonomics	21.04.2023	3	5	5	5	5	Clear understanding and guideline for usability testing.	This book talk discuss everything for usability testing, such as what is usability testing, what types of usability testing are, how to design the test and so on.
8	Cebi, S.	2013	"Determining importance degrees of website design parameters based on interactions and types of websites"	Decision Support Systems	21.04.2023	3	2	3	3	4	Talk about different types of website.	This paper discuss the website design for information website.
9	Sauer, J., Sonderegger, A., & Schmutz, S.	2020	"Usability, user experience and accessibility: Towards an integrative model"	Ergonomics	21.04.2023	5	4	2	3	5	Talk about usability testing can enhancing overall user satisfaction.	This paper examine the concepts of usability, user experience and accessibility.
10	Fang, W.	2007	"Using Google Analytics for improving library website content and design: A case study."	Library philosophy and practice	21.04.2023	2	2	3	3	4	Tell why Google Analytics good, and guide me how to use Google Analytics	This paper uses Google Analytics for improving library website content and design
11	Bekavac, I., & Garbin Praničević, D.	2015	"Web analytics tools and web metrics tools: An overview and comparative analysis"	Croatian Operational Research Review	11.04.2023	3	3	3	4	5	Tells what metrics I can use for web analytics.	The aim of the paper is to compare and analyze the impact of web analytics tools for measuring the performance of a business model.
12	Takahashi, A.	2016	"A "User-Flow Description" Method for Usability Investigation"	HCI International 2016–Posters' Extended Abstracts	21.04.2023	3	2	2	4	4	Shows how user flow works and analyzed.	Discuss what user flow is, what can it do, and why is it important for usability.
13	Franklin, A., Gantela, S., Shifarraw, S., Johnson, T. R., Robinson, D. J., King, B. R., ... & Okafor, N. G.	2017	"Dashboard visualizations: Supporting real-time throughput decision-making"	Journal of biomedical informatics	26.04.2023	4	1	2	3	3	Tells the importance of dashboards isualization.	This paper talk about the difficulties in creating visualizations and focus on a prototype of Dashboard and how it can aid real-time decision-making.
14	Haaksma, T. R., De Jong, M. D. T, & Karreman, J.	2018	"Users' personal conceptions of usability and user experience of electronic and software products"	IEEE Transactions on Professional Communication	28.04.2023	4	2	5	5	5	Tells ow can usability be evaluated.	This paper conceptualize the usability and user experience.
15	Sonderegger, A., Schmutz, S., & Sauer, J.	2016	"The influence of age in usability testing"	Applied Ergonomics	29.04.2023	3	3	3	4	4	Tells what usability testing can measure.	This paper examine the how usability is affected by age by using usability testing.
16	Zhang, D., & Adipat, B.	2005	"Challenges, methodologies, and issues in the usability testing of mobile applications"	International journal of human-computer interaction	29.04.2023	2	3	4	4	4	Talk about different types of usability testing.	This paper discuss the methodology of usability testing.
17	Abd-Elfattah, M., Alghamdi, T., & Amer, E.	2014	"Dashboard technology based solution to decision making"	International Journal of Computer Science Engineering	30.04.2023	3		4			Focuses on dashboard technology in decision making — useful for me to cite what is data dashboard and why is it important.	Explores how dashboard technology can enhance decision-making processes.
18	Young, G. W., Kitchin, R., & Naji, J.	2021	"Building city dashboards for different types of users"	Journal of Urban Technology	30.04.2023	5	3	3	3	4	Understanding what Citi dashboards for (similar to my car study)	This study aims to optimize city dashboard design through user evaluation analysis and user-centered redesign.
19	Barnum, C. M.	2020	"Usability testing essentials: Ready, set... test!"	Morgan Kaufmann	30.04.2023	5	5	5	5	5	Comprehensive guide to usability testing. Illustrate how to conduct Usability testing.	The author presents key methods and best practices for conducting usability tests.
20	Google	n.d.	"Exit Rate vs. Bounce Rate"	https://support.google.com/analytics/answer/2525491?hl=en	09.05.2023	1 (no date given, but Google webpages are often updated regularly)	5	4	5	4	Tells what is exit rate and bounce rate. Since I am using Google Analytics, the best and the most accurate information will definitely on Google webpages)	Definition of exit rate and bounce rate, and the difference between them.
21	International Organization for Standardization/ International Electrotechnical Commission	1991	"ISO/IEC 9126, Information Technology, Software Product Evaluation, Quality Characteristics and Guidelines for their Use"	Geneva: Author	05.06.2023	1	5	5	5		For the definition of usability. Important to know which definition I will use for my research.	International standard-setting: Discuss the definition of usability over time.
22	International Organization for Standardization	2018	"ISO 9241-11: 2018 Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts"	Geneva: Author	05.06.2023	4	5	5	5		It is perfect for the literature review of the usability.	
23	International Organization for Standardization	1998	"ISO 9241-11: 1998, Ergonomic Requirements for Office Work with Visual Display Terminals (VDTs), Part 11: Guidance on Usability"	Geneva: Author	05.06.2023	2	5	5	5			
24	Institute of Electrical and Electronics Engineers	1990	"610.12-1990, IEEE Standard Glossary of Software Engineering Terminology"	Los Alamitos, CA: Author	05.06.2023	1	5	5	5			
25	International Organization for Standardization/ International Electrotechnical Commission	2001	"ISO/IEC 9126-1 Standard, Software Engineering, Product Quality, Part 1: Quality Model"	Geneva: Author	05.06.2023	2	5	5	5			
26	Niranjanamurthy, M., Nagaraj, A., Gattu, H., & Shetty, P. K.	2014	"Research study on importance of usability testing/User Experience (UX) testing"	International Journal of Computer Science and Mobile Computing	21.06.2023	3	4	2	3	4	Help me define usability testing.	The paper focus on how important the usability testing is to improve user experience.

#	Author(s)	Year	Title	Source	Data Accessed	Currency (1-5)	Relevance (1-5)	Authority (1-5)	Accuracy (1-5)	Purpose (1-5)	Notes	Summary
27	Seffah, A., Donyaee, M., Kline, R. B., & Padda, H. K.	2006	"Usability measurement and metrics: A consolidated model"	Software quality journal	24.05.2023	2	4	5	4	5	Talk about the definition of usability and the limitation towards those definition, also discuss the metrics for usability testing.	The paper aims to address the lack of integration and standardization in usability evaluation methods, providing a framework for developers to assess and improve the usability of interactive software systems.

Appendix B

Usability Raw Data

Participant 1	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	No (didn't select domain for the youth care)	No: Disclaimer	NO	Yes	Yes	Yes
Time duration	1m40s	2m17s	2m3s	38s	3m47s	33s
Page views	3	4	5	2	9	2

Participant 2	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	No (Navigate to the right page, didn't select domain for the correct answer)	Yes	No (Didn't select "domain" and "indicaties or personnel")	Yes	Yes	Yes
Time duration	1m26s	1m14s	1m43s	2m	2m40s	1m18s
Page views	3	2	2	6	9	2

Participant 3	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	Yes	Yes	No (Didn't select indicates)	Yes	Yes	Yes
Time duration	1m11s	3m29s	1m24s	52s	2m21s	2m30s
Page views	2	6	2	3	6	2

Participant 4	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	No (didn't choose youth care)	No	No (Didnt select youth care and)	Yes	Yes	Yes
Time duration	33s	19s	1m4s	1m15s	1m42s	1m44s
Page views	2	1	3	4	3	2

Participant 5	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6

Participant 1	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	No (to the wrong page (Resume))	No (went ti (declaimer))	No (didn't select indicate and youth care)	Yes	Yes	Yes
Time duration	1m5s	1m50s	3m	18s	1m53s	26s
Page views	3	2	6	2	3	2
Participant 6	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	NO (went to resume)	Yes	Yes	Yes	No (skipped it cause he can't find)	Yes
Time duration	1m47s	1m59s	1m55s	24s	3m13s	39s
Page views	3	5	7	2	9	2
Participant 7	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	Yes	No	No	Yes	Yes	Yes
Time duration	6m40s	51s	39s	26s	1m37s	22s
Page views	13	3	2	2	3	2
Participant 8	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	NO (didn't select domain (youth care)	Yes	No (didn't select indicate and youth care)	Yes	Yes	Yes
Time duration	39s	1m02	1m6	41s	3m2s	28s
Page views	2	2	3	3	12	2
Participant 9	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Correction	Yes	Yes	Yes	Yes	Yes	Yes
Time duration	58s	2m58s	1m2s	55s	41s	45s
Page views	2	7	2	3	3	2

Appendix C

Post-test Interview transcript

Interview 1.

Interviewer: So first questions is how would you describe you overall experience with the website or data dashboards?

Participant 1: It is complicated, feels like information is scattered everywhere instead of a specific page. I kept looking around for information but still couldn't find it.

Interviewer: Which tasks were easy to complete?

Participant 1: 1 and 6 were easy. It is pretty clear where to look and what to do.

Interviewer: Which tasks were difficult to complete, and why do you think it is hard to complete?

Participant 1: 5 - I kept looking on the first page instead of checking all of them. There is no information about the age group on the first page too.

Interviewer: What content or features on the website help you in completing the task?

Participant 1: Nothing, nothing helped me, the buttons were confusing. I didn't know where the information are and it took me a lot of time to find out where the data are actually just in the first page.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 1: Confusing buttons, I can't tell where I can find the information based on the buttons. Needs a search bar and more standardized ways of writing down the information such that I can use a search bar to access it.

Interviewer: How do you feel about the navigation of the website?

Participant 1: Just like any other website. Nothing special. But buttons which are confusing, could be simpler and clearer.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 1: I am confident I can finish the tasks, however, it might take a long time to find.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 1: The data is easy to understand. It was hard to get to the data. The data was presented pretty nicely overall.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 1: The first 3 buttons are all confusing and if I click them there is data everywhere that is not displayed in an orderly manner. Needs more figures, less text.

Interviewer: Can you be more specific? Which buttons are you talking about?

Participant 1: The Thema's, Samenvatting, and Disclaimer en definities. Data are actually place under thema's, but there is also some data in Samenvatting and Disclaimer en definities. So I don't know what information are exactly the one I'm looking for.

Interviewer: What features that you found particularly useful or problematic?

Participant 1: Nothing was useful, there are no features in my opinion, just simple buttons.

Interviewer: Ok this gonna be the last question. What improvements would you suggest to make the website more user-friendly?

Participant 1: I think it needs a search bar, show data in the same manner through figure on all pages. Currently each page shows data in a different way.

Interviewer: Ok that's it for the interview questions. Thank you for participating.

Participant 2.

Interviewer: First questions is how would you describe you overall experience with the website or data dashboards?

Participant 2: Yeah I think it is easy to find some information and everything is clear on the website. But its my first time to use this website so its kinda difficult at first. But gradually I figured out what I should do, everything is going well.

Interviewer: Which tasks were easy to complete?

Participant 2: I think the first 3 tasks were easy, cause on the website you can clearly and straightly find the resident support, background, and providers data pages.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Participant 2: difficult thing is tasks 5, the number of women with support with age group. You can see I tried a lot of buttons, tried a lot of page, I was trying a lot of different buttons to go to different website tried to search for it. So I think it is difficult cause I can not straightly find it and it didn't have information about the gender and age group in any pages I looked.

Interviewer: What content or features on the website help you in completing the task?

Participant 2: I think its words if it counts, just the information.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 2: Nothing really, I only focus on the words I ignored everything else.

Interviewer: How do you feel about the navigation of the website?

Participant 2: it's ok, I think everyone can find what they find.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 2: I am so confident. I think I find any thing on the website. As long as you can read you can find the information you want for sure, just need to read and might take a bit of time.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 2: the data is nice and colorful, but it took me some time to understand the data, cause it has different kind of graph and I wasn't sure which one I should be looking to.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 2: Nothing is confusing, I think everything is clear. And I think the color is pretty nice.

Interviewer: What features that you found particularly useful or problematic?

Participant 2: nothing is really problematic or useful. Oh the icon to go to the home page is pretty nice.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Participant 2: Ok so first make the home page button bigger. Second make the information about age group and gender one more obvious or clear so people can know where to find it.

Interviewer: Ok that's it for this usability testing. Thank you for participating and thank you for the feedback.

Participant 3.

Interviewer: So how would you describe you overall experience with the website or data dashboards?

Participant 3: yeah pretty good, the second question I kinda overlooked but otherwise are pretty good.

Interviewer: Which tasks were easy to complete?

Participant 3: The second one was kind of easy but I just kept looking over. But overall the easiest was sixth, I just needed to read the page and see what's about.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Participant 3: the first two cause I did the most steps, maybe is also because its the first time I use this website. And tasks 5 was also kinda hard, feels like I was one step away.

Interviewer: What content or features on the website help you in completing the task?

Participant 3: the graph and the filter tool is pretty useful.

Interviewer: which filter tool? Can you specify more?

Participant 3: The thing you choose the area and the years for example.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 3: I think nothing really, just me kept reading over I think.

Interviewer: How do you feel about the navigation of the website?

Participant 3: At first it was pretty confusing for me, but after I used it a bit it was ok.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 3: Now probably pretty positive, but the tasks I did I'm not sure about them.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 3: one of the data I thought it was the gender related but it's not, it just the color code for what's the most and least popular thing. So its all just self-explanatory you just have to read. So I think it is doable.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 3: it is not confusing, it's clear.

Interviewer: What features that you found particularly useful or problematic?

Participant 3: the information about the data page is useful but I feel like you don't need to put it on the other page.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Participant 3: Maybe the data can be more clear about what numbers are showing, like sometimes I got confuse about what data it is, like the tasks 5 I thought it was numbers at first but it was percentage, and I need to hover around to see more figures.

Interviewer: Ok that's it for the interview questions. Thank you for participating.

Participant 4.

Interviewer: So how would you describe you overall experience with the website or data dashboards?

Participant 4: I think the website it was pretty easy to navigate, especially I didn't know what its about at first, so it was pretty obvious where should I go at a certain time.

Interviewer: Which tasks were easy to complete?

Participant 4: the easiest one were tasks 1, tasks 2, and 3. I think it's pretty clear for me to understand where to look.

Interviewer: And which were the difficult one to complete, and why do you think it is hard to complete?

Participant 4: probably 5 and 6, they took the longest time to do it. And for 6 it's just because I was reading in dutch and I have to translate to you in English.

Interviewer: What content or features on the website help you in completing the task?

Participant 4: because there were a lot of specific word, especially above the site, so it was kinda indicate what it's about, that was really helpful. So I knew like cause based on those words I knew where can get information from, it was pretty obvious that sometimes when you press something it will give you more information.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 4: No, not really, I think if you take your time with this site, oh never mind with taking time. But if you want some information on this site the first time, just take your time to read it should be pretty easy to find the information you need.

Interviewer: How do you feel about the navigation?

Participant 4: The navigation is pretty good. Sometime it's pretty obvious where I should go, sometimes I just have to read a bit more, that's nothing bad about taking some time. Yeah but I wasn't like I was searching so long and I couldn't find and getting frustrated.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 4: Pretty confident, for me everything is pretty clear.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 4: I think the data is pretty easy to understand. I like how there are different type of graphs, so if something is not understandable, I can just go look at other graph. I like the color and it's not too distracting, cause personally I don't like to see graph with too many colors like it's just too much. Yeah overall, it was pretty clear for me.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 4: Nothing really is confusing. I would say the only page it takes more time to read is the part about disclaimer and definition, but it was obvious need more time cause it's about disclaimer and definition and nothing bad about it.

Interviewer: What features that you found particularly useful or problematic?

Participant 4: I think the useful one is the provider one. Cause people and check which is the most popular one, I think I would use it.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Participant 4: Nothing really, for me is clear, the only thing is it needs some time to understand the website, but like I said before, it's nothing bad about taking more time, especially this website has a lot of data and information that need to be understanding.

Interviewer: Ok that's it for the interview questions. Thank you for participating.

Interview 5.

Interviewer: the first questions is how would you describe you overall experience with the website or data dashboards?

Participant 5: Pretty nice experience despite some struggles finding the specific task requested because I wasn't sure what information went in what category.

Interviewer: Which tasks were easy to complete?

Participant 5: Finding information about something, tasks 4 and 6. It is straightforward and clear, especially task 6, it directly tells to go disclaimer page.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Participant 5: The ones where you had to go to themes because I didn't know you had to go there, it should have a different name like "statistics"

Interviewer: What content or features on the website help you in completing the task?

Participant 5: Nothing really, just need to go through all the information myself.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 5: "Themes" is confusing a bit. Like I said before, it should simply put like 'statistics' or sth like that.

Interviewer: How do you feel about the navigation of the website?

Participant 5: It's easy, just the buttons are confusing.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 5: If it's in there, I will find it but might take some time.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 5: its nice, but hard to understand at first.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 5: pretty clear except Themes.

Interviewer: What features that you found particularly useful or problematic?

Participant 5: Nothing is useful or problematics. Only the name of the buttons are not that accurate or clear, cause it took me quite some time to figure out where the data are placed.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Participant 5: More accurate categories names and a search bar. It's hard to tell what kind of information lies under which categories.

Interviewer: Ok that's it for the interview questions. Thank you for participating.

Interview 6.

Interviewer: Perfect. So the first questions is how would you describe you overall experience with the website or data dashboards?

Interview 6: Quite confusing at first. No clue what could be behind each theme button. Not really clear about themes. I also gave up on one task because I was on the wrong theme.

Interviewer: Which tasks were easy to complete?

Interview 6: The tasks where you have to find what the website is about were easy. It tells directly of what page I should look at.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Interview 6: The age range one, because it didn't even come to mind that the answer would not be in the 1st theme. I also couldn't find any description or information about the age group, it is not clear to find at all.

Interviewer: What content or features on the website help you in completing the task?

Interview 6: it doesn't have anything help me, I think maybe previews

Interviewer: What content or features on the website hinder you from completing the tasks?

Interview 6: the theme buttons are confusing. It didn't tell anything about what exactly it is, so I have no idea where to look.

Interviewer: How do you feel about the navigation of the website?

Interview 6: I did not like it. It feels like there is a lot of layers and features hidden.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Interview 6: I could struggle between choosing what theme it is behind, so I guess I'm not that confident but still can find some of information I need.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Interview 6: The figures are easy to understand and easy to configure.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Interview 6: No the information itself was very clear.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Interview 6: Make the website sections clearer, make it clear what the buttons for and what the information can be provided.

Interviewer: Ok that's all for the interview. Thank you so much for participating.

Participant 7.

Interviewer: First questions is how would you describe you overall experience with the website or data dashboards?

Participant 7: Pretty bad to be honest, I found it very difficult to navigate and to locate certain information.

Interviewer: Which tasks were easy to complete?

Participant 7: None of the tasks were necessarily easy to complete, but none were too difficult. I think all of them are able to complete but at the same time, all of them have some problems to complete.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Participant 7: I found the ones hard to complete where I needed to filter the data. It was a bit difficult to figure out what graph to use for which information.

Interviewer: What content or features on the website help you in completing the task?

Participant 7: The main bar on top of the website, otherwise it was a bit hit or miss.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 7: The overall structure I guess? And the filter of the data is also a bit confusing cause I don't know which exactly filter to use to get the right answer.

Interviewer: How do you feel about the navigation of the website?

Participant 7: Not too good to be honest, it felt a bit overcomplicated. It didn't have enough indication for me to find the information.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 7: Not too confidently, I think I would resort to using google to search for results on the website.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 7: Not really, to me its not really clear what exactly the information on the website is representing and how it can be useful to me.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 7: I think there should be a better introduction to what the information on the website is representing and how it should be used.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Participant 7: Rewrite it. I'm sorry but I really don't see this currently as a viable design. The information are hard to find, the buttons are not clear, I'm also not sure about the data presenting cause it didn't tell what the information it provides clearly.

Interviewer: Well, thank you for your feedback. And that's all of the interview questions. Thank you so much for participating.

Participant 8.

Interviewer: So first, how would you describe you overall experience with the website or data dashboards?

Participant 8: I felt that the website had a lot of good content and data visualization but It took too long to load sometimes.

Interviewer: Which tasks were easy to complete?

Participant 8: Navigating between pages were easy and handling the graph api.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Participant 8: The deep search was hard to find since the webpage took too long to load and had too much detail on some screens.

Interviewer: What content or features on the website help you in completing the task?

Participant 8: The drop down menu and navigation bars.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 8: Slow loading, it took a long time to load all the data pages. Sometimes I leave the page because it was loading to long but it was the page I supposed to go.

Interviewer: How do you feel about the navigation of the website?

Participant 8: I felt that the navigation was good but could have more instructions to the average user.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 8: Im quite confident, I think I find all the information that's required. Only the reading time took a bit longer but other than that, it was easy to find information.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 8: The data was very clear and easy to understand.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 8: the information is clear, just take times to read.

Interviewer: What improvements would you suggest to make the website more user-friendly?

Participant 8: Maybe pop-ups to guide the user, so users will be more clear about the data and information provided on this website and they will know where to look.

Interviewer: Nice that's the last interview question. Thank you for your insight and thank you for participating for my research.

Participant 9.

Interviewer: My first questions is how would you describe you overall experience with the website or data dashboards?

Participant 9: Overall, it is easy to use, but the information that was displayed was a bit confusing.

Interviewer: Which tasks were easy to complete?

Participant 9: Tasks 3 & 5

Interviewer: Can you tell why they are easy?

Participants 9: Sure, for task 3, it is easy to navigate to the data page, cause it just called 'Aanbieders'. And task 5 is easy because I already know where the data about age group is by completing task 2.

Interviewer: Which tasks were difficult to complete, and why do you think it is or they are hard to complete?

Participant 9: Task 1, 2 & 4. The first task was difficult to complete because of how new the website was to me. The second one was difficult as I wasn't sure what WMO exactly was or in which category in would belong, as well as what age group had to do with it. With the 4th task it, it initially made sense to me that this concept would belong in belonged in Disclaimer en definities.

Interviewer: What content or features on the website help you in completing the task?

Participant 9: The drop down lists were easy or convenient to use.

Interviewer: What content or features on the website hinder you from completing the tasks?

Participant 9: It was a little confusing to navigate through the website since the buttons are not clear about what information the page about.

Interviewer: How do you feel about the navigation of the website?

Participant 9: Good. It doesn't have much pages in the website as well.

Interviewer: How confident do you feel that you would be able to find the information you need using this website?

Participant 9: Mildly confident, like in the middle. I think I was able to find most of the information but not all of them.

Interviewer: What do you think about the data presenting in the website, is it easy to understand?

Participant 9: The information could be organized better.

Interviewer: How clear do you think the information provided on the website? Were there any pages or sections that you found confusing?

Participant 9: The information itself that was displayed was a little confusing. It has statistics everywhere, I don't know what numbers I am looking exactly.

Interviewer: Ok, this will be the last question. What improvements would you suggest to make the website more user-friendly?

Participant 9: It would be nice if it was displayed with a simpler, more visual overview rather than with text this could be achieved.

Interviewer: Ok that's all for this usability testing. Thank you for your insights and thank you so much for participating.