ACIT5930

MASTER'S THESIS

in

Applied Computer and Information Technology (ACIT)

May 2024

Universal Design of ICT

An Investigation into Usability and Universal Design of Website Cookie Settings Interfaces

Karishma Sharma Bagale

Department of Computer Science
Faculty of Technology, Art and Design

OSLOMET

Preface

This thesis, "An Investigation into Usability and Universal Design of Website Cookie Settings interfaces," fulfils Oslo Metropolitan University's Master's degree requirements.

As we navigate various websites, we encounter cookies, which are small units of information that help improve our online experience by storing our preferences and personal data. However, the use of cookies raises significant privacy concerns, particularly when users are unaware of the collected data and its intended use. This thesis addresses these concerns by examining the usability and universal design aspects of cookie consent interfaces, which are critical for ensuring that users can make informed decisions about their privacy.

The journey to complete this thesis has been both challenging and rewarding. My sincere gratitude goes to my supervisor, Pietro Murano, for his continuous support, valuable comments, and guidance throughout this process. His insights and encouragement have been instrumental in shaping the direction and quality of this research. I am also indebted to the participants recruited in research for taking the time to be part of this study. Their valuable feedback and engagement significantly contributed to the findings and recommendations, which aim to benefit web developers, UX/UI designers, and end-users, fostering a more inclusive and user-friendly digital environment.

Oslo, May 2024

Department of computer Science, Oslomet.

Karishma Sharma Bagale

Abstract

The purpose of this thesis is to investigate the usability and universal design of cookie interfaces. Considering increasing concerns about online privacy and data protection, this study aims to identify the primary usability challenges users face and propose design improvements to make these interfaces more user-friendly and accessible. The research focuses on bridging the gap between regulatory requirements and actual user experiences, ensuring that cookie consent interfaces not only comply with legal standards but also empower users to make informed decisions about their privacy.

This study focused on analysing ten prototype cookie consent interfaces using a qualitative evaluative investigation, complemented by quantitative data. The study involved 20 participants from diverse backgrounds, though it did not include elderly individuals or people with disabilities. Ten different prototypes were created using Axure RP10 to investigate various design features and elements. Participants engaged with these prototypes through six tasks designed to simulate common user interactions, such as rejecting cookies and customising settings. Data collection methods included participant observations, semi-structured interviews, and Likert-scale questionnaires.

The study discovered significant usability challenges, including the lack of clear opt-out options, limited customisation features, and complex technical language that hindered user understanding. Prototypes often employ dark patterns to manipulate user choices, reducing transparency and user control. The findings highlight the need for cookie consent interfaces to improve usability and transparency, ensuring they align with universal design principles to cater to a broader range of user abilities and preferences.

The conclusions emphasise the need for cookie consent interfaces to adopt universal design principles, ensuring accessibility and simplicity. The study suggests improving the visibility and usability of opt-out options, standardising customisation features, reducing interface complexity, and presenting cookie information in a clear, non-technical manner.

Table of Contents

List of Figures

List of Tables

1. Introduction

In today's digital age, the internet has become a crucial part of everyday life for billions of people globally. As we navigate through various websites, be it for online shopping, reading news articles, or socialising with friends, we come across a technology known as "cookies". These are barely noticeable units of information that websites transmit to our devices to retain our identity and personal preference (Alharbi et al., 2023). Cookies plays an important role in improving our online experiences. They assist websites in storing our login credentials, tracking the contents of our shopping carts and our preferences , so enhancing the efficiency and personalization of our internet surfing experience(Sanchez-Rola et al., 2020).

With the help of cookies, the websites keep records of their user when and whether their site has been visited. Third party websites received such information of user by them (Kulyk et al., 2018). Thus rises the issues of threatens the user privacy as many websites unknowingly create user profiles without the knowledge of user and use them in third party websites from which they track user online actions and this make many debates and attract the many researchers to study about it (Alharbi et al., 2023).

This ability to monitor our browsing activities gives rise to issues about how our online date is used. In response to these concerns, many rules and regulations have been implemented worldwide including the General Data Protection Regulation (GDPR) in Europe (Kretschmer et al., 2021).This regulation mandates that websites must get clear permission from users before utilising cookies. This legal regulation is intended to safeguard user privacy and guarantee users' authority over their personal data (Sanchez-Rola et al., 2019).

As a result, cookie consent interfaces which are the pop-up and banners that request our authorization to use cookies, have become a frequent occurrence. The purpose of these interfaces is to give users with the necessary information to make well-informed decisions regarding their privacy. Having good and understandable interface, one can limit the amount of data that can be shared with third party's website and reduce the risk of targeted and unwanted advertising, tracking and other privacy concerns (Kulyk et al., 2018).However, as some websites attempt to comply with legal requirements while also aiming to offer a user-

friendly experience, the design and usability of these consent interfaces have become increasingly complex.

Most of the users do not have enough knowledge about what cookie settings interface does and which cookie option they want to be in their device and for how long their important information is being processed. In previous years ,interface of cookie was just a sentence without having information that user understands(Millett et al., 2001). As compared to earlier interfaces, existing cookie interfaces contain information and options in detail. But they are supposed to be design in much interactive and understandable form so that every user can understand easily and make right choice of decisions (Alharbi et al., 2023)

This complexity can lead to confusion and frustration for users. Certain interfaces are intentionally designed with ambiguous language, which poses a challenge for users to understand what they are consenting to. Other websites may employ design strategies that gently manipulate users into giving consent for all cookies, such practice known as “dark patterns”(Gray et al., 2018). Furthermore, the wide range of designs and terminologies used across various websites contributes to misunderstanding, making it challenging for users to establish consistent and well-informed choices regarding their privacy(Habib et al., 2022). Thus, growing complexity of cookie consent interfaces has a substantial impact on user interaction(Alharbi et al., 2023) . For many individuals, the initial reaction to cookie consent pop-up is to promptly select the “accept all” option to dismiss it and get to the desired content. This behaviour suggests a gap between the intended purpose of privacy regulations and the actual user experience in the real world. It implies that the current approaches to cookie interfaces may not effectively empower users to have control over their privacy.

This scenario becomes more complicated when considering the principles of universal design, which promote the creation of products and environments that are accessible and usable by all people, regardless of age, disability, or other characteristics. The many existing cookie consent interfaces frequently fail to meet these principles. For examples, users with any kind of disability may encounter difficulties navigating these interfaces if they are not specifically developed with accessibility in consideration.

1.1 Problem Statement

Recently, many concerns have been raised regarding the privacy and control over user information through the interface of cookie setting in websites. As mostly all websites track

and control user information and use it for their future improvements. Many literature have shown that websites deployed with such techniques of designs in there cookies interfaces that mislead the users in selecting right options from it and drive them to less privacy protection options (Habib et al., 2022).It becomes important to assess how the cookie interfaces are designed so that they become user-friendly and easily accessible to every user including users with disabilities.

Many efforts are done by the web developers and different regulatory bodies like GDPA to address issues but still users face difficulties while interacting with cookie interface and find it confusing, difficult to understand and sometimes it is not accessible for impairment users. Studies in (Alharbi et al., 2023; Habib et al., 2022; Jayakumar, 2021) have shown the importance of inclusive approaches in interfaces of cookie for the user. However there has been limited research done that specifically targeted on the usability as well as universally designed aspects of the cookie interface settings.

According to study(Habib et al., 2022), most of the cookie consent interface have poor usability ,a confusing and not user friendly that results into the difficulties and frustrations for users trying to manage their options of cookie preferences User find it challenging to understand and navigate for their privacy control methods in interface because of not in clarity, complex technical terminology and limited options(Kulyk et al., 2018; Shirazi & Volkamer, 2014). This results in interfering with the user's ability to accept or reject cookies without their full understanding of the implications.

There are also some complexity occurs while cookie banners popup on the screen with their undefined location sometime they appear at the top or bottom of the screen along with the different types of dark patterns used by the designer to make it more complex and understandable by a user(Hausner & Gertz, 2021) .By this problem ,user who require a clear and more accessible interface to manage their specific cookie preference affected the most (Matte et al., 2020)

1.2 Significance of the Study

Regarding above mentioned context, it becomes clear why an investigation into the usability and universal design of cookie interface settings is both timely and necessary. This study has the potential to shed light on the difficulties users have while using interfaces and explore how principles of universal design can be integrated to make the digital space more inclusive

and respectful of user privacy. Tackling these concerns not only conforms to legal and ethical norms but also improves the overall user experience on the web. This study will benefit developers including UX/UI designers and end-users to use usability and universal design concepts in developing websites cookie interfaces. Ultimately, this improvement in cookies interface settings will support user privacy, enhance user experience, and encourage a more accessible digital environment.

1.3 Research Objectives

This study aims to investigate the concept of usability and universal designs perspective of cookie interface settings to identify the important issues and provide relevant recommendations for improvements. This study used a prototype of cookie interface and examine different state of cookie settings interfaces, evaluating their usability challenges and investigate the user feedback so that it will help in developing more user-friendly and universally design cookie settings interfaces.

1.4 Research Questions

This study sought to answer the following questions regarding the usability and the universal design of cookie interfaces settings.

Q1) What are the Usability challenges that users mainly encounter while interacting with cookie interfaces settings.

Q2) What are the best practices and design patterns for presenting and organizing cookie interfaces settings in a clear and intuitive manner?

Q3) What are the key principles of universal design that should be incorporated into the interface?

1.5 Outline of the Thesis

In this section, I provide a concise summary of the topics covered in each chapter of the thesis.

Chapter 2: *Background and Related Work:* In this section, I provided some background information on the evolution of cookies, their purpose, the emergence of cookie consent interfaces, their usability, accessibility, universal design principles, and the presence of dark

patterns in cookies. It also includes literature review studies relevant to my research, highlighting gaps in my current knowledge.

Chapter 3: *Research Methodology:* Outline the research design, including the development of ten prototype cookie interfaces, participant demographics, and the methods used for data collection and analysis.

Chapter 4: *Result and Analysis:* Here I present the results and findings from the investigation using prototypes, interviews, and Likert scale questionnaires.

Chapter 5: *Discussion.* This chapter discusses the results in the context of the research questions, exploring the implications for interface design, user experience, and regulatory compliance. It emphasizes the need for clearer guidelines and the integration of universal design principles.

Chapter 6: Conclusion: Summarises the main findings, discusses their theoretical and practical implications, and acknowledges the study's limitations. It provides recommendations for future research and improvements to the cookie consent interface design.

Chapter 7: References. This chapter includes a thorough list of all the research papers this thesis has cited.

2. Background and Literature Review

This section of the study provides a comprehensive overview of the chapters on cookie interfaces and previous study work done on them. Beginning with the evolution of cookies and their purpose, this study delves into their significance in the technological field and the subsequent rise of cookie consent interfaces. Next, I explored how these interfaces fulfil not only functional goals but also present complicated difficulties concerning user permission and privacy management with the topic of dark patterns in cookie consent, as well as the principles of usability, accessibility and universal design that strive to improve the transparency and user-friendliness of these interfaces. After these chapters, I explained the studies that I took for this study and presented them in the literature review section. The review highlights notable deficiencies in the existing knowledge, specifically in relation to the interaction between user behaviour and interface design. These deficiencies form the basis for the fundamental research questions that guide this study.

2.1 Evolution of Cookies and Their Purpose

The concept of web cookies was proposed by Lou Montulli , a programmer at Netscape communications, in 1994 (Cahn et al., 2016) .Cookies were initially created to solve the problem of maintaining a state in the stateless HTTP protocol. They modernized web servers by allowing them to store small data pieces on the user's computer. This innovation was crucial for e-commerce, enabling shopping carts to remember the goods that a customer had added while navigating a website. The term "Cookie" is taken from the computer science phrase "magic cookie, "which specifically refers to data passed between programs without the requirement for the receiving program to understand it (Cahn et al., 2016).
In the early days, cookies were mainly employed for session management, customizations (such as user preferences) and tracking (particularly for advertising intentions)(Cahn et al., 2016). The widespread use of cookies experienced exponential growth and by the end of the 1990s they had become a crucial part of the web's infrastructure. Although their use for tracking and promoting purposes got more widespread, concerns regarding privacy started to arise. As a result, legal measures were implemented such as the European Union's e-privacy Directive (2002) and later the General Data Protection Regulation (GDPR) in 2018**.** These restrictions-imposed user consent for cookies with the capacity to identify them.

Over the years, technological progress has improved the usefulness of cookies, but the fundamental notion has remained mostly the same. Modern web applications frequently depend on cookies to perform various tasks, such verifying the identity of users and customizing content and advertisements based on individual preferences.

Cookies can be categorized into several types according to their duration, domain scope and intended use(Internet cookies, 2021). It is crucial to understand these classifications to recognize how cookies improve user experience and the possible privacy issues they may provide (Check, 2023).

In terms of their provenance the cookies can be categorized as either first-party or third-party cookies(Rasaii et al., 2023). First party cookies are those created by the website domain the user is currently visiting, while third-party cookies are created by domains other than the one user is visiting (Trevisan et al., 2019).Additionally, Cookies can also be classified based on their expiration time into session cookies and persistent cookies**.** Session cookies are temporary and exit only for the duration of the user's browsing session; they are deleted once the browser is closed (Habib et al., 2022; Trevisan et al., 2019) On the other hand, persistent cookies remain on the user's device for a longer period**.** These are uses by the applications for various purposes, such as storing user preferences, enabling authentication, and tracking activities (Englehardt et al., 2015)

2.2 Cookie Consent Interfaces

Interfaces that display information about the use of cookies by websites and to get consent from the user about their personal data to be stored before visiting the websites for the first time is cookie consent interfaces (*What Is a Cookie Banner?*, 2024.)This is the requirement that protect users online privacy ,emerges from various privacy and data protection regulations, such as the European Union's General Protection Regulation (GDPR) and e-Privacy Directive.

When a user first visits any website, sudden popup or banner appears on the screen sometimes at the bottom or top of it, with detailing the types of cookies being used and provide different options to user such as accept all, reject all or customize the cookie settings. Hence, this provides users the ability to have authority over their personal data and bridge the gap between legal compliance, privacy protection and user experience. Many

studies suggest that the most effective consent interface is that which are designed in clear, informative, and user-friendly manner (Habib et al., 2022; Matte et al., 2020; Sanchez-Rola et al., 2019; Singh et al., 2022).Such interfaces facilitate easy navigation of consent choices to improve user satisfaction while complying to privacy regulations.

The most common type of options available in cookie interfaces are opt-in (Accept)and opt-out (Reject) consent. Website designers intentionally use tricks in the interfaces to influence users to choose opt-in (accept) options and hide or make it difficult for users to find opt-out (reject) in many interfaces (Gray et al., 2018). Therefore, it's crucial to provide clear and precise information in the interface, enabling users to manage their sensitive data according to their preferences. There are different types of consent interfaces that websites owners are currently using for their web sites. Based on their functions and how they served by the user, some interfaces such as opt-out consent, opt-in consent, custom, implied and notice only consent interface are shown below:

a) ***No option interface*** Some cookie interfaces do not provide any options to their users, falling into the category of no options. They simply indicate consent that the website will use cookies. This form of consent is not very reliable, as it does not provide users with the ability to select or cancel the use of cookies.

Figure 1: Example of cookie interface without any option.

b) **Confirmation only**: This type of cookie banner displays a single button on its interface with text like “ok,” “I agree,” “I accept,” etc. The user can click the option to give their consent.

Figure 2: Example of cookie interface with confirmation option only.

c) **Binary options:** The consent notices only consider two buttons, giving the user the choice to accept or decline all the cookies on the website.

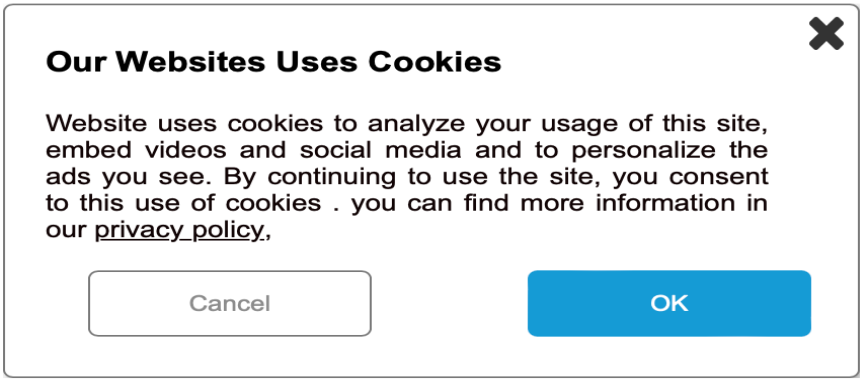

Figure 3: Example of cookie interface with Binary option only.

d) **Category options:** Figure 5 shows the type of interface that provides several options to accept or decline individual categories by using checkboxes or toggle switches. There could be several options for cookies available, but the most used are advertising cookies, website analytics, personalization, and necessary cookies.

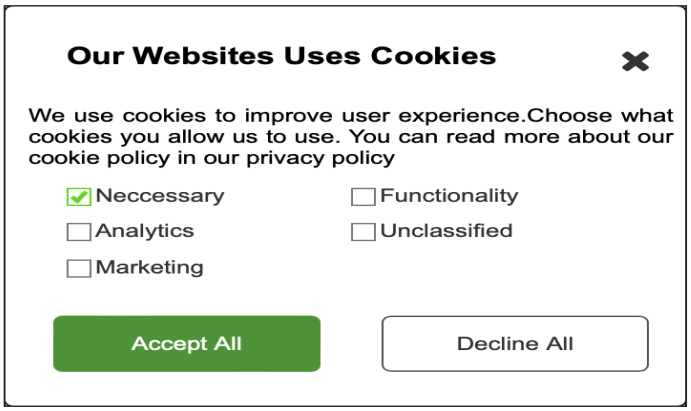

Figure 4:Example of cookie interface with category options only.

2.3 Dark Patterns in Cookie Consent

There are many deceptive or manipulative tricks used by website owners to get control of the data privacy settings of their users. These are designed in such a way that the user is forced to accept the cookies that are tracking and sharing their personal information. The intention behind such design practices is to mislead the concept of privacy and control, user autonomy, as well as hide ethical and transparent cookie usage. (Berghel, 2013) classified these designs as dark patterns .(Alharbi et al., 2023) study explained these patterns as “tricks being used in websites or apps that make users do things that they didn’t mean to do."
There are many studies done that explain several types of dark patterns used in the design

interfaces and their direct impact on the user regarding making their choices (Borberg et al., 2022; Gray et al., 2018; Hausner & Gertz, 2021; Krisam et al., 2021; Soe et al., 2020). Along with this, it is also found that these deceptive methods violate the several regulations (GDPR and others) by implementing them on consent interfaces(Gray et al., 2018; Paine et al., 2007; Soe et al., 2020)

There are different types of dark patterns discussed in many studies; some of them are highlighted buttons, pre-selected options, disclaimers without any choices, and consent walls (Alharbi et al., 2023) . There are obstructions, sneaking, interface interference, and forced actions, which are the dark patterns discussed in the study by (Gray et al., 2018)

No rejection option: Where the interface fails to offer a direct method to decline the use of cookies or the collection of their personal data from the interface. Such approach directly influences user decision and behaviour this is a significant concern in digital privacy, legal and ethical considerations.

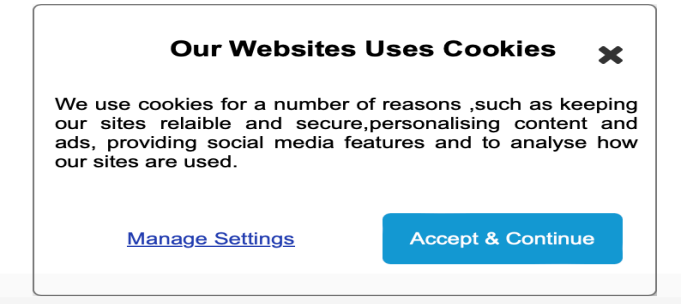

Figure 5: Interface without rejection option.

Obstruction: This type of dark pattern intentionally makes tasks or actions more difficult for users. Designer makes the interface obstruct by creating barriers to performing tasks the user wants to achieve. For example, there is a hidden or unclear option. This type of design pattern also includes confusing languages in interfaces, misleading the users, introducing unnecessary steps, etc.(Gray et al., 2018). On the page, it can be seen as an obstruction, as the user can opt-out of the consent only after selecting accept and can adjust the browser settings by clicking the link “cookie policy.

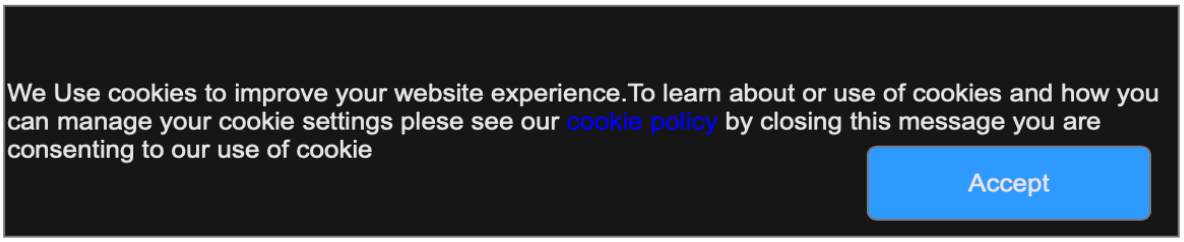

Figure 6:Interface with obstruction dark pattern.

Highlighted buttons: The most common technique used by the designer for getting user attention is accepting the specific option. They designed the interface in which one option is colored to highlight so that it can get attention, while other options are presented without any highlight or color.

Figure 7:Interface with highlighted button.

Disclaimer with no choice:

The cookie interface that appears to be disclaimer without providing any option to its users and information about what cookie does. Figure 1 is the example of this pattern.

Forced actions.

In some interfaces, the design patterns are in such a way that they tried to be force the user to accept their cookies before using their websites further. They try to make the user forcefully accept the option. Figure 5 shows the forced action to accept the option.

2.4 Usability Concept in Cookie Interfaces

In context with consent interfaces usability refers to the level of ease with which users can understand, navigate, and interact with digital interfaces. It includes a range of factors, such as including clear information, user-friendly design, and user satisfaction. The main objective of usability is to improve the user's experience by providing smooth and efficient interaction with less confusion and easy navigation within the interfaces (Speicher, 2022). A definition

given by ISO “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (Jokela et al., 2003).

Usability plays crucial role in shaping user experiences with consent interfaces as they have substantial influence on user understanding and decision making process (Habib et al., 2022) . Those consent interfaces with usability work as both informative tools and compliance with legal measures, particularly the general data protection regulation in the European union (GDPR). Such a law requires users to provide a clear and explicit interface for managing and storing their personal data. (Kretschmer et al., 2021)

Without giving proper attention to usability, it can cause frustration for users. Common problems that occur in the absence of usability are:

Complex language and Lack of clarity: When the information in the interface is conveyed in a complicated or technical language, users may have trouble in understanding the consequences of their decisions about cookie settings.(Habib & Cranor, 2022)

Hidden options: Users may mistakenly give consent to unwanted or undesired option if they find difficulty in locating or understanding the process of adjusting their cookie preferences.(Habib & Cranor, 2022)

Intrusive Design: Some interfaces cover most of the website´s consent and force the user for immediate action “accept” to click just to remove obstructions, as such a design can make users frustrated.(Habib & Cranor, 2022)

It is important that web designers include usability aspects such as ease of learning ,effectiveness to use and enjoyment in the interfaces(Wang & Huang, 2015).The designers must focus on developing an intuitive and user-friendly experience that allows users to understand, control and choose the right privacy option for them. Usability always becomes the centre of attention while delivering the interfaces because of its different issues related to it. In (Nielsen, 1994) book, he defined different quality components of usability that directly related with the its attributes:

a. Learnability: This component makes sure that the user completes the basic task rapidly and learns them effectively.

b. Efficiency: Once the user learns the design then how fast they can complete the task is efficient.

c. Memorability: After returning to the same design with certain time of not interacting with it, memorability is the capacity of how fast to complete the task without learning it again.
d. Errors: The mistake user made while interacting with the design.
e. Satisfaction: The user must be satisfied with the interactive interface while using them.
In the study (Wang & Huang, 2015) he purposed usability design principles that can control the complexities in the user interfaces. These are Visibility, Ease, Efficiency, and enjoyment.

Visibility: This principle states that interface should offer clear and precise information to their user before conducting any action. In context of cookie consent interface, The interface should provide the important information about what cookies are being used for and their straightforward instructions and transparency for how users can accept, reject or customize their cookie choices.(Wang & Huang, 2015)
Ease : The interface should be designed in an easy way so that users can familiarize themselves with the functions involved in the interface and hence they spent less time in finding out about the choices they made. (Wang & Huang, 2015)
Efficiency : when users get the familiar with the interface , it becomes easy for them to quickly make and apply their privacy choices which helps in optimize the user's time and effort.(Wang & Huang, 2015)
Enjoyment : When the consent interface is well-designed, user-friendly and provides clear options the user feels confident and satisfied after completing the task.(Wang & Huang, 2015)
There are many usability definitions in the both human computer interaction and privacy literatures that identifies seven important requirements of cookie setting interfaces (Habib et al., 2022).
a. User needs: These aspects ensure that the user's particular needs are address in selecting privacy context. Components like Effectiveness, usefulness and accuracy included while addressing user needs (Feng et al., 2021; Habib et al., 2022).
b. User Ability and Efforts: The cookie settings interface is built in such a way that requires minimum user effort and abilities to achieve user's particular privacy goal. Efficiency, usable and accessible are some components that are relevant to this requirement(Feng et al., 2021; Habib et al., 2022; Nielsen, 1994).

c. User Awareness: The important part of the interface design is to make sures that users know of what choices of privacy options exist and where to find them. The factors such as user awareness, easy to learn and easy to find can be add to the design requirements (Feng et al., 2021; Habib et al., 2022; Nielsen, 1994).

d. User Comprehension: The user must clearly understand the choice they selected for their privacy and what it does and the result of their selected option. Understandability and easy to learn components can be added to this usability factor (Feng et al., 2021; Habib et al., 2022) .

e. User sentiment: satisfaction of the users with the interface of cookies setting and option it displayed. The also involve user's faith with privacy choices that interface provides (Feng et al., 2021; Habib et al., 2022; Nielsen, 1994).

f. Decision Reversal: The usability component should also include the decision reversal features that means if user allows to change its decision of selecting options or correcting the errors(Habib et al., 2022).

g. Nudging Patterns: The designs that include some misleading patterns which affect privacy of the users should be avoided(Habib et al., 2022)

2.5 Accessibility in Cookie Consent

In the context of cookie consent interfaces, accessibility refers to the process of designing interfaces that all users, regardless of their disabilities, can easily use(*WCAG | WAI | W3C*, 2024). This means ensuring that individuals with visual, auditory, motor, or cognitive disabilities can understand and engage with the cookie consent functionalities without encountering any obstacles. The objective is to offer an inclusive digital experience, enabling all users to have equitable access to privacy settings and consent choices (Initiative (WAI), 2024)

The importance of accessibility in cookie consent interfaces is crucial, as these interfaces play a crucial role in the user experience on websites. In this context, accessible design ensures that all users can engage in making informed decisions about their data privacy and cookie preferences without any exclusion. By doing so, not only does it improve user satisfaction and trust, but it also conforms to ethical norms and legal obligations around digital inclusion(*WCAG | WAI | W3C*, 2024).

2.5.1 Accessibility Guidelines and Legislation

Web Content Accessibility Guidelines (WCAG 2.1) are a set of guidelines that provide standards for making web content accessible to all users, including those with disabilities(*WCAG | WAI | W3C*, 2024). The World Wide Web Consortium (W3C) established WCAG 2.1, which offers a collection of guidelines to improve the accessibility of digital content. Four principles structure the guidelines: perceivable, operable, understandable, and robust (POUR) (*WCAG | WAI | W3C*, 2024) .This means that for cookie consent interfaces, all elements must be perceivable by assistive technologies, operable through keyboard navigation, understandable in terms of language and functionality, and robust enough to withstand interpretation by various user agents, including screen readers. When applying WCAG 2.1 to cookie consent interfaces, several key principles and success criteria are particularly relevant to ensuring these interfaces are inclusive and user-friendly.(Initiative (WAI), 2024)

When developing and implementing cookie interfaces, we adhere to the standards and recommendations set by the W3C (World Wide Web Consortium) regarding consent interfaces, which are defined below:

Perceivable: Information and user interface components must be presented to users in a way that they can understand and perceive (*WCAG*, 2024)

Guideline 1.1 Text Alternatives

Include text alternatives for all non-text content: Make sure that any icons, graphics, or other non-text-based elements in the cookie interface have suitable text alternatives (alt text) that allow screen readers to understand.(*WCAG*, 2024)

Guideline 1.4 Distinguishable

- *Ensure sufficient color contrast*: To be clearly visible, the text and interface elements must have a color contrast ratio of at least 4.5:1 with respect to their backgrounds.(*WCAG*, 2024)
- *Don't depend solely on colour*. Avoid depending only on colour to communicate information. Incorporate color into textual labels or patterns.(*WCAG*, 2024)

Text Resizability: Ensure that you can expand the text within the cookie interface by up to 200% without losing any content or functionality (*WCAG*, 2024)

Operable: The user interface components and navigation should be functional.(*WCAG*, 2024)

Guideline 2.1 Keyboard accessibility

Allow all features to have complete keyboard functionality. Ensure keyboard accessibility for users to navigate and interact with the cookie interface(*WCAG*, 2024)

Guideline 2.2 Enough Time

Allow users an adequate amount of time to read and utilise the content. Remove timing limitations that may restrict users' ability to engage with the cookie consent choices (*WCAG*, 2024)

Guideline 2.4 Navigable

Use clear and consistent navigation. Ensure that the layout of the cookie interface is consistent and user-friendly (*WCAG*, 2024)

Understandable: The user interface's functionality and the information it provides must be simple to understand (*WCAG*, 2024)

Guideline 3.1 Readable

- Enhance the readability and understanding of textual content. When providing cookie descriptions and choices, use concise and straightforward language when providing descriptions and choices related to cookies (*WCAG*, 2024)
- Provide clear explanations for abbreviations and uncommon terminology. It is important to provide clear explanations for any specialised terminology or abbreviations (*WCAG*, 2024)

Robust: The information in the interface should include enough strength to provide consistent meaning for a diverse range of user agents, including assistive devices.(*WCAG*, 2024)

Parsing (4.1.1): Ensure that the use of markup is done in a manner that may be accurately understood by user agents, which includes assistive technology. For example, ensure that all interactive features in the cookie consent interface are implemented using appropriate HTML elements and attributes.(*WCAG*, 2024)

By following the WCAG 2.1 principles, developers can design cookie consent interfaces that are accessible, guaranteeing a favourable user experience for all individuals, including those with disabilities. This not only complies with legal and ethical norms but also improves the usability and inclusivity of web material.

2.6 Universal Design Concept in User Interface of Cookie Settings

Universal design as its name defines designs that can be used universally. Relating cookie interfaces to universal design principles requires creating interfaces that are understandable, accessible, and usable by all users, irrespective of their age, ability level or situational circumstances(Persson et al., 2015). Universal design is based on the concept of creating products and settings that can be used by broad range of people without requiring modification or specialized design. when implemented in cookie consent interfaces, this method prioritizes inclusivity by ensuring that all individuals have an equitable chance to comprehend and manage their online privacy settings (Persson et al., 2015) .

According to Ronald L. Mace "Concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life."(Persson et al., 2015).

As per disability act 2005, universal design can be defined as the design or composition of any products or service that can be easily accessed, understood and used as greatly as possible without the need for additional adaptation or assistive technology (*National Disability Authority*, 2024). Many researchers provide different definition of universal designs, but its roots are same that is designing products that can be accessible easily without any kind of barriers. These barriers can be different and depend on person to person. Therefore, designers must keep needs in broader angle while designing the interfaces. In the past years certain guidelines are created by the researchers know as seven principles of universal design to make any designs universally accessible (Persson et al., 2015) These guidelines can be applied to make sure that interface of cookie settings can be used and accessed by everyone.

i. ***Equitable in use:*** This guideline emphasizes that interface should ensure uniformity in user experience, offering comparable functionality whenever feasible and providing equivalent alternatives when necessary. This means guaranteeing that individuals with different kind of ability have accessible alternatives to accept, reject, or customize cookie settings. This can be achieved through features like keyboard navigation and screen reader compatibility, ensuring that no one group is put at a disadvantage(*National Disability Authority*, 2024)

ii. ***Flexibility in use***: The flexible design accommodates a diverse variety of people's preferences and abilities. Thus ,this may involve in offering various options for users to access and interact with the cookie consent interface for examples, through easy text or simplified layouts ,enabling users to select the options that most effectively meets their requirements.(*National Disability Authority*, 2024)

iii. ***Simple and intuitive use***: The third guideline "simple and intuitive use" emphasizes that interface should be designed to be easily understandable, irrespective of the user's level of experience, knowledge, language skills or level of concentration. Using plain language to explain cookies and consent options, while avoiding technical terminology, can enhance the overall understandability of the interface for a wider audience.(*National Disability Authority*, 2024)

iv. ***Perceptible information:*** Regardless of the surrounding environmental conditions or user's sensory abilities, design should efficiently convey necessary information to the user is fourth guideline in the universal design. This can be achieved by using contrasting colors for text and background ,Providing alternative text for images if it is presented in the interface(*National Disability Authority*, 2024)

v. ***Tolerance for error***. The guideline states that the interface should be designed with the aim of reducing hazards and limiting the negative outcomes of unintentionally or unexpected activities. This may include verifying choices prior to applying settings or providing means to undo their choices, ensuring that errors may be corrected without excessive effort.(*National Disability Authority*, 2024)

vi. **Low physical effort**. The Design should be efficient and comfortable to use while minimizing fatigue. For cookie consent interfaces, this means minimizing the amount of steps needed to make a choice, ensuring that user can express their preferences with as few clicks.(*National Disability Authority*, 2024)

vii. ***Size and space for approach and use***. This last guideline can be seen as ensuring that the interfaces can be accessed and visible to users, regardless of their screen size of their device or the technique they use to interact with it. Such responsive design ensures that the cookie interface is easily navigated on many devices including desktop computers ,smartphones and tablets (*National Disability Authority*, 2024)

2.7 Legal and Ethical Considerations

There are some laws regarding privacy of the user while interacting with websites.
In May 2018, the General Data Protection Regulation(GDPR) came in to forces which regulated the legal basis on website operators for gathering user personal information without the consent of the user in Europe(Degeling et al., 2019). After this law, cookies consent interface started appearing in the websites and made it obligatory before accessing user's data. Such cookie banners or pop-ups, provide information about their data being used with third party and options related to accept or decline such data should be available in the banner(Matte et al., 2020). The main requirements of GDPR is that the cookie consent should be explicit ,informed and withdraw functionality in it.(Bermejo Fernandez et al., 2021)
Under GDPR policy article 4 states that the action of users while giving their consent must be clear and understandable. The consent notices should not provide their options in default pre-checked boxes settings. Whereas article 12 discusses the accessibility of the consent notice that it should be easily accessible and the use of clear languages. Article 7 is focused on the withdraw functionality that user can change their option at any point of time.(*What Is GDPR, the EU's New Data Protection Law?*, 2018).

2.8 Literature Review

The study conducted by (Habib et al., 2022) provides a critical examination of the usability and design concepts of cookie consent interfaces across 191 websites , utilizing a comprehensive two stage evaluation methodology. Initially they employed an inspection-based evaluation of consent interfaces against five heuristic dark patterns criteria, identifying design choices that potentially impair usability. Subsequently, a large-scale online experiment involving 1,109 participants tested the usability impact of seven distinct design parameters on users' interactions with a prototype e-commerce website. The findings indicate a notable influence of design choices on users' ability to understand, engage with, and control their privacy choices through cookie consent interfaces. Significantly, the study reveals that interfaces lacking in-line cookie options on the initial screen lead users towards a forced acceptance of cookies, highlighting a potential gap in users' comprehension and engagement with their privacy choices. Their study also found that providing a persistent option for users to modify their consent choices at a later stage enhances the usability of

consent interfaces, aligning with the regulatory emphasis on user control over personal data processing. This research not only underscores the challenges posed by current design practices in cookie consent interfaces but also offers pragmatic recommendations for improving user interaction with provided mechanisms.

Understanding user preferences in the design of the cookie interfaces is important for enhancing user experiences and ensuring that these are effectively align with laws. The study by (Singh et al., 2022) addresses this need by exploring which cookie consent notice designs are preferred by users in natural settings. The objective of this study was to identify user-preferred design that could potentially increase user engagement and compliance rates. The study employed a comparative survey methodology which use used a browser extension to present various consent designs to their participants. These designs included sliders, cookie categories, binary choices and full vendor lists both with and without a "Reject All" option.(Singh et al., 2022) found that the slider design was significantly preferred by users, primarily due to its ease of use and clarity. The several key factors were highlighted by the study which influence user preferences, including the customizability of the notices, the amount of the information provide, and decision-making time required by each design. Hence the study findings suggest that a well-designed consent interface can enhance user experience by simplifying decisions and making information accessible and understandable. This study's insights are particularly relevant with my thesis on enhancing user experience in consent interfaces. The identified preferences for cookie interface design can inform broader design practices that prioritize user engagement.

Study done by (Habib & Cranor, 2022)address the complexities inherent in the cookie consent interfaces, highlighting the significant gap between user expectations and the actual usability of the interfaces. The authors introduce a comprehensive framework for evaluating the usability of privacy choice mechanisms, encompassing seven critical usability aspects: user needs, ability & effort, awareness, comprehension, sentiment, decision reversal and nudging patterns. This framework is pivotal for assessing the effectiveness of consent interfaces in meeting user needs. This study advocate for a blend of classic usability testing techniques and innovative approaches tailored to the unique challenges of privacy settings. Hence, such methodological guidance is vital for researchers and designers seeking to enhance the user-friendliness of privacy controls. Furthermore, the study explores the

extensive range of privacy choice mechanisms and the diversity in user interfaces, which frequently complicates users' ability to make well-informed privacy choices. The finding from this research reveals the frequently overlooked user burden in navigating these settings as well as the possibility of implementing improved design techniques that might greatly improve user experiences and results. The implications of this research are far-reaching, offering a foundational perspective for future studies on the usability of privacy choices. Thus, this work is particularly relevant for my study as it aligns with the need to address usability in privacy designs to ensure that they are not only functional but also accessible to users with varying levels of technical proficiency.

Usability is always a critical factor of cookie interfaces in ensuring that users can make informed decisions regarding their privacy. The empirical study by (Alharbi et al., 2023) provides a comprehensive analysis of cookie interfaces across e-government websites in 50 countries, offering valuable insights into the effectiveness of these interfaces in conveying privacy information. This analysis highlights significant variations in compliance with usability and privacy guidelines, particularly noting that European websites follows more regulations to establish usability in their interfaces because of law like the General Data Protection Regulation (GDPR). One of the key principles discussed int the study is 'Privacy by Design' which advocates for integration of privacy features at the initial design stage of the interface. The findings reveal that over 90% of the evaluated websites employ 'dark patterns'. The extensive utilisation of deceptive tactics highlights the need for universal design principles that prioritize transparency and user control across all regions. The study also employs a set of 7 usable privacy guidelines to evaluate the cookie interfaces, including the absence of tacking walls, separate consent per purpose and the configurability of consent banners. They also found that maximum number of websites failed to provide comprehensive privacy policies, which are essential for informing users about their data rights and how their information is processed. This lack of transparency directly conflicts with the usability principles that are the foundational to user trust and interface efficiency.

The study conducted by (Sanchez-Rola et al., 2019) offers an extensive evaluation of the impact of the general data protection regulation (GDPR) on user privacy and web tracking ,highlighting critical challenges in interfaces that directly relevant to my topic on usability and universal design. The detailed analysis of cookie usage and tracking mechanisms across

websites, they discovered that many websites continue to engage in tracking without obtaining explicit user consent and often present misleading information that complicates user decision-making (Sanchez-Rola et al., 2019). Moreover, the study reveals significant usability issues with the mechanisms provided for users to opt out of cookies for example , to opt-out process are frequently not straightforward, requiring users to navigate through complex interfaces .This complexity is contrary to the principles of universal designs which advocate for simple, intuitive interactions(Sanchez-Rola et al., 2019).Additionally, the global impact of GDPR observed in the study where even non- EU websites modify their practices suggests the need for universally accessible design in cookie interfaces that cater to a diverse user base. The study also suggests substantial improvement are needed in how cookie settings and privacy information are presented, advocating for simpler and more transparent interfaces.

The study (Xue, 2020)assesses 300 top-ranked Chinese websites based on Alexa to examine their current user data collection practices. They manually evaluated the websites, which included two experimental sets under the user study. Experiments and a survey that included more than 200 participants were involved. The result from the experiment sets concluded that the users did not know much about cookies, and they were not aware of the right choices for cookie selection. The result of each choice was not so understandable to the users, and the websites were not fully filled according to the Chinese cybersecurity law. Furthermore,(Degeling et al., 2019) , discovered from their study that there are many third-party consent notices with a lack of delete or block options from cookies and a need for some kind of additional modification in the cookie interface so that the user can react to it in a proper way. This study evaluated 500 European websites and used different automatic techniques like scans and reviews to determine the impact of GDPR on their privacy policies. Additionally, they found out that the website's transparency was impacted, and because of this, it informs the users about what type of privacy data has been collected and used by other parties. However, there were many websites that were tracking their users and did not meet the privacy law requirements.

Additional studies were done by (Fouad et al., 2020) The study aimed to identify the legal requirements of the cookie interface, as well as any related lawful violations. The study evaluated more than 20,218 third-party cookies. The result of the study shows that only 95%

of cookies do not declare their main purpose and do not comply with the law of consent interfaces. The identified issue was mainly that consent notices did not explain the purpose of cookies in a well-defined, structured form. Only 5% of the cookie interfaces provided a description of the cookie's purpose, while 30% of the interfaces provided information in a confusing and difficult way.

To understand the current approaches and design guidelines in online privacy(Barth et al., 2023), they did a systematic review of privacy visualisations from 15 privacy attributes with 14 Privacy by Design principles. These attributes are collection, control, correctness, disclosure, functionality, purpose, retention, right to be forgotten, sale, sharing, transparency, and pseudonymization. They used the method of an online survey to collect the results from 646 participants. The findings described using some of these attributes by privacy experts and users, for example, what type of personal data is being taken and with whom this information is shared and sold to other external parties.

The role of cookie banners as a privacy mechanism in websites and its design and implementation has been done in (Santos et al., 2020). They analysed different legal requirements that rely with GDPR policy, and the violation associated with consents design. They used both manual and technical methods for the evaluation of valid consent is required or not. They found 17 different requirements to validate the consent banner design by using the legal experts or consult technician in the existing device.

The concept of privacy with online behavioural advertising (OBA) is explained in the (Sakamoto & Matsunaga, 2019)This study clear the idea of being in OBA opt-out state by using browser cookies of the top 100 news websites as per Alexa. This study also explores the difference between enforcing GDPR before and after. The findings illustrated that 50% of websites do not track user after selecting optout. But some of the agencies of advertisement saved the user opt-out cookies for future use. Along with this, they did not find any huge difference in privacy settings before and after GDPR implementations.

Summary

The literature studied in this study emphasises the importance of usability in the design of cookie interfaces. The analysis demonstrates that design considerations have a substantial impact on how user interact with cookie interfaces, affecting their privacy choices and

overall engagement with cookie consent mechanisms. Notably, studies indicate that simplified interfaces with clear and straightforward options lead to higher user involvement and compliance with regulatory standards.

However, despite advancements in design practices, many interfaces still utilise 'dark patterns' that compromise user choice by nudging users towards less privacy decisions. This manipulation highlights a gap in both ethical and design standards and regulatory compliance, highlighting the need for more clear guidelines.

The above presented literature lacks insights into how user behaviour and preferences change in response to their interactions with cookie interfaces. This gap supports the necessity of the first research question (RQ1), which aims to reveal the usability challenges users encounter. Understanding these challenges is essential for designing interfaces that maintain user engagement and effectiveness over time.

In above mentioned studies, there is a clear difference between the presence of compliance elements in cookie interfaces and how well they really work. This observation leads to the second research question (RQ2), which aims to identify best practices and design patterns for presenting and organizing cookie interfaces in a clear and intuitive manner. Additionally, these studies primarily focus on western websites contexts, with a limited understanding of how cultural and regional differences might affect the usability and effectiveness of cookie interfaces. This deficiency informs the third research (RQ3), which investigates the key principles of universal design that need to be integrated into the interface to ensure worldwide applicability and compliance with varied user abilities.

3. Methodology

We are diving into the world of cookie settings on websites. Those little unwanted pop-ups that's always ask about cookies, this study is all about understanding how easy or tricky they are for people to use. Our main goal is to make those pop-ups user-friendly but also inclusive for everyone. This means our investigation is just not only study usable way to use cookie but also, we are making sure that everyone, no matter their abilities can easily manage their cookie preferences.

This section of the thesis outlines the methodology employed in investigating the usability and universal design of interface. The methods and Procedure described herein are designed to ensure a thorough investigation through several data collection and analysis. The aim is to investigate how different users interact with various cookie interfaces and to measure their effectiveness and what barriers they faced.

The following chapter includes detailed description of how this study is designed, its analysis techniques, data collections methods to answer the research questions and ethical considerations.

In the study, I developed prototypes of cookie interfaces with different design features and elements related to usability and universal design. After developing the prototype, the participants were investigated the prototypes to analyse the effectiveness of interfaces and their privacy. These participants were from diverse backgrounds; that is, they possessed different ages, and backgrounds. Which is explained more about it in Section3.3.2 of participants. The sample size of our participants was 20.

The research methods to answer the research questions are more qualitative in nature, with some numerical data from the Likert-based questionnaire, so it might be better to call it a qualitative evaluative investigation and explained the reason for choosing it. After completing the evaluative investigation, I employed various data collection methods, including semi-structured interviews, task-based observations, and data from a Likert-scale questionnaires.

3.1 Research Approach

There are three common methodologies for conducting research: quantitative, qualitative, qualitative and mixed methods (Lazar et al., 2017) Which method should be used depends

on the data required to answer the research questions. For example, if researchers need numerical data, textural data, or both numerical and textural data, they should choose one of the three methods mentioned to carry out their research. The quantitative approach is used when numerical data is involved to address research questions; the qualitative approach is for textual data; and the mixed-methods approach is for both numbers and text(Lazar et al., 2017).

3.1.1 Quantitative Research

The quantitative research method is an approach that focuses on numerical information, measurements, task completion percentages, and the amount of time taken to complete the task(Munir, 2021). The primary focus of this method is on utilising statistical data to quantify and analyse issues or problems(Sreekumar, 2023). Most researchers use this method to build empirical relationships and identify hidden patterns in their work. Along with this, it also provides answers to questions like “how many and how much”(Munir, 2021). According to (Mohajan, 2020)this method is used to quantify attitudes, opinions, behaviours, and other pre-defined variables from a broader sample population by producing numerical data. There are also different types of quantitative research, as per (Sreekumar, 2023) such as experimental research, survey research, causal-comparative research, correlational research, and descriptive research.

3.1.2 Qualitative Research

This method is more focused on collecting, analysing, and interpreting non-numerical data and understanding more complex scenarios. The main goal of this method is to identify user experiences, outlooks, and preferences in different circumstances(Lazar et al., 2017). It provides answers to questions like “what” the user thinks and “why” he thinks that way. In qualitative research, the most common methods are interviews, observation, focus groups, and content analysis to record the natural reactions and richness of human behaviours and their interaction with circumstances(Hammarberg et al., 2016). Different advantages are mentioned by (Bhandari, 2020) for using a qualitative approach, such as flexibility, meaningful insights, the generation of new ideas, and the natural setting of the issues. However, there are some disadvantages that are mentioned by(Lazar et al., 2017), among them is the extent to which one should pre-plan and structure the methods. This is an

important task because structured methods can help maintain data consistency across various sources, which directly helps researchers address the questions in a meaningful manner.

3.1.3 Hybrid Research

This approach is a mixture of both qualitative and quantitative research, known as a mixed approach within a single study. The result of this approach is that researchers can draw strength from both qualitative and quantitative methods and use them to produce a more comprehensive and thorough understanding of research problems.(Rudat, 2019).The process of this method is simple: start with collecting data, analyse it, and interpret it with a combination of both approaches(Rudat, 2019). Thus, this combination allows researchers to address research questions from more broad angles, validate findings, and provide a richer context for the study. This method can be used particularly in interdisciplinary studies, where the aim is primarily to collect data from various sources to improve the overall quality of the research through combination(Munir, 2021)

3.2 Approach for the Study

For this study, I have used a predominantly qualitative approach with some numerical data (quantitative) obtained from a post-task Likert scale questionnaire. The data were collected through task observation and semi-structured interviews, making it a mixed-methods research approach. This strategy was particularly well-suited for providing detailed and distinct solutions to the research questions. Mixed approach is useful to understand and explore complex phenomena by using user perceptions, their experiences and in-depth knowledge (Jackson et al., 2007). For example, the quantitative approach involves collecting numerical data that may be measured and analysed using statistical methods. Its objective is to quantify the scale range and frequency of phenomena (Ishtiaq, 2019) . Likewise in my study, I used some quantitative data as a supporting role in understanding user interactions comprehensively. It collects Likert-scale questionnaire responses from the users. However, qualitative approach is more focus on collecting non-numerical data such as words, meaning, characteristics and description of thing .It is more subjective in nature.(Di Pofi, 2002).

A qualitative approach involves methods like interviews, observation, or an open-ended questionnaire, aiming to particularly focus on the depth of human experiences and perspectives (Morse, 2005). Which align perfectly for giving a good depth understanding of user experiences in facing usability challenges, enhancing the best ideas for organising the user interfaces effectively, and identifying the key principles of universal design for cookie interfaces**.**

According to (Taylor et al., 2015) in qualitative methodology, researchers take a comprehensive approach by examining individuals, environments, or groups as a whole. Instead of being reduced to mere variables, settings, groups, or people are considered complete entities, acknowledging the interconnectedness and integrity of the whole context. Furthermore, researchers using a qualitative approach study people with respect to their past experiences and the circumstances in which they find themselves(Taylor et al., 2015). Naturalistic research is another name for qualitative research(Lincoln & Guba, 1985). The qualitative approaches are concerned about how people are thinking and their actions in everyday lives.

In the qualitative interviewing method, the researcher could structure the interview to resemble a typical conversation rather than a formal exchange based completely on asking and answering questions (Taylor et al., 2015) .The fact that the opinions of influential individuals carry more validity than those of less powerful individuals is dismissed by quality research, which says that every viewpoint holds value(Taylor et al., 2015). In qualitative research, researchers highlight the significance of their work, and the way they conduct their studies is flexible(Taylor et al., 2015).

According to (Berg et al., 2004) there are different approaches to qualitative methods like interviews, focus groups, or open-ended questionnaires. You can use these methods for both summative and formal purposes.(Lazar et al., 2017).In a qualitative research approach, the participant numbers are generally few, and it took a lot of effort and resources to carry it out. (Kurtishi, 2018)

While testing the interactive systems, one thing that comes to mind is usability(Olsen, 2007). Usability helps in evaluating how effective and easy to use the interactive systems are by observing the real users while they are interacting with the system to perform some specific task or goal(Thorngate & Hoden, 2017). In the context of this study, usability testing involved assessing how actual users interact with cookie interface prototypes. The aim behind this

process is to understand the user's experience and the challenges they will face while navigating to manage their cookie preferences. According to (Ivory, 2001) they suggest that usability testing techniques can be used once the user interface design or prototype has been developed and put into practice.

In this study, while the primary approach is qualitative, I incorporated some quantitative elements by using a Likert scale questionnaire to gather numeric data. According to (Cohen et al., 2002) quantitative research involves employing empirical techniques, with empirical statements expressed in numerical terms. “Quantitative research is valuable for measuring opinions, attitudes, and behaviours, ,enabling the assessment of the overall population’s sentiments on a specific issue.” (Sukamolson, 2007)

Technological advancements have made numerous research methods available for researchers to adopt for their studies (Lazar et al., 2017) Selecting a particular research approach is always a vital decision because the quality of the usability testing totally depends on the method used, and there are various methods to evaluate or test user interfaces, for example, heuristic evaluation and empirical evaluation (Munir, 2021)

3.2.1 Empirical Evaluation

This method is chosen when we want to collect feedback directly from the user and observe them and their interactions with cookie interface prototypes. The advantage of using this approach is that it helps in understanding user behaviours, addressing usability issues, and collecting in-depth insights. Therefore, this method is useful for dealing directly with users. The methods involved in it are questionnaires, interviews, focus groups, and performance measurement(Munir, 2021). According to(Lazar et al., 2017), “empirical evaluation plays a very crucial role in HCI. The HCI domain firmly establishes the credibility of experimental research. Significance testing permits the assessment of whether there are genuine differences in the means of observed groups. Nevertheless, this approach does have limitations, such as the necessity for clearly defined and testable hypotheses. In HCI experiments, it is challenging to exercise control over all conceivable variables and establish controlled experiment environments.”

3.2.2 Heuristics Evaluation

This method was first proposed by Jackob Nielsen .Heuristic evaluation is one of the informal evaluation methods that is mainly conducted by usability experts or evaluators(Nielsen & Molich, 1990). In this process, the interface is examined against a predefined set of usability principles, or heuristics, such as Nielsen's heuristics(Thovtrup & Nielsen, 1991). The main goal of the method is to reveal and address usability issues early in the development process, which therefore improves the user experience of the interface(Tan et al., 2009).Several advantages have been proposed by (Nielsen & Molich, 1990)such as that this method is cheap, does not require any advanced planning to conduct it, can be used at an early stage in the development process of interfaces, and is very easy to motivate designers to design interfaces. However, some disadvantages are also discussed, as it does not involve actual user testing or direct feedback, it is also time-consuming when multiple evaluators are involved, it requires more than one evaluator to achieve accurate usability testing's (Nielsen & Molich, 1990).

In this study, I conducted a comprehensive evaluation of our cookie interface settings prototype through user engagement sessions. This approach, while systematic, primarily emphasises qualitative data collection, focusing on direct interactions with real users to gather real-life insights on improving interface usability and overall user experiences. According to (Karat et al., 1992), such an evaluative method is effective in identifying a wide range of issues within the interface. My research is fundamentally observational, centred around user behaviours and reactions during task interactions. I fully engaged participants in specific tasks related to cookie consent and management, as detailed in Section 3.3.5. I designed these tasks not to perform under controlled conditions, but to understand real user actions in managing cookies, offering a structured exploration of the consent interface's functionality, user-friendliness, and effectiveness. As a result, this qualitative with some quantitative measures evaluation investigation provided deep insights into the usability of the user interface, highlighted design challenges, and suggested improvements to improve the user experience with cookies.

3.3 Research Design Process

In this section, I will provide a detailed explanation of the methodology used to explore the usability and universal design of our cookie interface prototypes. The study aims to gather in-depth insights into how participants interact with these prototypes through questionnaires administration and engagement in various tasks. Initially, participants shared their initial reactions to the interfaces, and their further engagement in task-based evaluations helped to uncover more detailed insights. Section3.3.4 discusses this evaluative process and provides further details on participant feedback on interface performance, preferences, and experiences.

For this investigation, I developed different user interfaces for cookie settings, and participants explored these interfaces through six varied tasks assigned across the prototypes. This study employed a more qualitative approach with 20 participants, allowing each to interact with all the interface designs. This method provided comprehensive feedback on each distinct interface as participants undertook specific tasks and responded to related questions. The upcoming sections present more elaborate discussions on prototype design, participant demographics, task environments, procedures, tasks, interviews, and questionnaires.

3.3.1 Prototype Design

For this study, I developed ten prototype sets of cookie settings interfaces. I took a systematic approach to the development process because I wanted them to be easy to use and interact. So, each set was made with a lot of care and attention to detail. Some of the sets followed the universal design principles, but it's worth mentioning that a few deviations also occurred. I will determine necessary adjustments to make it more inclusive through user evaluation and feedback. While designing the prototype, I took the following elements into consideration.

- Some interfaces I designed have proper font sizes and high contrast colours to ensure that people with diverse abilities can easily navigate and read through them.
- I also organised the cookie settings into logical categories, for example, necessary and other cookies, which make it easy for users to find and manage them according to their preferences.

Please click on the link to interact with the prototypes.

https://m40bm2.axshare.com

Each prototype included some key features and designs, some of which are as follows:

- Some of them allowed users to personalise cookie settings based on their preferences, while others provided clear information about the use of cookies.
- However, I have also designed some prototypes with unfriendly interfaces so that we can get user reactions.
- I gave users full control over a few interfaces to revoke consent easily.

I designed prototypes using the Axure RP10 tool. It is known for its powerful prototyping capabilities and flexibility. The reasons for choosing Azure RP 10 over other tools are mentioned below (Axure, n.d.):

- We can create highly interactive and dynamic prototypes with this tool. Which helped in this study to know how users would engage with cookie interfaces.
- It allowed for the creation of realistic and detailed representations of cookie interfaces, which were essential for accurate usability testing.
- It helped our prototypes by showcasing different states of the interfaces based on user interactions, with its unique feature of flexibility in designing complex interactions.
- For any usability testing, features such as clicking buttons, navigating through pages, and selecting different options are important, allowing us to observe how our participants interacted with each of the prototype.

Screenshots of the prototype

Below, I have included just a few screenshots of the prototype. Appendix D contains the remaining screenshots.

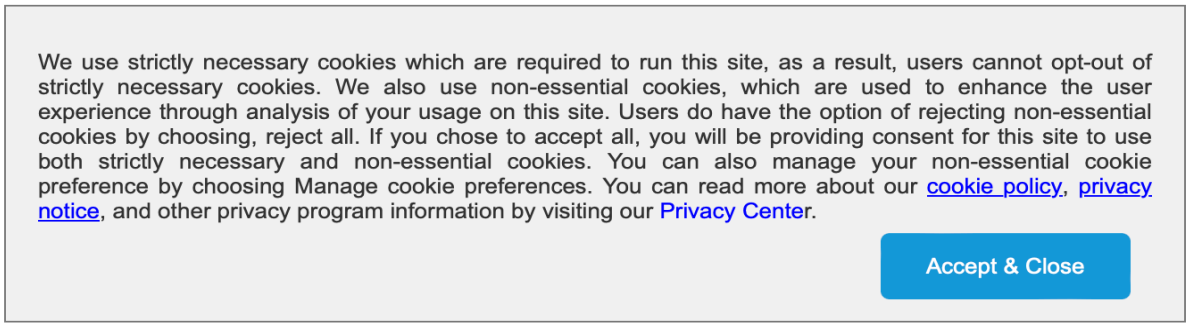

Figure 8:Screenshot of the prototype 1

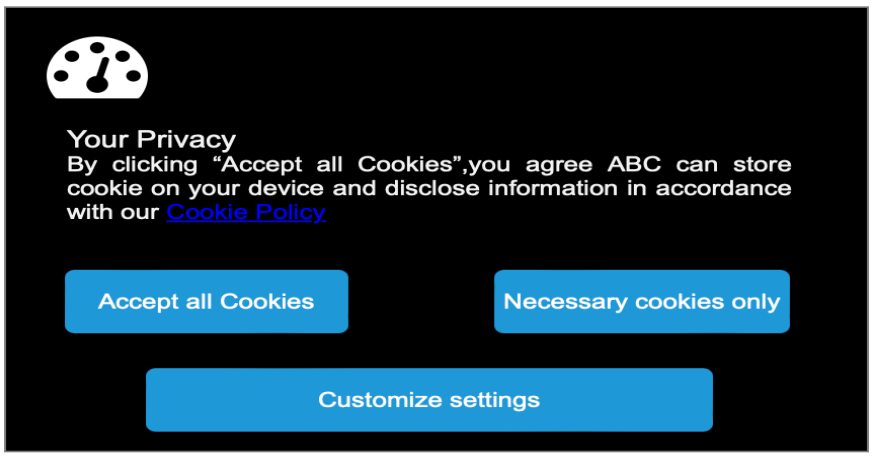

Figure 9:Screenshot of the prototype 2

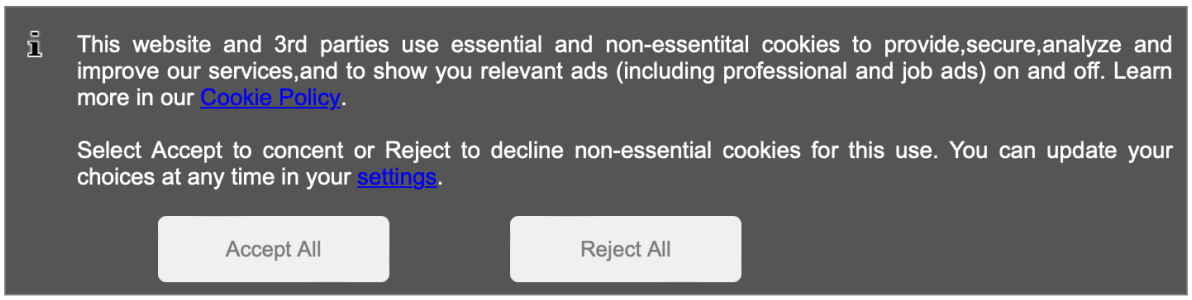

Figure 10:Screenshot of the prototype 3

3.3.2 Participants

I wanted a diverse group for the study, so my plan was to gather twenty (12 males and 8 females) various people from Oslomet University, friends, family members, and the local people to participate in my study. All were from different ages, genders, and educational backgrounds. In this study, I planned for each participant to act as their own reference point to compare different aspects of tasks and experiences. Each participant performed the evaluation individually, and each session lasted for 15-20 minutes. The investigation contained four stages: an introduction, a series of tasks, a short questionnaire, and an interview. The participant's experiences and preferences were gathered from the observations, questionnaire, and interview rounds.

3.3.3 Test Environment

I conducted the evaluation process in the master's room of P35 at Oslomet university. Participants and I were only present in the room during the whole Investigation process. If they encountered any difficulties while performing the tasks or answering the questionnaire,

I could assist them. The master room was exceptionally silent, serving as a noise-protected space. This ensured that participants could perform tasks without being distracted by external noises. All participants used my laptop for the investigation process.

3.3.4 Procedure

The procedure to conduct the evaluation with each participant is explained in this session. The procedure that I followed with participants was the same for each participant. In the beginning, all participants were greeted and informed with a detailed introduction about the purpose of this study, a general idea of what a cookie interface is in websites, and the details of this evaluation.

Prior to proceeding with any subsequent steps, obtaining consent from all participants was essential. Therefore, I provided them with our information sheet with consent form, which they were required to read and sign. For a detailed view of the consent form, please refer to Appendix A

After signing the consent form, all participants were provided with an introductory questionnaire mentioned in Appendix B which aimed to gather demographic information and helped me assess their familiarity with cookie interfaces.

To observe the user interactions and potential challenges all participants involved in adjusting basic cookie preferences. As the process continued, I introduced some more complex tasks, like being asked to select their preferred cookie option and note the situations where they might not be able to select their choices. I also encouraged the participants to note any difficulties they encountered throughout these tasks. With participant observations, I was also writing my observations for each task so that I could compare them later with participant observations.

In addition to these structured evaluation tasks, a Likert-scale questionnaire, and a semi-structured interview section 3.3.7 components were also integrated to further enhance the understanding of participants experiences and perceptions regarding cookie interface setting.

To conclude our evaluation process, participants engaged in a questionnaire and a semi-structured interview designed to capture their overall impressions, suggestions for improvement, and preferences. This helped me to uncover usability challenges, identify best

practices in design, and reveal key principles of universal design within the context of the interface of cookie settings.

3.3.5 Tasks

To evaluate the prototypes, I created tasks for our participants to complete on each prototype. Which are described below. The purpose of these tasks was to gather insights from participant observations so that I could use them later to answer the research questions. Another reason for doing these tasks was to see the difference between participants and my observations, which I did along with these tasks.

Task 1: Initial impression: Participants were asked about the initial impression from the interface like are they easy, difficult to understand. This task was selected to gather first-hand reactions that reveal the intuitive aspects of the interface design—whether it appears easy or difficult to understand at first glance. Insights from this task are crucial as they set the stage for more in-depth exploration of usability and user experience. Observations from this task helped me in understanding the immediate barriers or facilitators to user engagement.

Task 2: Cookie Rejection: Here the participants were asked to find and execute the process to opt-out (Reject) cookies. The intention here was to evaluate how effortlessly they discover and use the *Reject cookie* option. This task helped me to answer my first research questions that is based on usability challenge about what challenges user faces when opting out of cookies.

Task 3: Customisation: Participants were instructed to set their cookie preferences by selection of their preferred cookie options and block or reject others. This task helped me to see how easy it was for them to find and changes these settings.

Task 4: Information Access: Participants asked if they could access detailed information about cookies and their uses. The inclusion of this task is vital for determining if the interface supports transparency and educates users effectively about the use of their data. It assists in assessing the sufficiency of the information presented, which is a fundamental aspect of user consent and trust.

Task 5: Check Clarity: The participants checked if the interfaces used any kind of confusing buttons or options to force the users to allow all cookies. This task helped in identifying

confusing elements and insights into if the interface is trying to pressure users into agreeing to all cookies without really understanding what they are agreeing to.

Task 6: Confirm saved preferences: Participants were asked to confirm if they could easily find and use the 'Save Preferences' option. This task ensures that the changes made by users are not only acknowledged by the system but also preserved, which is essential for a respectful and reliable user experience.

3.3.6 Questionnaire

All the involved participants filled out a questionnaire; some of the questions were asked before starting the tasks, and some of them were asked after the tasks were finished. The aim of this questionnaire is to collect details about the participant's background and diversity. Before the task, I asked them about their past experiences participating in research and about their interactions with cookie interface settings while surfing websites. The users provided their answers on a scale from 1 to 5, with 1 representing no experience and 5 representing extensive experience. I also added the age interval question in the first part of the questionnaire. The reason for doing this was that the user might not want to share their private date, for example, their name or address. How experienced are you with interacting with cookie interfaces while surfing websites? (On a scale from 1 to 5, where 1 is not experienced at all and 5 is very experienced.)

I also asked participants some Likert scale-type questions Appendix B about the interface prototype and their experience with it after they completed the tasks. The first four sets of questions were entirely based on usability challenges that users primarily encountered while interacting with the cookie interface. The next four sets of questions were about design layout and elements that needed improvement.

I chose these questions because they helped me understand how users feel and navigate through different cookie-setting interfaces. These questions give insights into whether the interfaces were easy to understand and if there were any confusing parts. In the questions that asked about managing preferences, I aimed to figure out if users could easily accept, reject, or customise their cookie settings. The question about language clarity helped me identify if the information provided was clear or confusing. I also wanted to know which design users preferred most; therefore, I included questions regarding interface appeal and their intuitiveness. Lastly, I asked participants if it was easy to find detailed information

about cookies, their purposes, and implications in each of the interfaces. Overall, these questions covered a range of aspects to make sure the cookie-setting interfaces were user-friendly and considerate of everyone's needs.

3.3.7 Interview

The purpose of conducting research interviews is to allow us to delve deeply into the study. We can ask lots of questions about the issue we are looking into and give people more chances to share more about what they think(Lazar et al., 2017). We might find new things to talk about when we hear what people say in interviews. We can talk freely about interesting and important issues, and it helps us understand more. Interviews are different from using surveys or questionnaires, where there are high chances of missing out on important and deeper insights. We generally set up interviews based on the person's flexibility in asking questions and their freedom in answering them. There are three different ways to organise interviews based on this (Lazar et al., 2017).These are structured, semi-structured, and open-structured / unstructured interviews (DiCicco-Bloom & Crabtree, 2006).

In a structured interview, questions are fixed and strict; we can't add more questions, talk more, or ask no-follow-up questions. But the good part is that it makes collecting and analysing data easier (DiCicco-Bloom & Crabtree, 2006)The other one is an unstructured interview, where in this interview questions don't stick to a specific set of questions and the person being interviewed gets to choose how the conversation goes(Lazar et al., 2017). The third one is a semi-structured interview, and as this study aims to investigate individual experiences about the interface of cookies, a semi-structured interview is one of the most desirable approaches to getting a direct, independent response from the user (Lazar et al., 2017) therefore, I chose this approach in my study.

Semi-structured interviews are the most commonly used in hybrid research(Andersson, 2019). Researchers often use this type of interview, where they prepare a set of questions and allow participants to express their own ideas and words. The questions guide the conversation, but there is always room for flexibility (DiCicco-Bloom & Crabtree, 2006) I went with this approach because I could plan some questions beforehand, but I still had the freedom to ask some more if needed. Which helped me to know the participants thoughts in their own words and gave me a better chance to learn about the topic. The only drawback

of using a semi-structured interview is that it is very tough to analyse and compare open-ended questions(Hasan, 2020). Despite this challenge, we still think the information we get from these interviews can be really valuable (Hasan, 2020)

While preparing for the interview question, I thought about a few important things, like that the question needs to be clear and understandable. The following questions were asked of each participant that were best suited to understanding more about the usability and universal design of cookie interfaces.

1. Can you tell me about your experience with managing cookies when you use websites? How often do you get to see cookie interfaces?
2. When interacting with cookie interfaces, have you faced any difficulties or challenges?
3. In your opinion, what aspects of the cookie interface make them confusing?
4. Have you ever felt frustrated or dissatisfied while trying to adjust cookie preferences?
5. What design element makes website cookie settings easy to understand and navigate?
6. Have you ever encountered poorly designed cookie interfaces? Tell me briefly.

3.4 Qualitative and Quantitative Data

Initially, all raw qualitative and quantitative data were collected in Word files and analysed when all participants performed the test. The study collected qualitative data in the form of subjective opinions, preferences, and data from semi-structured interviews and questionnaires, while quantitative data consisted of numerical values obtained from participants using the Likert scale questionnaire. All these data are available in Appendix C. *Analysis of the qualitative data:* There are various techniques available for analysing the qualitative data in research studies, such as grounded theory, conversational analysis, discourse analysis, thematic analysis, and content analysis.(Cairns & Cox, 2008) . The method I selected for analysing the collected data was content analysis. This analysis is a way of looking at the words and information people share and breaking them down to understand what they want to tell us(Shrestha, 2017). The reason I chose this method is that it allows me to look closely at words or phrases in interviews & observations data. I can also check how often certain words appear together and are used, which may show the importance of

different ideas and how they are connected with each other.(Lazar et al., 2017). The detailed explanation of this analysis is explained in the following chapter, Result.

Analysis of quantitative data: In this study, I have only data from a Likert-type scale questionnaire in numerical form and therefore used Excel to get descriptive statistics for each prototype.

3.5 Research Ethics

Research ethics is all about doing study in a fair and more responsible way. It can be understood in a way of setting rules that researchers need to follow to make sure their studies are conducted with honesty, integrity, and care. Such rules are there to protect the rights and well-being of the people participating in the research and to make sure the findings from the study are reliable(Fischer, 2006). According to(Oliver, 2010) "Researchers are now getting better at thinking about ethical issues. They are paying more attention to the right way of planning and doing research. It seems like there is a growing awareness and code about the ethical side of things when it comes to research."

We should only gather user data that is not too personal and keep participants safe from unfair treatment, harm, or tricks during the research. Before the study begins, participants need to know exactly what study is about and what the researcher is trying to find out. Researcher must provide a clear form explaining everything before the study starts and they should understand it and agree to it. Such form is called informed consent. In my study I am not collecting any kind of personal data of the participants which will affect them in any means. For this study I am using consent form which is in Appendix A. To follow the rule of Norwegian personal data act and guidelines for using participants personal information in study , I also provided them an sheet with information that explains what my study is all about and what I am going to ask them to do (*NSD - Norwegian Centre for Research Data*, 2019) .

During interaction with participants, I made sure that they knew how I would take care of their data and information before starting with the procedure of study with them. I also shared with them that whatever they shared with us would be keep private and without their concern I will not misuse their information. I also told the users that they could change their mindset and withdraw from the study at any time without any stress. I want the user

that they feel safe and stress free. After making sure they understood everything, I asked them to sign a consent form saying that they agree to take part in the study (Munir, 2021) I have not collected any personal information such as name, address in the study. All participants were voluntary participants. User remained unknown. All these measures are followed to maintain ethical consideration in this study.

4. Result and analysis

This section of the thesis consists of the results and analysis of the data collected through user observations, interviews, and Likert scale questionnaires. I used the content analysis method to analyse the participant responses from the tasks they performed in the first subsection, as well as the interview data. I analysed the questionnaire data using word to calculate the mean of the responses. The final subsection presents the findings from the analysis.

4.1 Analysis of Participants Responses from Observations

Content analysis serves as a robust methodological tool for systematically analysing qualitative data, such as participant responses (Lazar et al., 2017) .In the context of this study, content analysis played a pivotal role in deriving meaningful insights from the observations provided by participants regarding their interaction with cookie settings interfaces.

Here's how content analysis facilitated the analysis of participant responses across various tasks:

Data Organization and Preparation

In the process of analysing the data, first the raw data which includes participants to each task was compiled and organized systematically. This involved transcribing participants' verbal responses, ensuring that all relevant data were captured accurately. Additionally, any supplementary materials, such as field notes or observations, were also included for analysis. I made sure to label each response with the matching prototype number. Which helped with analysing the data easily and maintain the context's integrity.

Task Categorization and Coding

To facilitate analysis, the data were categorized according to the tasks outlined in the study. Each participant response was then coded based on key themes or concepts relevant to the research objectives. For instance, responses related to clarity, ease of use, customization options, information access, and confirmation of preferences were identified and coded accordingly. This coding process enabled me to systematically categorize and organize the data for subsequent analysis. Which I have explained in following section.

Identifying Patterns and Themes

Now, the next step involved identifying patterns and themes within the coded data(Lazar et al., 2017) . By examining participants' responses across different tasks and prototypes, recurring themes and trends emerged. Which I have explained in each task below. These patterns provided valuable insights into participants' experiences, preferences, and challenges encountered while interacting with the cookie settings interfaces. For example, themes such as the importance of clarity in interface design or the need for robust customization options were identified through this process.

Comparative Analysis

After finding the patterns and themes, Participants responses were compared across different prototypes and researcher observations .For example, in task 2 , participants consistently reported difficulty locating the option to reject cookies in prototypes, while I noted its presence but acknowledged its hidden placement, this misalignment highlighted an important usability issue that needed to be addressed and hence in this way analysis facilitated a comparative analysis between responses.

In-Depth Interpretation and Insight Generation

With the help of content analysis , it became easy to derive in-depth interpretations and generate actionable insights from coded data (Lazar et al., 2017). In this study, it enabled me to uncover the exact insights into user perceptions, behaviours, and preferences regarding cookie interfaces. For example, in task 4, analysis revealed that participants valued interfaces with clear and concise explanations about cookie policies, indicating a need for transparent communication of privacy practices.

Ensuring Validity and Reliability

It is important to took steps to ensure the validity and reliability of findings from analysis. The process of qualitative data analysis was carefully and deliberately followed without jumping into the following steps before not fulfilling the previous steps to increase the findings of this study. The data were collected and transferred into the word file in a tabular form so that it could be easier to go back and check the data numerous times. Hence, to ensure validity and reliability involved clear guidelines, checking for consistency among different results and maintained detailed documentation of the analysis process.

Based on the insights generated through content analysis, this study able to draw meaningful conclusions and formulate recommendations for interface improvement. These conclusions were grounded in the empirical evidence derived from the participant responses, ensuring that the recommendations were informed by user experiences and preferences. For instance, recommendations might include redesigning the interface to enhance clarity, increasing the visibility of customization options, or providing clearer explanations about the implications of cookie choices.

The responses collected from the task were analysed using the same technique. Mentioned above.

4.1.1 Task 1: Initial Impression

Task 1 was about the initial impression of each prototype as perceived by the participants see table 1. Responses were coded based on various aspects of initial impressions, such as clarity, ease of understanding, visual appeal, and engagement. Themes such as the need for improved visual appeal or the presence of limited customization options emerged from the analysis. While comparing observations I noted consistencies to understand user perceptions comprehensively.

Consensus on Clarity and Simplicity: Several prototypes, such as Prototype 2, 4, 6, and 8, were highlighted by both participants and the researcher for their clarity and ease of understanding. These findings suggest that the design's simplicity and straightforwardness are well-received, aligning with usability principles that prioritize clear and concise interfaces.

***Design and Customization Needs**:* There was a recurring theme related to the need for improved aesthetic appeal and customization. Prototypes 3 and 7 received comments on their lack of engaging designs and limited user customization options. Similarly, Prototype 10 was noted for lacking control over customization. These observations indicate a gap in meeting user expectations regarding personalization and visual engagement, which are crucial for user satisfaction and overall user experience.

Interface Issues: Specific issues were noted with certain prototypes that could impact user interaction. Prototype 1 was observed to be overshadowing other options and pushing users to accept cookies, which might affect user autonomy and choice. Prototype 5 felt

incomplete, and Prototype 9 had ambiguous button texts, suggesting areas where the interface might not effectively communicate or provide necessary information to the users.

Agreement on Interface Problems: In cases where the researcher's observations agreed with the participants' observations (Prototypes 2 and 6), it underscores the importance of these aspects being addressed in future iterations of the design. This consensus adds weight to the need for design modifications.

Prototypes	Participants Observations	Researcher Observations
1	Overshadowing other options	Interface force to accept cookies
2	Clear & easy to understand	Agree with participants
3	Need for improved visual appeal.	Lack of engaging designs.
4	Logical and straightforward	Simple and clear
5	Feels incomplete	Limited options
6	The interface is clear & easy	Agree with participants
7	It lacks user customization	Limited options
8	Well-designed & easy to understand	Clear and concise
9	Text in buttons is ambiguous	text too long in button.
10	Lack more control in customization	lack of customization options

Table 1: Responses from Task 1

The results from Task 1 suggest that while some aspects of the interface design were successful in delivering clarity and simplicity, However, there are specific areas that need to be enhanced. It was clear that there was a need for improved visual appeal and more choices for customisation, as well as some interface elements that had the potential to hinder the user's experience. These insights are critical for informing the developers for refinement of the interfaces to better meet user needs and preferences. Hence, it can be concluded from the analysis of participant observations for task 1 is that enhancing visual appeal and allowing more customization options could potentially increase user engagement and satisfaction. Furthermore, addressing specific interface issues such as misleading or ambiguous button labels and ensuring that the interface does not overshadow options or impose decisions upon users could result in a design that prioritises the needs of the user.

4.1.2 Task 2: Cookie Rejection

In Task 2, Participants experiences with finding and using the option to reject cookies were analysed (refer to table 2). Themes such as the presence or absence of the acceptance option, ease of locating it, and any confusion encountered. Each theme was further categorized to capture specific observations, such as the clarity of instructions or the visibility of the option. Discrepancies in user experiences were analysed to understand potential usability issues and areas for improvement. Analysis of participant responses provided insights into the effectiveness of the interfaces in facilitating cookie rejection.

Visibility of rejection option: A significant finding from the observations of task 2 response was the frequent absence or poor visibility of opt-out options for cookies. Prototype 1,4,5,7 and 9 were noted both by participants and the researcher for lacking a clear or direct option to reject cookies. This indicates a design approach that may not support user privacy preferences effectively.

Hidden rejection methods: Prototypes 2 and 8 were noted for having the reject option available but not prominently displayed, being hidden within the interface. This suggests a design strategy that may be perceived as intentionally creating obstacles for users to find and use the reject option, potentially have an impact on user confidence and satisfaction.

Ease of Opt-Out Process: Prototypes 3, 6, and 10 demonstrated a more user-friendly approach, as participants were able to easily locate and use the reject option.

These instances were characterized by the rejection option being straightforward and requiring only a few clicks, highlighting an effective design practice that respects user preferences for managing cookies.

The results from Task 2 reveal significant variation in the design of cookie rejection options in interfaces with a tendency towards reducing the visibility of these options in several prototypes. This trend could have implications for user confidence and the ethical principles governing the design of digital interfaces. The findings suggest that:

Lack of Clear Opt-Out Options: Most prototypes do not provide clear, direct methods for users to reject cookies, which could break the principles of privacy design that emphasise the importance of transparent user choices and consent management.

Interface Design Recommendations: To improve, design strategies should incorporate more transparent, easy-to-access rejection options. Designs like those in Prototypes 3, 6, and 10

for opting -out cookies should be considered as benchmarks for effective cookie rejection options.

To opt-out (Reject) option

Prototypes	Participants Observations	Researcher Observations
1	No clear way to opt-out	Absence of reject option
2	Reject not in the main interface	Available but hidden in interface
3	Opting out with a single click	Easy to figure it out
4	No option for direct rejection	Agree with participants
5	No option to reject cookies	Agree with participants
6	Found and clicked	Agree with participants
7	No option to reject cookies	Agree with participants
8	Hard to figure it out	Reject option not in the main interface
9	No option to reject cookies	Agree with participants
10	Found and clicked	Easy to figure it out

Table 2:Responses from task 2

4.1.3 Task 3: Customization

Task 3 focused on participants' experiences with customizing cookie settings (see Table 3). Each response was analysed and coded based on themes such as the ease of customization, availability of options, and user-friendliness of the interface.

Limited customization options: The analysis during task 2 of several prototypes (1, 3, 4, 5, 7, 9 and 10) revealed a noticeable absence or restriction of customisation options. Both participants and the researcher regularly observed this, indicating a widespread problem in the design of these interfaces. Prototypes 1 and 10 were criticized for a lack of customization options, which could impact user satisfaction by preventing users from personalising their experience.

Clarity of customization features: Prototype 3 was particularly known for its unclear availability of customization options, suggesting that even if these options are present, they may not be user-friendly or easily accessible. This highlights a deficiency in the clarity of the design, which has the potential to hinder user interaction and enjoyment.

User-friendly customization: Prototypes 2,6 and 8 were praised for their efficient and user-friendly customization features, which allowed for quick and easy customization experiences. These cases highlight successful design and usability implementations that effectively address user needs for customising their interface experiences.

The results from task 3 observation reflect the variability in how customization options were integrated and presented in user interfaces.

Many of the prototypes (1,3,5,7 ,9 and 10) did not support the extensive or clear customization options, which can detract from user engagement and personalization experiences. This is particularly crucial in universal design, which aims to accommodate diverse user abilities and preferences.

Some prototypes (2,6 and 8) that did offer easy and user-friendly customisation were well-received and demonstrate the successful application of usability principles. These design not only support user preferences but also enhance the overall user experience by making the interface more adaptable.

Customization

Prototypes	Participants Observations	Researcher Observations
1	Lack of customization	Restricted in customizing
2	Quick & easy customization	Agree with participants
3	Struggled with customization	Option was not very clear
4	User-friendly for customization	Limited options in customizations
5	No such option available	Agree with participants
6	Quick & easy customization	Agree with participants
7	No such option available	Agree with participants
8	User-friendly for customization	Agree with participants
9	No such option available	Agree with participants
10	Lack of customization	Agree with participants

Table 3:Responses from task 3

4.1.4 Task 4: Information Access

I methodically categorised the responses for examination based on their purpose to obtain specific information about cookies (see table 4). Themes such as the clarity of information presentation or the ease of locating detailed cookie information emerged from the coded data. Analysis of participant responses provided insights into the effectiveness of the interfaces in providing detailed cookie information.

Effectiveness in Presenting Information: The data reveals a mixed effectiveness across prototypes in presenting information about cookies. Prototypes 2, 3, 5, 7, 8, and 9 were successful, as participants could easily find and access detailed information about cookies. This aligns with the principles of transparency and user education, suggesting that these prototypes are more effective in informing users about how their data is used**.**

Challenges in Information Accessibility: Prototypes 4, 6, and 10 were noted for the absence of information or the inability of users to find details about cookies. This indicates a significant deficiency in fulfilling the fundamental requirements of informed consent, since users are not informed of important information on the use of their personal data.

Over-Complexity in Information Presentation: Prototype 1 was unique in that it provided detailed cookie explanations, but the feedback suggested that the information was too technical. This points to a need for balancing detail with understandability to ensure that all users, regardless of their technical background, can understand the information provided.

Result from the task 4 underline the importance of how information about cookie is presented to users:

The prototypes that effectively provided accessible and understandable information about cookies demonstrate good practices in transparency. This is crucial for building trust and ensuring users feel informed about their choices regarding data privacy.

Prototypes failing to provide this information are not only less usable but also less inclusive, potentially excluding users who are not from technical background, or who have disabilities that require clearer and more direct information.

The lack of accessible information in several prototypes suggests a design oversight that could potentially alienate users and diminish trust. Moreover, presenting information that is too technical could deter users from fully understanding the implications of their consent.

Information Access

Prototypes	Participants Observations	Researcher Observations
1	Detailed cookie explanations	Too much technical info.
2	Found the cookie policy page	Agree with participants
3	Found info easily.	Agree with participants
4	Couldn't access info about cookie	No such info Presented in interface
5	link provided easy access	Agree with participants.
6	Not found cookie details	Agree with participants.
7	Info was easy to find	Agree with participants.
8	Info was easy to locate	option was straightforward
9	Found info easily.	Agree with participants.
10	Not found cookie info	Agree with participants.

Table 4:Responses from task 4

4.1.5 Task 5: Check Clarity

Task 5 assessed the clarity of the interface design for the study. Table 5 presents the information. Themes such as the clarity of options or the presence of confusing elements emerged from the coded data.

Clarity and Transparency: Prototypes 1, 2, 3, 6, 8, and 10 were generally perceived as clear or straightforward by participants, which was mostly confirmed by participants observations. Prototypes 2 and 10 were noted for offering distinct choices, aiding users in making informed decisions about their cookie settings.

Confusion and Pressure Tactics: Prototypes 4, 5, 7, and 9 present concerns regarding usability and ethical design. Prototype 4 was criticized for failing to provide clear options, while Prototype 5's design seemed to pressure users into consenting by not offering clear alternatives. Prototype 7 was noted for forcing users to dismiss cookie notices, potentially leading to unintentional consent. Similarly, Prototype 9 was observed to limit user options, indirectly manipulating users into giving consent.

Effect on participant choice and Consent: The analysis of task 5 suggest a disparity in how prototypes manage user consent. While some interfaces promote clarity and provide users with clear choices, others utilise confusing elements or manipulative strategies that may hinder user's understanding and control over their data privacy.

Usability and Ethical Design Implications: The analysis from the observation for this task also highlight significant concerns regarding ethical design principles. Interfaces that lack clarity or mislead users can undermine trust and violate guidelines on informed consent, which are fundamental to data privacy laws and user-centred design.

Check clarity.

Prototypes	Participants Observations	Researcher Observations
1	Button is straightforward.	force to accept cookies
2	Clear & offer distinct choices	Agree with participants.
3	Didn't find any confusion	Agree with participants.
4	Fails to provide clear options	Agree with participants.
5	Lack of clarity in interface design	Feel pressured to click 'Got It'
6	Interface easy to understand.	Agree with participants.
7	force to dismiss cookies	Lack of clarity
8	Interface easy to understand.	Agree with participants.
9	Limited options	Force users to accept
10	Clear & offer limited choices	Agree with participants.

Table 5:Responses from task 5

4.1.6 Task 6: Confirm Saved Preferences

Participants experiences with confirming saved preferences were analysis here see table 6. In the next step, responses were coded and themes such as the visibility of the confirmation option or the ease of accessing it emerged from the coded data.

Access and ease of use of "Save Preferences" option: The data indicates a significant variability across the prototypes. Prototypes 2, 6, and 8 were successful, as participants could easily find and use the 'Save Preferences' option. This suggests that these prototypes are well-designed in terms of providing users with control over their preferences, enhancing user preferences and satisfaction.

Challenges in Locating the Option: Prototypes 1, 4, 5, and those where the option was not clearly available or navigable (3, 7, 9 and 10) highlight a major usability issue. The absence or difficulty in finding the 'Save Preferences' option can lead to frustration and a sense of lack of control, potentially causing users to feel their choices are not adequately supported or respected by the system**.**

Impact on User Experience and Trust: The task analysis, emphasize the importance of designing interfaces that not only acknowledge user preferences but also make it easy to manage and preserve these settings. The inability to confirm and save preferences can undermine user trust and satisfaction, as it affects their control over personal data and the customization of their experience.

Usability and Design Recommendations: the analysis of user observation with researcher observation for the task 6, Interfaces should be designed to ensure that the 'Save Preferences' option is easily accessible and user-friendly. This includes clear labelling, intuitive placement within the interface, and straightforward navigation that does not require excessive searching or complex steps.

Confirm Saved Preferences

Prototypes	Participants Observations	Researcher Observations
1	Couldn't find the option	No such option available
2	Found the option	Easy access
3	Not available in main interface	Difficult to navigate the option
4	Couldn't find the option	No such option available
5	Couldn't find the option	Agree with participants.
6	Found the option	Easy access
7	Not available in the interface	Agree with participants.

8	Found the option	Agree with participants.
9	Not available in the interface	Agree with participants.
10	Not available in the interface	Agree with participants.

Table 6:Responses from task 6

4.2 Analysis of Participants Responses from Semi-Structure Interview

After analysing the participants' observations, I began analysing the interview data. During the interview, I relied on handwritten notes rather than audio or video recordings for the data. These notes are in Appendix C. So, I used my notes to analyse the interview data due to the relatively small number of interview numbers, which I can manage manually.

I have broken down the process of analysing participant responses from a semi-structured interview into clear, systematic steps, which I describe below:

Step 1: Data Preparation

Handwritten Notes: I documented each interview with participant consent using detailed handwritten notes to accurately capture their responses and observations.

Data Transcription: I meticulously transcribed these handwritten notes into a comprehensive textual dataset. I reviewed and corrected any typographical errors during this transcription process to ensure the inclusion of all relevant details.

Step 2: Familiarization with the data:

Initial Reading: The transcribed data was read multiple times to immerse myself fully in the information provided by the participants. This helped in understanding the depth and context of their responses.

Notes and initial impressions: Initial responses were recorded to highlight emerging patterns and recurrent themes relevant to the research questions. These patterns and themes are mentioned in each analysis of the interview questions.

Step 3: Coding

Generating Initial codes: I developed initial codes to label significant features of the data that were relevant to the research objectives. These codes focused on usability challenges, user preferences and notable design elements mentioned by the participants.

Applying codes: The codes were systematically applied across the dataset to organize the data into manageable segments for further analysis.

Step 4: Searching for Theme

Gathering codes into potential themes: Codes that were similar in nature were grouped to form potential themes. Each theme represented a distinct pattern in the data that was relevant to the main questions of the study.

Reviewing Themes: I conducted a thorough review of these themes to verify their accuracy in capturing the code extracts and their ability to represent the entire dataset.

Step 5: Defining and Naming themes

Refining Themes: Each theme was further refined to clearly express its significance to the research questions. Additionally sub-themes were established to offer more comprehensive understanding of regions.

Finalizing themes: Themes were concluded and assigned clear, descriptive titles that accurately summarised the fundamental patterns found in the data.

The above-mentioned steps helped me in analysing the participants responses for each of the interview questions, which I have described in detail below. Each analysis made connections between user experiences and general design principles, highlighting the importance of improving cookie interface design to meet user requirements and enrich the whole digital experience. This detailed examination of individual reactions provides a solid basis for formulating suggestions that can have an important effect on the usability and user-friendliness of cookie interfaces.

4.2.1 Analysis of Responses to Question 1

Experience with Managing Cookies and Frequency of Cookie Interfaces

After transcribing detailed notes from the interviews, I conducted multiple readings to become familiar with how often participants encounter cookie interfaces and their management practices. I coded common themes like "frequent encounters" and "annoyance" to highlight the general frustration with the ubiquitous and intrusive nature of cookie pop-ups. Many participants expressed a routine interaction with these interfaces, often choosing default settings for the sake of convenience. This highlights a feeling of acceptance and less sensitivity towards managing cookies. I synthesised these finding under the theme “interface intrusiveness and Management Frequency”, reflecting the pervasive nature of cookie interaction in daily web browsing and their resulting influence on user experience. This theme aligns perfectly with issues that discuss the balance between privacy concerns and user convenience in interface design.

4.2.2 Analysis of Responses to Question 2

Difficulties or Challenges with Cookie Interfaces

For the second question, the transcribed data revealed significant challenges related to the usability and complexity of cookie interfaces. Participants frequently mentioned difficulties such as complex settings, unclear terminology, and the overwhelming nature of the choices presented. I categorised responses into codes such as "complexity," "lack of clarity," and "design issues," which led to the theme "Usability Challenges in Cookie Settings." This theme captures the critical need for simpler and more intuitive design solutions that can reduce user frustration and enhance the transparency of information. The insights from this analysis emphasise the importance of addressing these usability issues to improve overall user interactions with cookie settings.

4.2.3 Analysis of Responses to Question 3

Confusing Aspects of Cookie Interfaces

Analysing responses to the third question involved identifying elements of cookie interfaces that participants found confusing. Codes derived from the data included "technical jargon," "unclear grouping," and "inconsistent design." These were grouped into a broader theme of "Confusion Due to Technical Complexity and Inconsistent Design." This theme illustrates how the use of complex language and varied interface layouts across different sites adds to user confusion, detracting from an effective user experience. The findings underscore the need for standardised, clear, and user-friendly designs that can help users make informed decisions about their privacy preferences more confidently.

4.2.4 Analysis of Responses to Question 4

Frustration or Dissatisfaction with Adjusting Cookie Preferences

For the fourth question, I focused on the frustrations and dissatisfactions expressed by participants regarding cookie settings. The analysis revealed common frustrations with the lack of simple rejection options, settings not saving, and manipulative design practices. I coded these issues as "lack of control" and "design manipulation," forming the theme "User Dissatisfaction with Cookie Interface Manipulations." This theme reflects the negative impact of perceived control loss and deceptive designs on user satisfaction and trust. The

analysis highlights the critical need for ethical design practices that respect user choices and promote transparency.

4.2.5 Analysis of Responses to Question 5

Design Elements that Make Cookie Settings Understandable and Navigable

The analysis of responses to the fifth question provided insights into the design elements that enhance the usability of cookie interfaces. Participants highlighted the importance of simplicity, clear labelling, and accessibility features. The data were coded with terms like "simplicity," "clear explanations," and "accessible design." These were grouped into a broader theme, "Effective Design Elements for Enhancing Usability." This theme encapsulates participants' preferences for user-friendly designs that facilitate easy navigation and understanding, such as a clear layout, large buttons, and minimal jargon. It emphasises the necessity for cookie interfaces to incorporate universal design principles to ensure they are accessible and straightforward for all users.

4.2.6 Analysis of Responses to Question 6

Experiences with Poorly Designed Cookie Interfaces

For the final question, participants discussed their negative experiences with poorly designed cookie interfaces, which were often perceived as manipulative, confusing, or overly complex. Key frustrations included hidden decline options, overwhelming technical terms, and settings that failed to save. These experiences were coded under "manipulative design," "technical complexity," and "unreliable functionality." The resulting theme, "Challenges Posed by Poor Design Practices," highlights the adverse effects of poor interface design on user experience and trust. This theme serves as a critical reminder of the importance of ethical design standards that prioritize user needs and clarity over business tactics, which may prioritize data collection over user convenience.

The comprehensive analysis of each question has illuminated various facets of the user experience related to cookie interfaces, from frequent annoyances and usability challenges to confusion caused by inconsistent and complex designs. These insights underscore the importance of designing cookie interfaces that are not only functionally efficient but also user-centric, transparent, and respectful of user preferences. These interviews collect detailed feedback that serves as a valuable foundation for proposing enhancements in cookie interface design, with the aim of enhancing overall user satisfaction and adhering to

privacy standards. This approach ensures that the findings are robust, directly applicable to improving interface design, and aligned with the principles of universal design.

4.3 Analysis of responses from Likert-scale questions:

Participants responded to seven Likert scale questions designed to assess their levels of satisfaction and overall experience with each prototype after completing tasks on each one. The Likert scale used ranged from 1 (strongly disagree) to 5 (strongly agree). Each participant answered these questions for each of the ten prototypes, providing a robust data set for analysis Appendix C.

In the analysis, prototypes that achieved a mean score greater than 3.6 were considered to have received positive feedback, indicating a high level of participant satisfaction. I interpreted mean scores below 2.5 as negative feedback, highlighting areas that require substantial improvements. I regarded scores between 2.5 and 3.5 as moderately positive, indicating that these prototypes met some user expectations, but there is still room for enhancement to fully satisfy user needs.

4.3.1 Statement 1

Interface was Visually Appealing

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	2	3	2.75	.44426
2	20	4	5	4.8	.41039
3	20	2	3	2.2	.41039
4	20	3	4	3.6	.50262
5	20	2	4	3.45	.82557
6	20	4	5	4.9	.30779
7	20	1	2	1.65	.48936
8	20	4	5	4.2	.41039
9	20	2	4	2.6	.68055
10	20	3	4	3.4	.50262

Table 7: Descriptive Statistics For Statement 1

To analyse the data for the statement "Interface was visually appealing" across 10 prototypes, here's an assessment based on the descriptive statistics:

High Appeal (Mean ≥ 3.6): Prototypes 2, 4, 6, and 8 demonstrated high visual appeal, with Prototype 6 showing the highest mean score of 4.9, suggesting it was the most visually

appealing. The low standard deviation in Prototype 6 (0.30779) indicates consistent positive feedback across participants.

Moderate Appeal (Mean 2.6 to 3.5): Prototypes 1,5,9 and 10fall into this category, where the visual appeal was rated positively but with room for improvement, as indicated by their mean scores close to 3.5. Prototype 5 showed more variability in participant responses (SD = 0.82557), suggesting divergent opinions about its visual appeal.

Low Appeal (Mean < =2.5): Prototypes 3, and 7 received lower scores on visual appeal. Prototype 7, with the lowest mean score of 1.65, was rated poorly by participants in terms of aesthetics, which might be crucial for re-evaluation and redesign.

This analysis highlights the importance of visual design in how users perceive an interface and indicates the necessity for creating targeted improvements based on specific input to improve both the general visual and functional appeal of the prototypes.

4.3.2 Statement 2

Interface was easy and clear to understand.

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	2	4	2.6	.68055
2	20	5	5	5	0
3	20	3	3	3	0
4	20	3	4	3.95	.22360
5	20	3	5	3.95	.75915
6	20	4	5	4.9	.30779
7	20	1	2	1.9	.30779
8	20	4	5	4.6	.50262
9	20	2	3	2.15	.36634
10	20	3	4	3.6	.50262

Table 8:Descriptive statistics for statement 2

The table above summarizes the descriptive statistics for the ease and clarity of understanding for each prototype, according to the responses from participants:

High Clarity (Mean ≥ 3.6): Prototypes 2, 4, 5, 6, 8, and 10 were rated highly for clarity and ease of understanding. Prototype 2 stands out with a perfect mean score of 5, indicating unanimous agreement on its clarity among all participants. Prototype 6 also scored highly with a mean of 4.9. These prototypes likely used clear layouts and intuitive designs.

Moderate Clarity (Mean 2.6 to 3.5): Prototype 1and prototype 3 fell into this category with mean scores indicating they were generally understood but might benefit from some improvements to enhance clarity.

Low Clarity (Mean ≤ 2.5): Prototypes 7, and 9 received low scores, suggesting significant issues with ease of understanding. Prototype 7 had a very low mean score of 1.9, highlighting a critical need for redesign to improve comprehensibility.

The analysis points to the vital role of interface design in ensuring that users can easily understand and navigate through interface, which is crucial for a positive user experience. Enhancements based on these insights could lead to more efficient and satisfying user interactions with the prototypes.

4.3.3 Statement 3

It was easy to locate the option to reject cookie.

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	1	1	0
2	20	3	4	3.75	0.4442
3	20	2	3	4.2	.41039
4	20	1	1	1	0
5	20	1	1	1	0
6	20	4	5	4.35	.48936
7	20	1	1	1	0
8	20	2	4	2.6	.68633
9	20	1	2	1.15	.36634
10	20	4	5	4.85	.36634

Table9:Descriptive statistics for statement 3

The table above summarizes the descriptive statistics for how easily participants could locate the option to reject cookies across ten different prototypes:

Very Difficult (Mean ≤ 2.5): Prototypes 1, 4, 5, and 7 show a mean score of 1, indicating that participants found it extremely difficult to locate the option to reject cookies, as scores near 1 reflect strong disagreement with the statement that it was easy to find the rejection option. Prototype 9, with mean 1.15 indicated that, user also found difficulty to locate the option.

Prototype 8(mean=2.6) had score that suggest moderate ease in finding the reject option. Prototype 8 suggests slightly better performance but still room for improvement.

Easy (Mean ≥ 3.6): Prototypes 2,3,6 and 10, with their mean scores respectively, indicate that participants found it relatively easy to locate the reject option. This suggests that these prototypes likely featured more prominently placed or clearly marked rejection options.

This detailed assessment reveals significant variability in how easily users can find the option to reject cookies across different prototypes. Addressing these differences is crucial for

ensuring that all users have straightforward, understandable interactions with privacy settings, aligning with best practices for user-friendly design and compliance with privacy regulations.

4.3.4 Statement 4

It was easy to customize your cookie settings.

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	1	1	0
2	20	4	5	4.85	0.3663
3	20	2	3	2.45	.51041
4	20	3	4	3.8	.41039
5	20	1	2	1.25	.44426
6	20	4	5	4.7	.47016
7	20	1	2	1.45	.51041
8	20	4	5	4.05	.22360
9	20	1	2	1.6	.50262
10	20	2	3	2.1	.30779

Table10:Descriptive statistics for statement 4

The table above summarizes the descriptive statistics of how easy it was to customise cookie settings for participants.

Very Difficult (Mean ≤ 2.5): Prototypes 1, 5, 7, 3,9, and 10 reflect significant challenges in customizing cookie settings, with means ranging from 1.0 to 2.1. These low scores indicate that participants found the customization process very difficult, potentially due to hidden settings, complex navigation, or lack of clear options.

Moderately Easy (Mean between 2.6 and 3.5): None of the prototype fall into this category, where customization is somewhat accessible but could be improved.

Easy (Mean ≥ 3.6): Prototypes 2, 4,6, and 8 scores, indicating that participants found these interfaces relatively easy to use for customizing settings. These prototypes presumably provide clearer, more intuitive pathways to adjust settings, possibly including better visual cues and simpler layout.

This analysis highlights the importance of designing interfaces that are straightforward and user-friendly, especially concerning privacy settings customization. Making cookie setting adjustments easy and intuitive is crucial for ensuring user control and satisfaction with the interface.

4.3.5 Statement 5

Interface was user-friendly.

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	2	1.45	.51041
2	20	4	5	4.8	.41039
3	20	3	4	3.15	.48936
4	20	2	3	2.85	.36634
5	20	1	2	1.9	.30779
6	20	3	4	3.15	.36634
7	20	1	2	1.85	.36634
8	20	3	4	3.5	.51298
9	20	1	2	1.85	.58714
10	20	2	3	2.45	.51041

Table 13:Descriptive statistics for statement 5

The table above describes the statistics for how user-friendly the interfaces were.

Very Unfriendly (Mean ≤ 2.5): Prototypes 1, 5, 7, 9 and 10 scored below 2.5, indicating that participants found these interfaces to be not user-friendly. These low scores suggest significant usability issues, potentially due to complex navigation, lack of clear instructions, or poor design aesthetics that hinder user interaction.

Moderately Friendly (Mean between 2.6 and 3.5): Prototypes 3, 4, 6, and 8 fall into this category, where the interfaces were somewhat user-friendly but could benefit from improvements. These scores suggest that while users found some aspects of the interfaces satisfactory, there are areas that need enhancement for better usability.

Highly User-Friendly (Mean ≥ 3.6): Prototype 2 stands out with a mean score of 4.8, indicating a high level of user-friendliness. This suggests that Prototype 2 likely incorporated elements that significantly enhanced user interaction and satisfaction, such as intuitive design, clear labelling, and easy navigation.

This analysis underscores the importance of creating interfaces that are not only functional but also highly user-friendly. Ensuring that interfaces are intuitive and easy to navigate can significantly enhance user satisfaction and overall interaction quality.

4.3.6 Statement 6

You are confident that your preferences were successfully saved.

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	1	1	0

2	20	4	5	4.8	.41039
3	20	2	3	2.45	.51041
4	20	1	1	1	0
5	20	1	2	1.2	.41039
6	20	4	5	4.55	.51041
7	20	1	2	1.65	.48936
8	20	3	4	3.9	.30779
9	20	1	2	1.5	.51298
10	20	1	2	1.3	.47016

Table 14:Descriptive statistics for statement 6

Above is a summary of the descriptive statistics for how confident participants felt that their preferences were successfully saved across the ten prototypes:

Low Confidence (Mean ≤ 2.5): Prototypes 1, 3,4, 5, 7, 9, and 10 showed low confidence levels among participants regarding the successful saving of their preferences, with means significantly below 2.5. These prototypes likely lack clear confirmation messages or feedback mechanisms that assure users their settings have been saved.

Moderate Confidence (Mean between 2.6 and 3.5): None of the prototype falls in this category which suggests moderate confidence among users about their settings being saved.

High Confidence (Mean ≥ 3.6): Prototypes 2 ,8 and 6, with mean scores 4.8,4.55 and 3.9 respectively, indicate high confidence among participants that their preferences were successfully saved. These prototypes probably feature robust feedback mechanisms or visual confirmations that reassure users.

This analysis points to the crucial role of clear feedback in interface design, especially in settings where users adjust preferences. Ensuring that users feel confident that their changes have been saved is fundamental to the usability and effectiveness of any interactive system.

4.3.7 Statement 7:

It was easy to find detailed info about cookies, their purposes, and implications.

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	4	3.3	.7326
2	20	4	5	4.6	.5026
3	20	3	4	3.75	.4442
4	20	1	1	1	0
5	20	3	4	3.7	.4701
6	20	1	3	2.4	.5982
7	20	1	3	2.1	.4472

8	20	3	4	3.2	.41039
9	20	2	4	3.35	.6708
10	20	1	2	1.15	.3663

Table 15:Descriptive statistics for statement 7

Here's a summary of the descriptive statistics for how easy participants found it to locate detailed information about cookies across the ten prototypes.

High Ease (Mean ≥ 3.6): Prototypes 2, 3, and 5, with means ranging from 3.7 to 4.6, suggest that participants found it relatively easy to access detailed information about cookies. These prototypes likely featured clear and accessible information sections that were easy to navigate.

Moderate Ease (Mean between 2.6 and 3.5): Prototypes 1, 8, and 9 have mean scores that suggest a moderate level of ease. These scores indicate that while some information was accessible, improvements could make it easier to understand or find.

Low Ease (Mean ≤ 2.5): Prototypes 4 ,6,7 and 10, with very low mean scores of 2.1,2.4,1.0 and 1.15, respectively, indicate significant difficulty in finding detailed cookie information. This could be due to poorly designed information architecture or lack of clear signposting of cookie information.

This analysis highlights the importance of transparency in cookie management interfaces. Ensuring that users can easily find and comprehend detailed information about cookies is crucial for building trust and enabling informed decisions regarding their privacy preferences.

Summary

Based on the analysis of responses from the Likert-scale questionnaire, participants evaluated various aspects of interface design across ten prototypes. The analysis revealed significant variability in user satisfaction and ease of interaction with each prototype, assessed through statements addressing appearance, usability, and privacy settings.

We noted high user satisfaction for prototypes that combined visual appeal with intuitive design, particularly prototypes 2, 4, 6, and 8, which scored above 3.6, indicating strong positive feedback. We identified prototypes 3 and 7 as needing significant improvements due to their low appeal and usability scores.

The analysis also highlighted the critical role of clear navigational cues and straightforward settings management in enhancing the user experience. Prototypes with clear, intuitive

layouts (e.g., prototypes 2 and 6) received high scores for ease of understanding and customization of settings, reflecting their success in meeting user expectations for simplicity and clarity. Further, the findings underscored the importance of effective feedback mechanisms, as prototypes that clearly confirmed the successful saving of user preferences (such as prototypes 2, 6, and 8) enhanced user confidence and satisfaction. Conversely, prototypes that scored low on this aspect demonstrated a need for better feedback integration.

In contrast, prototypes 1, 3, 5, 7, and 9 demonstrated significant shortcomings in several areas, according to the analysis. The analysis noted Prototype 1's extreme difficulty in locating the cookie rejection option and customizing settings, along with its low score for user-friendly aspects, indicating a need for a major redesign. Despite scoring moderately on clarity, Prototype 3 received low ratings for visual appeal and encountered customization issues, indicating a discrepancy between user expectations and design. Prototype 5 exhibited variability in visual appeal and faced similar challenges in setting customization, highlighting a divide in user perceptions and actual usability. Prototype 7 scored very poorly across all evaluated areas, including visual appeal, ease of understanding, customization of settings, and confidence in saving preferences, making it the prototype most in need of comprehensive improvements. Finally, Prototype 9 was particularly problematic in terms of clarity and ease of understanding, as well as locating the cookie rejection option and customizing settings, reinforcing the necessity for significant enhancements in user interaction and design clarity. These findings underscore crucial areas for development to enhance user satisfaction and interface effectiveness.

4.4 Overall Result and findings

The collective analysis from observations, interviews, and questionnaires paints a comprehensive picture of the current state of cookie interface usability and its design issues. The findings underscore the need for more intuitive, transparent, and user-friendly designs that align better with user expectations and privacy standards. Implementing the suggested improvements could significantly enhance user satisfaction and trust in digital environments, ultimately leading to better compliance with data protection regulations and an improved overall user experience.

1. User Experience with Cookie Interfaces

- **Inconsistency and Confusion:** There was a notable inconsistency in cookie interface designs across different prototypes, leading to confusion among users. Both interviews and Likert-scale responses highlighted the impact of this inconsistency on users' ability to quickly understand and navigate these settings.
- **Managing Preferences:** Participants expressed difficulty managing cookie settings due to complex designs and unclear options**.** This was particularly evident from the interviews, observations, and questionnaire where users described the settings as overwhelming and not user-friendly.
- **Frequent Intrusions:** Users frequently encountered cookie pop-ups, often perceiving them as intrusive and disruptive to their browsing experience. Interview responses consistently confirmed this observation.

2. **Design and usability challenges.**
    - **Complexity and Clarity:** Users reported that cookie interfaces often featured complex options that were hard to understand. Interviews and observational data pointed to a need for simplifying interfaces and using clearer language.
    - **Hidden Rejection Options:** The analysis uncovered a common practice of hiding or making cookie rejection options less prominent, thereby complicating the opt-out process. This issue was especially prominent in observational data and questionnaire feedback, where prototypes with poor visibility of rejection options scored lower.
    - **Poor Customisation Support:** Responses indicated that interfaces generally did not support easy customisation of cookie settings, restricting user control over their data privacy. This feedback was consistent across all data sources, suggesting a widespread design flaw.
    - **Absence of Options**: Participants struggled to find options like rejecting cookies or confirming saved preferences in several prototypes.
3. **Positive Design Features**
    - **High Satisfaction with Clear Interfaces:** Prototypes that were rated highly for clarity and ease of use in the questionnaire often included straightforward layouts with well-marked options. These designs correlated with higher user satisfaction and confidence in managing privacy settings.
    - **Effective Confirmation Feedback:** Interfaces that provided clear feedback on saved settings were viewed positively, as evidenced by high scores in the Likert-scale

analysis. Users felt more confident that their preferences were successfully recorded, enhancing their overall interaction experience.

4. **Information Accessibility**
   - **Access to Information:** There was a significant variance in how easily users could access detailed information about cookies. While some prototypes provided clear and accessible information, others did not, leading to lower satisfaction ratings in those areas.
   - **Demand for Clearer Explanations:** Users voiced a strong preference for transparent and straightforward explanations regarding how their data would be used. This was particularly evident in interview responses where participants advocated for less technical jargon and more understandable information.
5. **Ethical Design Considerations**
   - **Manipulative Design Practices:** Multiple users have expressed feeling tricked by the design of certain cookie interfaces, which appeared to force consent through design strategies such as hiding alternatives to reject or highlighting buttons to accept. These discoveries were especially noticeable in the qualitative data obtained from interviews and open-ended responses.

5. Discussion

This study investigates the usability and universal design of cookie consent interfaces, a crucial and timely subject given the changing digital privacy and user interface design environments. Prior research has emphasized the importance of user-friendly design in digital consent procedures. However, these studies have mostly focused on meeting legal requirements rather than gaining in-depth insights on user experience (Habib & Cranor, 2022).

This thesis uncovers substantial user dissatisfaction with existing cookie consent interfaces, highlighting an urgent requirement for more transparent and user-friendly interfaces. A thorough analysis of user behaviours and preferences revealed that existing designs often fail to meet the requirements for true usability and accessibility. This is crucial for user satisfaction and flexibility, aligning with the principles of universal design, which aim to make systems accessible and comprehensible to all users, regardless of their abilities or backgrounds (Sanchez-Rola et al., 2019).

Specifically, the study aligns with the conclusions of (Habib et al., 2022) who raised concerns about the complexity and user-friendliness of consent interfaces. However, it surpasses this by offering a thorough analysis of how we can redesign these interfaces to adhere to universal design principles, guaranteeing not only legal compliance but also genuine accessibility and user-friendliness. This thesis not only supports past findings but also offers a direction for future research and growth in the field of digital interface design, which I have discussed in the coming section.

5.1 Interpretations of Results

The results of this study offer a profound understanding of how users perceive and engage with cookie consent interfaces, exposing broader implications for usability and universal design ethics in consent interfaces. Since the primary goal of this study was to investigate and find the usability and universal design practices in cookie settings user interfaces, as a result, it was critical to get users to interact with cookie interfaces. By implementing our different purposed prototypes, I came across the issues and barriers faced by the participants. The results and analysis presented in the above section helped me to discuss and answer the research questions for this study.

RQ1) What are the Usability challenges that users mainly encounter while interacting?

Participants' experiences with the cookie settings interfaces provide valuable insights into the usability challenges they face. Difficulties in finding and utilizing key features such as the opt-out option and confirmation of preferences highlight usability challenges related to accessibility and user control. These challenges align with the need to address usability issues and enhance user experience in cookie interfaces, which is the focus of my first research question.

Usability Challenges

- **Lack of Opt-Out Options**

The ability for users to control their privacy settings, including the option to reject or opt out of certain cookies, is an important aspect of user experience and privacy protection on websites. In this study, I found that participants encountered varying levels of difficulty in finding the option to reject cookies across the different prototypes. This indicates a significant usability challenge where users may find it difficult to exercise their privacy preferences effectively. While analysing task 2 responses, prototypes 1, 4, 5, 7, and 9 participants either struggled to find the option to reject cookies or it was hidden in the interfaces.

In response to the question asked in the questionnaire table 9, “It was easy to locate the option to reject cookies.” on each of the ten prototypes. with the lowest mean 1 in prototypes 1,4,5,7, and 9 was opposed to this statement. So, the lack of a reject button is one of the usability challenges that the user faced during the investigation.

While reviewing the literature review part, lack of options(reject/accept)can definitely create usability challenges ,impacting user trust, control, legal compliance and overall experience(Habib & Cranor, 2022). The paper suggest that users may feel like they have no control over their privacy settings if they're unable to reject cookies. This can lead to frustration and a negative perception of the website. In (Habib & Cranor, 2022)study, they confirmed that some interfaces use confusing or unclear language so that user get force to accept the cookie. During task experiment, it was observed that participants had experience that reject options in some prototypes were hidden (prototype1,2 and 8).

- **Limited Customisation Options**

Participants' experiences with customisation varied, with some prototypes offering quick and easy customisation options while others lacked flexibility or presented confusing choices. Lack of standardized and user-friendly customisation features poses a usability challenge, preventing users from effectively tailoring cookie settings to their preferences. The analysis report for task 3 shows that participants in prototypes (1, 5, 7, and 9) couldn't find the customisation options; however, prototypes (3, 4, and 10) had limited or struggled with options. In the process of analysing the responses, it was noted that participants appreciated when the customisation option was available and were frustrated when it was absent. The response to the question asked in the questionnaire table 10 "It was easy to customise your cookie settings" on prototypes 1,5 and 7 was completely opposed to the statement; however, prototypes 2, 6, and 8 were in favour of the statement.
According to the law and jurisdiction, regulations like the GDPR (General Data Protection Regulation) in the European Union may require websites to offer users options for managing cookies. Failure to provide customization options could lead to non-compliance with these regulations(*General Data Protection Regulation (GDPR) – Official Legal Text*, n.d.).Thus it is observed during testing that the absence of customization options in a cookie interface can be a critical usability issue, it can also lead to dissatisfaction among users who expect more control over their privacy settings. Providing customization options is generally considered good practice for websites and applications that collect user data through cookies.

- **Complexity and cognitive overload**

*Complex interfaces***:** Instances where participants found interfaces unclear or confusing, particularly in tasks such as confirming saved preferences or accessing detailed information about cookies, highlight usability challenges. Users may face obstacles in understanding and navigating the interface effectively. The responses that came from the statement table 11 "Interface was user-friendly" were not aligned with prototypes 1,5, 7, and 9. Participants in the prototype investigation reported confusion with complex interfaces. Users also frequently complained that the interfaces for managing cookie settings were overloaded with options, incorporating several layers and complex hierarchies that proved challenging to navigate. This intricacy not only heightened the mental burden but also made it challenging for users to promptly make well-informed decisions.

Technical Language and Lack of Clarity: The use of technical terminology without adequate explanations left many users confused. The presence of such language barriers prevents users from understanding the full consequences of their decisions regarding cookie settings, hence leading to a lack in informed consent.

Difficulty accessing and understanding cookie information:

Prototypes 4, 6, and 10 were particularly problematic because they did not present cookie information clearly, if at all(table 13 and table4). Users struggled to find and understand detailed information about cookies and their uses, which is critical for making informed decisions. The technical complexity of the information, as seen in Prototype 1, also adds to the challenge, as overly complex explanations can deter users from fully engaging with the information.

- **Navigation Challenges**

Some participants found it difficult to navigate certain options, such as confirming saved preferences. Several prototypes (e.g., Prototypes 1, 4 and 5) were mentioned as having the 'Save Preferences' option that was not clearly visible or easy to access table 6. Participants struggled to find where to confirm their choices, which could lead to uncertainty about whether their preferences were being applied. For some prototypes (3,7,9 and10) even when participants found the 'Save Preferences' button, the process to reach this option involved multiple unnecessary steps or confusing paths. This complexity can deter users from effectively using the interface, as they may give up before their settings are saved. Differences in how the confirmation options were presented across various prototypes (e.g., different placements or inconsistent labelling) can confuse users who expect a certain level of consistency in the user interface. The lack of consistency might pose challenges for user in gaining and maintaining knowledge about how to perform actions. Such navigation challenges might cause frustration, especially when users are compelled to spend an excessive amount of time in understanding how to save their preferences. Hence, this frustration might have a negative effect on their overall satisfaction.

Based on the usability challenges identified in this study, here are some recommendations for improving usability in cookie settings interfaces:

a) **Improved visibility and usability of opt-out options:** Ensuring users have a transparent and straight-forward way to decline cookies is essential for strengthening privacy control

and trust. Interfaces should include a visible "Reject All" button that is as visible and reachable as the "Accept All" button. Users can achieve this by applying consistent colors, clearly defined positions, or consistent visibility as they navigate through the settings. It is also important to consider using standard placement and design to ensure that users can easily find and utilise these options without any confusion. Hence, it will increase the user experience by providing a consistent method for managing privacy.

b) **Simplified and Standardized Customization Options:** Customisation options should be designed to enable users to easily modify their cookie preferences with minimal effort. Designers should use consistent, clean layout across the interface. For example, elements in the interface like switches, checkboxes, or toggle buttons should be easy to understand and interact with, and they should use standardised icons and colors (green for enabled or grey for disabled) to enhance user understanding. Each category in the customisation interface should be accompanied by a clear, brief description of its content, such as ‘Necessary’, ‘Analytics’, 'Functional', and ‘Advertising'. Each of these categories should have a simple and clear explanation of what these cookies do and what they are used for. It is also important to use non-technical language so that all users, regardless of their technical proficiency, can understand the consequences of their selections.

c) **Reduction of Interface Complexity**: Interface design should prioritise clarity and simplicity to avoid distractions and to make it easier for users to use. Also, avoid using complicated words or technical vocabulary unless you provide a clear explanation of their meaning. The design should aim to minimise the user's required actions to save their selections, and important features such as the 'save preferences' button should be readily visible and user-friendly. Aim for a neat and organised layout that focuses on the most crucial information and features first. If necessary, only use additional options or sections for more detailed settings. By implementing this approach, users won't have to work as hard to manage their settings, which will make their overall experience with the interface smoother and more straightforward.

d) **Clear and detailed presentation of cookie information:** To present cookie information in a more direct and easily understandable manner, designers should ensure that their cookie policies are defined in a clear and accessible manner. It is important to provide users with precise information about the specific cookie being used, the type of data

they gather, and the intended purpose of collecting data. All should be presented in clear and straight-forward language, avoiding technical terminology. It is also important to provide a comprehensive description of each cookie type, including the duration of how long user data is kept and how it enhances the user experience. In addition, users should have access to user-friendly tools that allow them to easily manage their cookie choices, increasing their control over personal data and ensuring that the procedure is transparent. By prioritising simplicity and transparency in the interfaces, developers of websites can help users make informed decisions about their privacy.

RQ2) What are the best practices and design patterns for presenting and organizing cookie interfaces settings in a clear and intuitive manner?

To answer this research question, I analysed the participants' feedback. For example, regarding interface clarity, customisation options, and information accessibility, we can identify potential best practices and design patterns for presenting and organising cookie settings interfaces. For example, the patterns of clear option presentation, standardized customization features, and transparent information provision can inform recommendations for designing intuitive and user-friendly interfaces, addressing our second research question.

- **Clear Presentation of Options**

Participants in the study appreciated interfaces that presented options in a clear and distinct manner. When users interacted with the cookie settings interface, they favoured easily distinguishable choices presented in a visually appealing manner.

The results from tasks 1, 4, and 5 showed that participants found prototypes 2, 6, and 8 to have a good initial impression, easy access to information, and positive feedback on the clarity of the interface. This presentation clarity facilitated easy navigation and decision-making for users, as they could quickly identify and select the options that best suited their preferences.

The statements like “interface was easy and clear to understand, interface was user-friendly, and it was easy to find detailed information about cookies, their purposes, and their implications” have been in favour of prototypes 2, 6, and 8, while others have opposed to used them. It is also noted that, with a clear presentation of options, users easily carried out the tasks.

- **Standardised Customisation Features**

Prototypes that offered quick and easy customisation options received positive feedback from participants. This means that users appreciated interfaces where they could easily modify their cookie preferences without encountering unnecessary complexity or confusion. Standardised customisation features refer to the use of consistent and user-friendly design patterns across different settings and options. For example,

Participants in task 3 preferred interfaces that used familiar controls (such as accept, reject, marketing, preferences, statistical cookie options, etc.) and maintained a consistent layout throughout the customization process. However, we discovered that prototypes 2, 6, and 8 offer faster and simpler customization compared to prototypes 3, 4, and 10.

The responses that the participants got for the statement “It was easy to customise your cookie settings” were completely in favour of prototypes 2, 6, and 8.

By incorporating standardised and user-friendly customisation features, cookie settings interfaces can improve usability and enhance the overall user experience, enabling users to tailor their preferences effectively without feeling overwhelmed or frustrated**.**

- **Transparent Information Provision**

Participants valued interfaces that provided clear and accessible information about cookies and their implications. This means that users appreciated when the interface offered detailed explanations or descriptions of different types of cookies, their purposes, and the potential implications of accepting or rejecting them.

Transparent information provision involves presenting information in a way that is easy to understand and accessible to all users, regardless of their level of technical knowledge. For example, interfaces that included links to additional resources or pop-up explanations when users hovered over specific terms or options were perceived positively by participants in prototypes 2 and 8. By designing interfaces with transparent information provision, users can make more informed decisions about their privacy preferences, thereby enhancing trust and confidence in the platform and ultimately improving the overall user experience.

In summary, the best practices and design patterns identified under the second research question emphasise the importance of clarity, usability, and transparency in presenting and organising cookie settings interfaces. By incorporating these principles into interface design, developers can create interfaces that are intuitive, user-friendly, and conducive to informed decision-making regarding privacy preferences.

RQ3) What are the key principles of universal design that should be incorporated into the interface?

The observations regarding interface clarity, availability of features, and transparency in information presentation can be related to the principles of universal design. By ensuring that cookie settings interfaces are designed to be clear, accessible, and transparent, designers can incorporate principles of universal design that cater to the diverse needs and preferences of users. This aligns with my third research question, which focuses on identifying key principles of universal design for interface development.

Universal design principles are important to consider. When they are followed it often means the usability is good. The seven principles of universal design cover various aspects of universal design and some are more relevant than others in regards to interfaces (Story, 1998)

- **Principle 1: Equitable Use**

This principle is about making the design useful and usable for users with diverse abilities. It also ensures that the interface is clear and understandable for all users regardless of their level of familiarity with technology.

"*Guidelines 1a. Provide the same means of use for all users: identical whenever possible equivalent when not"* (*National Disability Authority*, 2024)

In prototype 1,2,3,6and10 some options are hidden or use complex language which may not be usable for everyone and thus it does not comply with this guideline.

"Guideline 1c: Provisions for privacy, security and safety should be equally available to all users"(*National Disability Authority*, 2024)

Prototypes 1,4,5,7 and 9 does not fulfil these conditions as these interfaces forced the users to accept the cookies without providing other or hidden some option which directly affect user privacy and security.

"Guideline 1d. Make the design appealing to all users."(National Disability Authority, 2024)

Results shown that Prototype 1,3,4and5 does not fulfil this requirement and need to be design in an appropriate way however prototypes 2,6 and 8 give positive responses and fulfilled this guideline 1d.

- **Principle 2: Flexibility in Use**

Principle 2 of Universal Design, Flexibility in Use, improves cookie consent interfaces by allowing users to customise options, supporting various ways of interacting, and using simple and clear language. This guarantees that a wide variety of users may easily access and use the interface, enhancing the overall user experience and meeting privacy regulations.

"Guideline 2a. provide choice in methods of use"(*National Disability Authority*, 2024) This guideline does not fit in some of the prototypes like prototype 1,4,5,7,9and10 as these prototypes does not provide choices like to customise/reject/ save . On the other hand prototypes 2,6 and 8 align with guideline 2a.

Guideline 2b. "Accommodate right or left-handed access and use."

(*National Disability Authority*, 2024)

Prototypes 2, 6, and 8 received positive feedback for their design which inherently provides flexibility in navigation, likely accommodating both right and left-handed users.

Guideline 2c. Facilitate the user's accuracy and precision.

(*National Disability Authority*, 2024)

Prototype 3, noted for its lack of engaging designs, could benefit from redesigning elements to enhance user interaction accuracy, such as clearer buttons and better visual design.

- **Principle 3: Simple and Intuitive Use**

This Principle deals with making designs easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

"Guideline 3a. Eliminate unnecessary complexity"(*National Disability Authority*, 2024)

Prototypes 9 and 10, which have ambiguous button texts and lack customization controls, should be simplified to remove any unnecessary elements that could confuse users. Also prototype 3 and 4 does not follow this guideline to eliminate unnecessary complexity but it adds more complexity by hiding reject or save all options. Thus, this principle needs to be incorporated into the interfaces.

Guideline 3b. Be consistent with user expectations and intuition.

Prototypes 2, 6, and 8 are noted for their clear and easy-to-understand interfaces, which align with user expectations and adhere to this guideline by providing intuitive navigation and interaction. (*National Disability Authority*, 2024)

Guideline 3e. Provide effective prompting and feedback during and after task completion.

Prototypes 1, 4, and 5 need improvements in feedback mechanisms, as users found it difficult to confirm if their preferences were successfully saved or understood the implications of their choices(*National Disability Authority*, 2024)

- **Principle 4: Perceptible Information**

This principle guarantees that essential information is efficiently present to the user, irrespective of environmental conditions or the user's sensory capabilities. (*National Disability Authority*, 2024). In the context of interfaces, Universal Design's Principle 4, Perceptible Information, enhances cookie consent interfaces by incorporating high-contrast visuals, text alternatives, and multi-format information. This approach guarantees clarity and accessibility for users with varying sensory capacities. This improves the overall comprehension and engagement of users with permission choices.

Guideline 4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. (*National Disability Authority*, 2024)

Prototypes 5 and 9, which have issues with ambiguous button texts and limited information, should integrate visual icons and tactile feedback (like vibrations on mobile devices) to complement textual information, making instructions clearer and more accessible.

Guideline 4c. Maximize "legibility" of essential information.

(*National Disability Authority*, 2024)

Prototypes 1 and 3, noted for their technical or complex language and lack of engaging designs, should use simpler language and larger, more readable fonts to enhance legibility and comprehension.

Guideline 4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).

(*National Disability Authority*, 2024)

Prototype 2, which was clear and easy to understand, serves as a good example of how design elements should be differentiated. Similar strategies should be applied to other prototypes like 4 and 7 where differentiation is poor.

Principle 5: Tolerance for Error

The aim of this principle is to reduce risks and decrease the negative outcomes of unintentional or unplanned activities. This approach enhances cookie consent interfaces by enabling users to effortlessly undo or correct their choices, offering clear confirmation

prompts, minimising the risk of accidental selections, and enhancing overall user control and satisfaction.

Guideline 5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. (National Disability Authority, 2024).

Prototypes 4 and 5, which do not provide clear options for rejecting cookies, should redesign elements to make rejection options more obvious and accessible, reducing the risk of accidental acceptance.

Guideline 5b. Provide warnings of hazards and errors. (*National Disability Authority*, 2024)

Prototype 7, lacking user customization and clear reject options, should incorporate warnings or confirmations when users select settings that might compromise their privacy or result in unintended consequences.

Guideline 5c. Provide fail-safe features.

(*National Disability Authority*, 2024)

Prototypes 1 and 9, which force users to accept cookies, should include fail-safe features such as undo options or easy-to-access settings adjustments after initial selection, ensuring users can easily correct mistakes.

Prototypes 2and 6 satisfied these guidelines of principle of tolerance of error.

- **Principle 6: Low Physical Effort**

In cookie interfaces, Principle 6 of Universal Design emphasizes the need to minimize the effort required to manage cookie preferences. This means that users should be able to change their settings easily and quickly without having to navigate through many pages or click multiple times.

Guideline 6a. Allow user to maintain a neutral body position.

According to this guideline, designers need to design user-friendly cookie consent interfaces that eliminate the need for users to assume uncomfortable positions. From the analysis report, the prototypes that required extensive scrolling or precise click to particularly find a option to opt-out in the interface (prototypes1,4 and 5) could cause discomfort. Users responded more favourably to interfaces like prototypes 2 and 6, which facilitated comfortable interaction.

Guideline 6b. Use reasonable operating forces

This guideline ensures that buttons and interactive elements for example links, possess a minimal activation force need. During the investigation, participants found prototypes with well-sized, easily clickable buttons (such as prototype 2 ,6 and 8) more user-friendly compared to those with small, hard-to-find options in the interface like prototype 7.

Guideline 6c: Minimize repetitive actions.

This guideline dictates that the interface design should facilitate the user's easy acceptance or rejection of cookies. Users found prototypes with single-click options (like 3 and 10) to be less laborious than those requiring multiple steps (like 1 and 5).

Guideline 6d: Minimize sustained physical effort.

According to this guideline, it is essential that users are not required to continuously hold or press items for long periods of time. participants preferred prototypes with quick action buttons (like 6 and 10) over those that required prolonged interaction or continuous pressing (like 1 and 9).

- **Principle 7: Size and Space for Approach and Use**

This principle improves cookie consent interfaces by ensuring that interactive elements are easily reachable and well-spaced, accommodating users of various physical abilities, as well as those using assistive devices (for example, screen reader). This promotes a user-friendly and accessible experience, enhancing overall usability and satisfaction.

Guideline 7a: Provide a clear line of sight to important elements for any seated or standing user.

Under this guideline, ensure that all important elements, such as cookie consent options (accept all or reject all), are easily visible and not hidden. Prototypes with clearly visible options (such as 2 and 6) were well-received, whereas those with hidden options (like 4 and 5) caused frustration.

By aligning each prototype with these guidelines, we can effectively address areas of improvement and strengths in interface designs, making them more universally usable and accessible. This approach not only improves usability for a diverse range of users but also enhances the overall user experience in interacting with cookie consent interfaces. Also integrating these principles and guidelines into the design of cookie interface prototypes, we can significantly enhance their usability and overall effectiveness, ensuring a more inclusive experience for all users.

WCAG 2.0 and W3C accessibility guidelines apply to the interfaces.

In section 2.5, I discussed the guidelines that are applicable to interfaces.

Based on the analysis in the results and findings of the study, several prototypes did not fully comply with Web content accessibility guidelines (WCAG2.0). Prototype 1 had issues with complex technical jargon and unclear information, affecting text readability and user comprehension. It also lacked clear opt-out methods, impacting its compatibility with assistive technologies. Participants criticised Prototype 3 for its unclear customisation options, which complicated user understanding. Prototype 4 presented significant navigability issues, failing to provide straightforward navigational options, and lacked accessible information about cookies, which is crucial for informed consent. Prototype 5, like Prototype 1, struggled with making the reject cookies option clear, thus hindering user control. Prototype 7 forced users to dismiss cookie notices, making it difficult to read and access text and options easily. Prototype 9 had poor navigability, like Prototypes 1, 4, 5, and 7. Lastly, prototype 10 lacked control over customisation options, affecting user management of cookie settings, and failed to provide detailed information about cookies. To effectively meet accessibility standards, we need to make improvements in simplifying language, enhancing navigational elements, and ensuring robust user control options.

GDPR Impact and Compliance

Several prototypes evaluated in this study displayed usability issues directly conflicting with GDPR principles. For instance, many interfaces failed to provide clear and accessible options for rejecting cookies or withdrawing consent, which are fundamental GDPR requirements. These issues were further compounded by complex and technical language, making it difficult for users to understand their choices and the implications of their consent.

This research has important practical consequences for developers and designers working in the digital field. The study offers practical insights for developing more efficient and morally sound cookie consent interfaces by identifying certain usability issues and design deficiencies, such as the common use of misleading or overly complex options. Not only do these improvements enhance user satisfaction, but they also play a crucial role in upholding privacy regulations and guaranteeing users' full awareness and consent.

The study highlights how confusing or deceptive interface designs can alienate users, leading to reduced interaction quality and potential non-compliance with privacy laws. The findings

obtained from a thorough examination of user feedback and interface effectiveness emphasize the importance of simplicity and clarity in design. Providing informed user consent is crucial for creating trust and legal compliance, making it not just helpful but essential to uphold privacy requirements.

The identification of design deficiencies, such as the excessive complexity of information presentation and the absence of distinct rejection choices, has implications for future interface development. The study helps to address these widespread concerns by offering precise suggestions. The study suggests that interfaces should steer clear of technical terminology and ensure that all choices, including the ability to opt-out, are clearly visible and accessible to all users.

This research goes beyond usability to touch upon ethical considerations in interface design. The findings suggest that cookie consent interfaces often manipulate user choices to favour less privacy-friendly options. The study presents a convincing ethical case for redesigning interfaces to prioritize user choice by thoroughly documenting these practices and their effects. This is linked to wider discussions on digital ethics, which highlight the importance of user consent and transparency in the era of digital technology.

6. Conclusion

The study conducted an evaluative investigation on the usability and universal design concepts of cookie consent interfaces, revealing important findings regarding usability difficulties and manipulative tactics that undermine user freedom and privacy. With the current focus on digital security concerns in the technology industry, it is now more important than ever to create interfaces that not only comply with legal requirements but also improve the user experience. In this conclusion section, I will recapitulate the primary findings of this empirical investigation, explore their implications for both theoretical understanding and practical application, and acknowledge the limitations inherent in the study. I will present recommendations for future work to address these limitations and broaden the range of investigation. Furthermore, a personal reflection will express the evolution of my understanding and expertise acquired through this research process, highlighting the personal and academic advancement experienced during the study.

6.1 Summary of Findings

This thesis conducted a comprehensive investigation into the usability issues and design considerations related to cookie consent interfaces. The study uncovered noteworthy findings across several key areas. Firstly, participants interacting with these prototypes frequently encountered complex and unclear interface designs that affected their ability to effectively manage privacy settings. This often resulted in confusion and a reduced probability of giving informed consent. Furthermore, the study discovered a significant use of dark patterns, which are deceptive design strategies incorporated into the prototypes to manipulate users into making privacy choices that do not align with their own best interests. These patterns involved hiding rejection choices and highlighting consent in a way that affects user choices.

Additionally, the study also highlighted the presence of inconsistencies across several prototype designs, which further contributed to user confusion and varied experiences with managing cookie settings. However, participants greatly appreciated the prototypes that provided clear, understandable information about the purpose and consequences of cookies, enabling them to make more informed choices regarding their privacy preferences. These findings emphasize the urgent need for better usability and design standards in the creation of cookie consent interfaces. This suggests prioritizing increasing transparency and

organising user interactions to safeguard user privacy and improve the overall user experience. Furthermore, our examination of prototype cookie consent interfaces emphasizes the critical requirement of integrating universal design principles. Through investigating these prototypes, I showcased how we can make these interfaces accessible and useful for a diverse range of individuals, including those with disabilities. This approach is not solely a question of ethical design; it is also imperative for adhering to legal requirements and improving the overall user experience. Adopting universal design principles in the development of these prototypes provides a practical framework for ensuring that all users can navigate and use these interfaces effectively.

6.2 Implications

These findings have significant theoretical and practical implications.

Theoretically, the study enhances the current discussion on the usability of consent interfaces and design standards. This emphasises the important requirement for cookie consent interfaces that not only enhance the user experience but also fully comply with ethical standards. This study deepens our understanding of the seamless integration of transparency and user control into design approaches, thereby promoting informed user choices and ensuring compliance with privacy regulations.

Practically, these findings provide guidance for web developers and designers, encouraging them to implement user-focused design principles when creating cookie consent interfaces. Developers can significantly enhance the user experience by including principles such as presenting options clearly, offering standardised customisation features, and providing transparent information. This includes improving interfaces to be simpler and more uncomplicated, which has the potential to decrease user irritation and increase trust and happiness. The study also points out the need for policymakers and regulators to implement stricter rules and enforcement measures regarding the design and functioning of cookie consent systems. Given the essential function of these interfaces in protecting user privacy, it is imperative to strengthen legal frameworks such as the GDPR with practical and enforceable rules that guarantee designs are transparent, user-friendly, and free of manipulative tactics.

6.3 The study has Limitations.

The section acknowledges several limitations identified by this study on the usability and universal design concepts of cookie consent interfaces:

Sample size and diversity: The study utilised a relatively small sample size of 20 participants. While the participants were from diverse backgrounds, the sample may not be fully representative of the broader population. I did not include elderly people or people with disabilities, which could have enhanced the significance of the findings.

Prototype Variability: The study examined a limited number of prototypes (ten in total) to investigate the usability and design of cookie consent interfaces. Although these prototypes covered a range of design features and elements, they might not capture the full spectrum of existing designs in real-world applications.

Context of Use: I conducted the study in a supervised environment, which may not accurately replicate real-world scenarios where users interact with cookie consent interfaces. Real-world factors such as fluctuating internet speeds, different types of devices, and engaging in many tasks simultaneously may have distinct impacts on user experiences.

Limited Tasks: The tasks carried out were basic. However, engaging people in more complicated tasks on cookie interfaces could have produced different outcomes. Hence, the tasks assigned to participants in the study may not cover all the different ways users usually engage with cookie consent screens. The tasks focused on specific aspects of usability and design, potentially overlooking other important interactions and scenarios such as revisiting preferences, interacting on different devices or impact of visual impairments etc.

6.4 Recommendation for Future Work

Based on the insights gathered from the study, the following recommendations are made for future work to address the limitations and broaden the scope of the investigation:

Increase Sample Size and Diversity: Future research should include a larger and more diverse sample size to ensure that the findings are representative of the broader population. This should include elderly people and people with disabilities to gain insight into how these groups interact with cookie consent interfaces and ensure that the designs meet their needs effectively.

Expand Prototype Variability: While the study examined ten prototypes, future work should include a wider variety of designs to capture the broader range of cookie consent interfaces

in real-world applications. This will help in identifying optimal techniques and common obstacles across a wider variety of interface designs and functionalities.

Real-World Contexts: To identify more usability issues in interfaces, conduct research in real-world environments where participants use their own devices and experience varying internet speeds and multitasking scenarios. This will provide a more accurate representation of how users interact with cookie consent interfaces in their daily lives and identify usability issues that may not be apparent in controlled settings.

Complex Task Scenarios: To enhance understanding of every aspect of user interactions with cookie consent interfaces, it is advisable to include more complex and diverse tasks in future studies. These tasks may involve activities such as reviewing and adjusting preferences, managing cookie settings across various devices, and addressing accessibility features.

Enhanced Customization and Transparency: Future research should prioritise the development and evaluation of interfaces that provide improved customisation features and increased transparency. This includes clear, non-technical explanations of cookie functions and consequences, as well as easily accessible opt-out options.

Universal Design Principles: Future research ensure that universal design principles are consistently incorporated and evaluated during the creation of cookie consent interfaces. Ensure that interfaces are designed to be inclusive and user-friendly for all individuals, irrespective of their skills or backgrounds. This means adhering to rules such as offering several styles of information presentation and guaranteeing that all elements are easy to identify and useful.

Ethical Considerations and Dark Patterns: Future research should more focus on creating norms and frameworks for ethical design approaches that prioritise user freedom and informed permission in relation to dark patterns.

Policy and Regulatory Impact: It is crucial to examine the impact of different regulatory rules on the design and usability of cookie consent interfaces. Future studies should assess the level of acceptance of interfaces to regulations such as GDPR and determine how to boost compliance through enhanced design. This will guarantee that interfaces not only comply with legal regulations but also efficiently safeguard user privacy.

6.5 Personal reflection

Embarking on this research journey has been both challenging and rewarding. Throughout the process, I have gained a deeper understanding of the complexities involved in designing user-friendly cookie consent interfaces. This study has not only expanded my technical knowledge but also improved my understanding of the importance of ethical design and user experience.

Firstly, I initiated a search for extensive research and articles that focused on cookie interfaces and the challenges users encounter with these interfaces. As I reviewed various studies, it became evident that many users struggle with cookie consent interfaces due to poor design choices. This often leads to frustration and, in some cases, unintentional consent to data tracking. It was particularly eye-opening to learn about the concept of "dark patterns," which refers to intentionally designed interfaces that deceive users. It underscored the critical need for transparency and user empowerment in digital design. I also uncovered numerous studies that highlighted the technical challenges and ethical considerations in designing cookie consent interfaces.

To further understand the user perspective, I developed ten prototypes of cookie consent interfaces. This hands-on approach was instrumental in translating theoretical knowledge into practical solutions. Evaluating these prototypes with 20 participants provided invaluable insights into usability issues and preferences.

One of the most enlightening aspects of this research was the direct interaction with participants. Observing their struggles and frustrations with various cookie interface prototypes provided invaluable insights that went beyond the scope of a theoretical study. Their feedback underscored the significant gap between current design practices and user expectations.

The process of designing and testing multiple prototypes taught me the importance of simplicity and clarity in interface design. Prototypes that were straightforward and easy to navigate received overwhelmingly positive feedback, reinforcing the principle that good design should facilitate, not hinder, user decision-making. This insight will guide my future work, reminding me to prioritise user needs and preferences in all design endeavours.

Furthermore, this research project has been a significant step in my academic and professional development. It provided an opportunity to apply theoretical knowledge in a

practical setting, enhancing my skills in qualitative and quantitative research methods. The experience of conducting user interviews, analysing data, and synthesising findings into actionable recommendations has been immensely valuable. It has prepared me for future research projects and professional challenges, providing me with the tools to contribute meaningfully to the field of user experience design.

Throughout this project, the guidance and support of my supervisor were invaluable. His expertise and constructive feedback helped shape the study's direction and refine the methodologies employed. Regular discussions and his prompt responses to my queries were crucial in overcoming the hurdles encountered during the research process.

In conclusion, this research has been a transformative journey, shaping my understanding of the critical intersection between usability, universal design ethics, and legal compliance in digital interface design. The lessons learned and skills acquired during this project will undoubtedly influence my future work, driving me to create designs that are not only functional and compliant but also genuinely user-centric and transparent.

7. References

Alharbi, J. A., Albesher, A. S., & Wahsheh, H. A. (2023). An empirical analysis of E-governments' cookie interfaces in 50 countries. *Sustainability*, *15*(2), 1231.

Andersson, S. (2019). *Universal Design Of Smartphone User interface Interaction in Stressful Situations*.

Barth, S., Ionita, D., & Hartel, P. (2023). Understanding Online Privacy—A Systematic Review of Privacy Visualizations and Privacy by Design Guidelines. *ACM Computing Surveys*, *55*(3), 1–37. https://doi.org/10.1145/3502288

Berg, B., Lune, H., & Lune, H. (2004). *Qualitative research methods for the social sciences Pearson Boston*.

Berghel, H. (2013). Toxic Cookies. *Computer*, *46*(9), 104–107.

Bermejo Fernandez, C., Chatzopoulos, D., Papadopoulos, D., & Hui, P. (2021). This Website Uses Nudging: MTurk Workers' Behaviour on Cookie Consent Notices. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW2), 1–22. https://doi.org/10.1145/3476087

Bhandari, P. (2020, June 19). *What Is Qualitative Research? | Methods & Examples*. Scribbr. https://www.scribbr.com/methodology/qualitative-research/

Borberg, I., Hougaard, R., Rafnsson, W., & Kulyk, O. (2022). "So I Sold My Soul": Effects of Dark Patterns in Cookie Notices on End-User Behavior and Perceptions. *Usable Security and Privacy (USEC) Symposium*, 1–11. https://www.ndss-symposium.org/wp-content/uploads/usec2022_23026_paper.pdf

Cahn, A., Alfeld, S., Barford, P., & Muthukrishnan, S. (2016). An Empirical Study of Web Cookies. *Proceedings of the 25th International Conference on World Wide Web*, 891–901. https://doi.org/10.1145/2872427.2882991

Cairns, P., & Cox, A. L. (2008). *Research methods for human-computer interaction* (Vol. 10). Cambridge University Press Cambridge.

Check, 211. (2023, July 10). What are internet cookies. *Internet Cookies*. https://211check.org/explainer-what-are-internet-cookies-and-what-are-they-used-for/

Cohen, L., Manion, L., & Morrison, K. (2002). *Research methods in education*. routledge.

Cookie Banner. (2024). https://www.cookiebot.com/en/cookie-banner/

Degeling, M., Utz, C., Lentzsch, C., Hosseini, H., Schaub, F., & Holz, T. (2019). We Value Your Privacy ... Now Take Some Cookies: Measuring the GDPR's Impact on Web Privacy. *Proceedings 2019 Network and Distributed System Security Symposium*. https://doi.org/10.14722/ndss.2019.23378

Di Pofi, J. A. (2002). Organizational diagnostics: Integrating qualitative and quantitative methodology. *Journal of Organizational Change Management*, *15*(2), 156–168.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical Education*, *40*(4), 314–321. https://doi.org/10.1111/j.1365-2929.2006.02418.x

Englehardt, S., Reisman, D., Eubank, C., Zimmerman, P., Mayer, J., Narayanan, A., & Felten, E. W. (2015). Cookies That Give You Away: The Surveillance Implications of Web Tracking. *Proceedings of the 24th International Conference on World Wide Web*, 289–299. https://doi.org/10.1145/2736277.2741679

Feng, Y., Yao, Y., & Sadeh, N. (2021). A Design Space for Privacy Choices: Towards Meaningful Privacy Control in the Internet of Things. *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1–16. https://doi.org/10.1145/3411764.3445148

Fischer, B. A., IV. (2006). A Summary of Important Documents in the Field of Research Ethics. *Schizophrenia Bulletin*, *32*(1), 69–80. https://doi.org/10.1093/schbul/sbj005

Fouad, I., Santos, C., Al Kassar, F., Bielova, N., & Calzavara, S. (2020). On compliance of cookie purposes with the purpose specification principle. *2020 IEEE European Symposium on Security and Privacy Workshops (EuroS&PW)*, 326–333. https://ieeexplore.ieee.org/abstract/document/9229842/

General Data Protection Regulation (GDPR) – Official Legal Text. (n.d.). General Data Protection Regulation (GDPR). Retrieved March 24, 2024, from https://gdpr-info.eu/

Gray, C. M., Kou, Y., Battles, B., Hoggatt, J., & Toombs, A. L. (2018). The Dark (Patterns) Side of UX Design. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–14. https://doi.org/10.1145/3173574.3174108

Habib, H., & Cranor, L. F. (2022). Evaluating the usability of privacy choice mechanisms. *Eighteenth Symposium on Usable Privacy and Security (SOUPS 2022)*, 273–289. https://www.usenix.org/conference/soups2022/presentation/habib

Habib, H., Li, M., Young, E., & Cranor, L. (2022). "Okay, whatever": An Evaluation of Cookie Consent Interfaces. *CHI Conference on Human Factors in Computing Systems*, 1–27. https://doi.org/10.1145/3491102.3501985

Hammarberg, K., Kirkman, M., & de Lacey, S. (2016). Qualitative research methods: When to use them and how to judge them. *Human Reproduction*, *31*(3), 498–501. https://doi.org/10.1093/humrep/dev334

Hasan, S. K. (2020). *Accessibility Study of interactive maps and design recommendation to enhance screen reader accessibility*.

Hausner, P., & Gertz, M. (2021). *Dark Patterns in the Interaction with Cookie Banners* (arXiv:2103.14956). arXiv. http://arxiv.org/abs/2103.14956

Initiative (WAI), W. W. A. (2024). *W3C*. Web Accessibility Initiative (WAI). https://www.w3.org/WAI/fundamentals/accessibility-intro/

Internet cookies. (2021, November 26). *All About Internet Cookies*. CookieYes. https://www.cookieyes.com/blog/internet-cookies/

Ishtiaq, M. (2019). Book Review Creswell, JW (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches . Thousand Oaks, CA: Sage. *English Language Teaching*, *12*(5), 40.

Ivory, M. Y. (2001). *An empirical foundation for automated Web interface evaluation* [Ph.D., University of California, Berkeley]. https://www.proquest.com/docview/304684748/abstract/8AE15F1281604428PQ/1

Jackson, R. L., Drummond, D. K., & Camara, S. (2007). What Is Qualitative Research? *Qualitative Research Reports in Communication*, *8*(1), 21–28. https://doi.org/10.1080/17459430701617879

Jayakumar, L. N. (2021). Cookies 'n'Consent: An empirical study on the factors influencing of website users' attitude towards cookie consent in the EU. *DBS Business Review*, *4*. https://dbsbusinessreview.ie/index.php/journal/article/view/72

Jokela, T., Iivari, N., Matero, J., & Karukka, M. (2003). The standard of user-centered design and the standard definition of usability: Analyzing ISO 13407 against ISO 9241-11. *Proceedings of the Latin American Conference on Human-Computer Interaction*, 53–60. https://doi.org/10.1145/944519.944525

Karat, C.-M., Campbell, R., & Fiegel, T. (1992). Comparison of empirical testing and walkthrough methods in user interface evaluation. *Proceedings of the SIGCHI*

Conference on Human Factors in Computing Systems, 397–404. https://doi.org/10.1145/142750.142873

Kretschmer, M., Pennekamp, J., & Wehrle, K. (2021). Cookie Banners and Privacy Policies: Measuring the Impact of the GDPR on the Web. *ACM Transactions on the Web*, *15*(4), 1–42. https://doi.org/10.1145/3466722

Krisam, C., Dietmann, H., Volkamer, M., & Kulyk, O. (2021). Dark Patterns in the Wild: Review of Cookie Disclaimer Designs on Top 500 German Websites. *Proceedings of the 2021 European Symposium on Usable Security*, 1–8. https://doi.org/10.1145/3481357.3481516

Kulyk, O., Mayer, P., Volkamer, M., & Käfer, O. (2018). A concept and evaluation of usable and fine-grained privacy-friendly cookie settings interface. *2018 17th IEEE International Conference On Trust, Security And Privacy In Computing And Communications/12th IEEE International Conference On Big Data Science And Engineering (TrustCom/BigDataSE)*, 1058–1063. https://ieeexplore.ieee.org/abstract/document/8456017/?casa_token=8BZZAqutJOYAAAAA:D9cZmZ3wrFa3c8bSHqYR6s_6pu_dzuH-AxhhyI0WjH8_LUEqerfYvmD49Z6Kexfk46WNHLtU3nZi

Kurtishi, R. (2018). *Universal design of intelligent personal assistants*.

Lazar, J., Feng, J. H., & Hochheiser, H. (2017). *Research methods in human-computer interaction*. Morgan Kaufmann. https://books.google.com/books?hl=en&lr=&id=hbkxDQAAQBAJ&oi=fnd&pg=PP1&dq=+research+methods+lazar&ots=Sr225c029S&sig=TKaFz6RmO1XfMkI5uF28Raty8q0

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. SAGE.

Matte, C., Bielova, N., & Santos, C. (2020). Do cookie banners respect my choice?: Measuring legal compliance of banners from iab europe's transparency and consent framework. *2020 IEEE Symposium on Security and Privacy (SP)*, 791–809. https://ieeexplore.ieee.org/abstract/document/9152617/?casa_token=ta0m-31z6noAAAAA:iqHxw5DhesXEB8KUyavNH-iydrElMJ_CX-an4gs9lKFzTCioMpUKVP1JSif7sX9H6ovuShohiqhu

Millett, L. I., Friedman, B., & Felten, E. (2001). Cookies and Web browser design: Toward realizing informed consent online. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 46–52. https://doi.org/10.1145/365024.365034

Mohajan, H. K. (2020). Quantitative Research: A Successful Investigation in Natural and Social Sciences. *Journal of Economic Development, Environment and People*, *9*(4), Article 4. https://doi.org/10.26458/jedep.v9i4.679

Morse, J. M. (2005). What Is Qualitative Research? *Qualitative Health Research*, *15*(7), 859–860. https://doi.org/10.1177/1049732305279135

Munir, M. (2021). *An usability and universal design investigation into hidden user interface navigational elements*.

National Disability Authority. (2024). Centre for Excellence in Universal Design. https://universaldesign.ie/about-universal-design/the-7-principles

Nielsen, J. (1994). *Usability engineering*. Morgan Kaufmann. https://books.google.com/books?hl=en&lr=&id=95As2OF67f0C&oi=fnd&pg=PR9&dq=introduction+to+usability+nielsen+&ots=3dzzFlin0p&sig=xuQc5kavh9O_XODRfgoOa7LG30o

Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Empowering People - CHI '90*, 249–256. https://doi.org/10.1145/97243.97281

NSD - Norwegian Centre for Research Data. (2019, August 12). RDA. https://www.rd-alliance.org/nsd-norwegian-centre-research-data

Oliver, P. (2010). *The student's guide to research ethics*. McGraw-Hill Education (UK).

Olsen, D. R. (2007). Evaluating user interface systems research. *Proceedings of the 20th Annual ACM Symposium on User Interface Software and Technology*, 251–258. https://doi.org/10.1145/1294211.1294256

Paine, C., Reips, U.-D., Stieger, S., Joinson, A., & Buchanan, T. (2007). Internet users' perceptions of 'privacy concerns' and 'privacy actions.' *International Journal of Human-Computer Studies*, *65*(6), 526–536.

Persson, H., Åhman, H., Yngling, A. A., & Gulliksen, J. (2015). Universal design, inclusive design, accessible design, design for all: Different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects. *Universal Access in the Information Society*, *14*(4), 505–526. https://doi.org/10.1007/s10209-014-0358-z

Rasaii, A., Singh, S., Gosain, D., & Gasser, O. (2023). Exploring the Cookieverse: A Multi-Perspective Analysis of Web Cookies. In A. Brunstrom, M. Flores, & M. Fiore (Eds.), *Passive and Active Measurement* (Vol. 13882, pp. 623–651). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-28486-1_26

Rudat, M. (2019, April 3). *Hybrid Research: Combining Qualitative and Quantitative Methods and More*. GutCheck. https://gutcheckit.com/blog/hybrid-research/

Sakamoto, T., & Matsunaga, M. (2019). After GDPR, still tracking or not? Understanding opt-out states for online behavioral advertising. *2019 IEEE Security and Privacy Workshops (SPW)*, 92–99. https://ieeexplore.ieee.org/abstract/document/8844599/

Sanchez-Rola, I., Balzarotti, D., & Santos, I. (2020). Cookies from the Past: Timing Server-side Request Processing Code for History Sniffing. *Digital Threats: Research and Practice*, *1*(4), 1–24. https://doi.org/10.1145/3419473

Sanchez-Rola, I., Dell'Amico, M., Kotzias, P., Balzarotti, D., Bilge, L., Vervier, P.-A., & Santos, I. (2019). Can I Opt Out Yet?: GDPR and the Global Illusion of Cookie Control. *Proceedings of the 2019 ACM Asia Conference on Computer and Communications Security*, 340–351. https://doi.org/10.1145/3321705.3329806

Santos, C., Bielova, N., & Matte, C. (2020). *Are cookie banners indeed compliant with the law? Deciphering EU legal requirements on consent and technical means to verify compliance of cookie banners* (arXiv:1912.07144). arXiv. http://arxiv.org/abs/1912.07144

Shirazi, F., & Volkamer, M. (2014). What Deters Jane from Preventing Identification and Tracking on the Web? *Proceedings of the 13th Workshop on Privacy in the Electronic Society*, 107–116. https://doi.org/10.1145/2665943.2665963

Shrestha, V. (2017). *Procedures for achieving universally designed website for the Norwegian Broadcasting Cooperation [NRK]*.

Singh, A. K., Upadhyaya, N., Seth, A., Hu, X., Sastry, N., & Mondal, M. (2022a). What Cookie Consent Notices Do Users Prefer: A Study In The Wild. *Proceedings of the 2022 European Symposium on Usable Security*, 28–39. https://doi.org/10.1145/3549015.3555675

Singh, A. K., Upadhyaya, N., Seth, A., Hu, X., Sastry, N., & Mondal, M. (2022b). What Cookie Consent Notices Do Users Prefer: A Study In The Wild. *Proceedings of the 2022 European Symposium on Usable Security*, 28–39. https://doi.org/10.1145/3549015.3555675

Soe, T. H., Nordberg, O. E., Guribye, F., & Slavkovik, M. (2020). Circumvention by design—Dark patterns in cookie consent for online news outlets. *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*, 1–12. https://doi.org/10.1145/3419249.3420132

Speicher, M. (2022). *What is Usability? A Characterization based on ISO 9241-11 and ISO/IEC 25010* (arXiv:1502.06792). arXiv. http://arxiv.org/abs/1502.06792

Sreekumar, D. (2023, March 23). *What is Quantitative Research? Definition, Methods, Types, and Examples | Researcher.Life*. https://researcher.life/blog/article/what-is-quantitative-research-types-and-examples/

Story, M. F. (1998). Maximizing Usability: The Principles of Universal Design. *Assistive Technology*, *10*(1), 4–12. https://doi.org/10.1080/10400435.1998.10131955

Sukamolson, S. (2007). Fundamentals of quantitative research. *Language Institute Chulalongkorn University*, *1*(3), 1–20.

Tan, W., Liu, D., & Bishu, R. (2009). Web evaluation: Heuristic evaluation vs. user testing. *International Journal of Industrial Ergonomics*, *39*(4), 621–627. https://doi.org/10.1016/j.ergon.2008.02.012

Taylor, S. J., Bogdan, R., & DeVault, M. (2015). *Introduction to Qualitative Research Methods: A Guidebook and Resource*. John Wiley & Sons.

Thorngate, S., & Hoden, A. (2017). Exploratory Usability Testing of User Interface Options in LibGuides 2. *College & Research Libraries*, *78*(6). https://doi.org/10.5860/crl.78.6.844

Thovtrup, H., & Nielsen, J. (1991). Assessing the usability of a user interface standard. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Reaching through Technology - CHI '91*, 335–341. https://doi.org/10.1145/108844.108937

Trevisan, M., Traverso, S., Metwalley, H., & Mellia, M. (2019). Uncovering the Flop of the EU Cookie Law. *Proceedings on Privacy Enhancing Technologies*, *2019*(2), 126–145. https://doi.org/10.2478/popets-2019-0023

Wang, C.-M., & Huang, C.-H. (2015). A study of usability principles and interface design for mobile e-books. *Ergonomics*, *58*(8), 1253–1265. https://doi.org/10.1080/00140139.2015.1013577

WCAG. (2024). https://www.w3.org/WAI/WCAG22/quickref/?versions=2.1#compatible

WCAG | WAI | W3C. (2024). https://www.w3.org/WAI/WCAG21/Understanding/intro#understanding-the-four-principles-of-accessibility

What is a cookie banner? (n.d.). Cookie Information. Retrieved April 23, 2024, from https://cookieinformation.com/cookie-banner/

What is GDPR, the EU's new data protection law? (2018, November 7). GDPR.Eu. https://gdpr.eu/what-is-gdpr/

Xue, Y. (2020). *Make a More Meaningful Interaction: Exploring the Framework of Cookie Notice* [PhD Thesis, Waseda University]. https://waseda.repo.nii.ac.jp/record/58139/files/t5118FG22.pdf

Appendix

8. Appendix A

8.1 Information Sheet

Title of the Research: Investigation into Usability and Universal design of website cookie settings interfaces.

Introduction and Purpose of the Study:

We kindly request your involvement in a research project regarding cookie settings interfaces on websites. The study aims to explore the usability and universal design aspects of these interfaces The purpose of the research is to identify the challenges users face when interacting with cookie consent pop-ups and propose improvements that make these interfaces more accessible and user-friendly for everyone. The results of this study will contribute to a master thesis of Karishma Sharma at Oslo Metropolitan University.

Procedures:

We will ask participants first to read information sheet to answer some introductory questions then to interact with several prototypes of cookie settings interfaces. The procedure involves performing tasks related to managing cookie preferences on these interfaces. The provided task form describes each of the six tasks in total.

Task 1: Initial Impression

Task 2: Cookie Rejection

Task 3: Customisation

Task 4: Information Access

Task 5: Check clarity

Task 6: Confirm Saved Preferences

Participants must follow the requirements and perform these tasks, which include actions such as opting out of cookies, customising cookie settings, and accessing cookie information. At the end of the tasks, participants will fill out a post-experiment questionnaire to provide their opinions on the usability and design of the interfaces. We will also conduct a brief interview to glean additional insights into their experiences.

Duration

The investigation process is divided into four stages. First Introduction about cookies after that, a series of task and Likert-scale questionaries. finally, the short interview related with participants past experiences. The total time will take approximately 15-20 minutes.

Who to contact.

If you have any questions or need further information, please contact:

Karishma Sharma
Email: s371071@oslomet.no
Oslo Metropolitan University

8.2 Consent Form.

- I _____, voluntarily agree to participate in this research study.
- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
- I have had the purpose and nature of the study explained to me in writing, and I have had the opportunity to ask questions about the study.
- I understand that participation involves interacting with several prototypes of cookie settings interfaces and performing tasks related to managing cookie preferences.
- I understand that I will not benefit directly from participating in this research.
- I understand that in any report on the results of this research, my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview that may reveal my identity or the identity of people I speak about.
- I understand that I am free to contact the person involved in the research to seek further clarification and information.

Signature of the research participant

Signature of participant: _____ *Date:* _____

9. Appendix B

9.1 Introductory Questionnaire

Questions	Description	Answer
How old are you?	0-19 20-29 30-39 40-49 49-above	
How experience is you when it comes to participate in research?	1-Not experienced 2-Slightly Experienced 3-Moderately experienced 4-Experienced. 5-Very experienced	
How experience are you with interacting cookie interfaces while surfing websites?	-Not experienced 2-Slightly Experienced 3-Moderately experienced 4-Experienced. 5-Very experienced	

Table 16: Introductory Questionnaire

9.2 Likert-Scale Questionnaires

Indicate your response to each question below by circling the one that most accurately reflects your feelings towards the question. where 1= Strongly Disagree,2=Disagree,3=Neither Agree nor Disagree,4=Agree, 5=Strongly Agree.

S.No	Statements	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	Interface was visually appealing	1	2	3	4	5
2	interface was easy and clear to understand.	1	2	3	4	5
3	It was easy to locate the option to reject cookie.	1	2	3	4	5
4	It was easy to customize your cookie settings	1	2	3	4	5
5	interface was user-friendly	1	2	3	4	5
6	You are confident that your preferences were successfully saved	1	2	3	4	5
7	It was easy to find detailed info about cookies, their purposes and implications.	1	2	3	4	5

10. Appendix C

10.1 Participants responses from interview

Question 1: Experience with Managing Cookies and Frequency of Cookie Interfaces

1. "I frequently encounter cookie pop-ups whenever I visit new websites. It seems almost every site has them now."
2. "I see cookie interfaces maybe once or twice a week; I mostly visit the same websites regularly."
3. "Almost every new site shows a cookie interface, which I find annoying as it disrupts my browsing."
4. "I usually manage cookies on e-commerce sites to avoid repetitive ads."
5. "I encounter them daily and find them quite intrusive, but I understand they're necessary for personalized experiences."
6. "I rarely notice them because I use a cookie management tool that automates my preferences."
7. "I often see these interfaces but usually just accept the defaults to save time."
8. "I interact with cookie settings quite frequently as I am concerned about privacy."
9. "I see cookie pop-ups so often that I've become desensitized and just click accept to get them out of the way."
10. "As a tech enthusiast, I often explore different settings within these interfaces."
11. "I usually ignore them unless a website forces me to interact to continue browsing."
12. "Every site seems to require some form of cookie acceptance, which has become a routine part of surfing the web."
13. "I encounter them occasionally, especially on sites that are GDPR compliant."
14. "I see them often and try to customize settings to minimize tracking."
15. "Cookie notices pop up every time I clear my browser cache, which is quite frequent."
16. "It's a daily occurrence, especially since I browse a lot of international news sites."
17. "I see them rarely because most of my browsing is on familiar sites."
18. "I often have to deal with them when using shopping sites, and I take the time to adjust the settings."
19. "I encounter cookie settings mostly on new websites or when I use different devices."
20. "I deal with them frequently, especially on websites that offer customizable content."

Question 2: Difficulties or Challenges with Cookie Interfaces

1. "Sometimes the settings are too complex to understand easily."
2. "The main challenge is the lack of clear information about what each option means."
3. "Often, the options are either too technical or there are too many choices, which makes it overwhelming."
4. "I find it frustrating when there's no option to reject all non-essential cookies quickly."
5. "The interfaces are sometimes not mobile-friendly, making it hard to select preferences on a small screen."
6. "Some sites make it intentionally difficult to find how to opt out of all cookies."
7. "I've encountered cookie settings that don't seem to save my preferences for the next visit."

8. "The terminology used is sometimes unclear or too jargon-heavy for a layperson."
9. "Often, the 'accept all' button is much more prominent than the 'more options' link."
10. "Some websites reset your cookie preferences with every visit, which is tedious."
11. "I've had issues where the settings interface is buggy or fails to load properly."
12. "Some cookie pop-ups don’t have a straightforward way to view detailed settings."
13. "The biggest challenge is the time it takes to properly set up these preferences."
14. "It’s hard to tell what the implications of my choices are, especially regarding privacy."
15. "Occasionally, the explanations are too vague or generic to make informed decisions."
16. "Some interfaces are cluttered and visually overwhelming."
17. "Navigating through different categories of cookies can be confusing and time-consuming."
18. "I find it challenging when the cookie settings link is hidden at the bottom of the page or in small text."
19. "Sometimes the interface is slow to respond, which can be frustrating."
20. "I struggle with finding how to change settings once the initial choice has been made."

Question 3: Confusing Aspects of Cookie Interfaces

1. "The legal jargon often used in descriptions can be very confusing."
2. "Options are sometimes too technical without simple explanations."
3. "The grouping of cookie types can be unclear, making it hard to decide what to allow or block."
4. "Some interfaces offer too many choices without clear distinctions."
5. "It's confusing when the interface layout varies significantly from one site to another."
6. "Unclear what the consequences of my choices are, especially in terms of functionality loss."
7. "Often, the essential cookies are mixed with optional ones, which isn't transparent."
8. "Terms like 'third-party cookies' and 'beacons' are confusing without context."
9. "The different levels of consent are not always explained clearly."
10. "It's confusing when there's no straightforward way to decline all non-essential cookies."
11. "Some sites provide minimal information on why certain cookies are necessary."
12. "Frequent use of technical terms without definitions makes it hard to understand."
13. "The design is sometimes inconsistent, with important options hidden under advanced settings."
14. "It’s confusing when the accept and customize buttons are similarly styled."
15. "Confusion arises when settings do not seem to remember my preferences."
16. "The fine print is often too small and detailed, making it easy to overlook important choices."
17. "Sites that require multiple clicks to customize settings lead to confusion."
18. "Cookie settings often don't provide enough information about the data handlers."
19. "The lack of a clear 'reject all' option is misleading and confusing."
20. "It's unclear how to go back and change settings after the initial selection."

Question 4: Frustration or Dissatisfaction with Adjusting Cookie Preferences

1. "I feel frustrated when I can't find a simple reject all option."
2. "It's annoying when the settings don't save and I have to redo them each visit."
3. "I'm dissatisfied when the interface is cluttered and difficult to navigate."
4. "Frustration arises from the time it takes to properly set these preferences on every new site."

5. "It's irritating when the customization options are less prominent than the accept all button."
6. "I've been frustrated by the lack of clarity about what I'm agreeing to."
7. "Sometimes the settings page crashes or fails to load, which is very frustrating."
8. "I feel forced into accepting cookies because rejecting them is made so difficult."
9. "Dissatisfaction comes from interfaces that seem designed to trick you into accepting more cookies."
10. "I'm often frustrated by not being able to understand the implications of my choices."
11. "The lack of a universal setting across all websites to manage cookie preferences is annoying."
12. "It's frustrating when there's no obvious way to change settings later."
13. "I get annoyed when I have to deal with cookies on every site despite using a private browser mode."
14. "I'm dissatisfied with the performance impact on the website after adjusting settings."
15. "Finding that my settings have been reset without my input is very frustrating."
16. "I dislike having to scroll through long lists of cookie providers to understand who gets my data."
17. "The time it takes to read and understand each option makes the process tedious."
18. "I'm frustrated when websites make the decline option much harder to find than the accept option."
19. "It bothers me when the settings do not clearly state the duration of cookie storage."
20. "The general opacity of what each setting really means leads to a lot of dissatisfaction."

Question 5: Design Elements that Make Cookie Settings Understandable and Navigable

1. "A simple layout with clear, large buttons for each choice helps a lot."
2. "Having a one-click option to reject all non-essential cookies makes it user-friendly."
3. "Clear explanations of what each type of cookie does are crucial."
4. "Consistency in design across different sites would help make the process more intuitive."
5. "Options presented in layman's terms rather than technical language are easier to navigate."
6. "A clean interface with minimal clutter makes the choices clearer."
7. "The use of tooltips or info icons that provide more details when hovered over helps understanding."
8. "Good contrast and readable font sizes make a big difference."
9. "An easy to find 'more options' button that is as prominent as the 'accept all' button is helpful."
10. "Providing examples of what will change if I alter settings can guide my decisions better."
11. "Organized categories for different cookies make it easier to decide what to accept."
12. "The ability to see and adjust preferences on one page without scrolling is beneficial."
13. "Effective use of visuals to represent the implications of my choices helps."
14. "A straightforward way to revisit and change my preferences later is essential."
15. "Having a summary of the effects of my choices before I finalize them helps to navigate."
16. "Settings that are remembered across sessions prevent repeated adjustments."
17. "The use of familiar terms and avoidance of technical jargon makes the interface accessible."
18. "A search function to quickly find specific cookie settings is useful."

19. "Feedback on the impact of my settings, like improved privacy or browsing speed, adds value."
20. "A step-by-step guide through the cookie settings process when first encountered improves clarity."

Question 6: Experiences with Poorly Designed Cookie Interfaces

1. "I've seen interfaces where the decline option was hidden in very small text, very hard to find."
2. "Some cookie settings are designed with confusing layouts, where accept buttons are highlighted and decline options are not visible."
3. "I've encountered pop-ups that are extremely cluttered, making it hard to understand anything."
4. "There was an interface that required navigating through multiple tabs to manage preferences, which was very cumbersome."
5. "I've seen some where the settings didn't save correctly, forcing me to redo them every visit."
6. "Some interfaces use technical jargon with no explanations, which makes it hard to make informed choices."
7. "I once had to click through five different screens to set my preferences, which was too time-consuming."
8. "Interfaces that reset your choices after each visit are particularly frustrating and poorly designed."
9. "I've dealt with some that are very slow to load or respond, which makes adjusting settings a test of patience."
10. "Pop-ups that cover the entire screen and don't allow you to read the content unless you make a choice are very aggressive."
11. "Some interfaces do not provide any information on what the cookies are used for, just an option to accept."
12. "I've seen designs where the 'more options' link was almost the same color as the background, nearly invisible."
13. "Interfaces that automatically opt you into everything unless you manually change settings are manipulative."
14. "Some cookie settings are non-responsive on mobile devices, making them almost impossible to manage on the go."
15. "I've seen interfaces where the reject all button actually leads to more complex settings instead of simplifying the process."
16. "There are pop-ups that seem to reappear even after setting preferences, as if they're ignoring the user's choices."
17. "I've encountered interfaces where you can't proceed without accepting cookies, which feels like a violation of choice."
18. "Some sites use intimidating language about the consequences of not accepting cookies, which seems unfair."
19. "I've experienced cookie interfaces that hide the fact that you can opt-out of data selling, which seems unethical."
20. "Some cookie management tools are so poorly integrated that they seem like an afterthought rather than a functional part of the website."

10.2 Participants responses from Likert scale questionnaire

Likert scale type Questionnaire

1. The interface was visually appealing.
2. Easy and clear to understand
3. It was easy to locate the option to reject cookie.
4. It was easy to customize your cookie settings
5. Interface was user-friendly.
6. You are confident that your preferences were successfully saved
7. It was easy to find detailed info about cookies, their purposes, and implications.

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	3	2	1	1	1	1	1
2	3	3	1	1	1	1	4
3	2	2	1	1	2	1	3
4	3	4	1	1	1	1	4
5	2	2	1	1	2	1	3
6	3	3	1	1	2	1	3
7	3	4	1	1	2	1	3
8	3	3	1	1	1	1	4
9	2	2	1	1	1	1	3
10	3	2	1	1	2	1	3
11	3	2	1	1	1	1	3
12	3	3	1	1	2	1	3
13	3	2	1	1	2	1	3
14	3	3	1	1	1	1	4
15	3	3	1	1	2	1	4
16	3	3	1	1	2	1	4
17	2	2	1	1	1	1	4
18	3	3	1	1	1	1	4
19	2	2	1	1	1	1	3
20	3	2	1	1	1	1	3

Table 17:Questionnaire Responses for Prototype 1

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	5	5	4	5	5	5	5
2	5	5	4	5	5	5	5
3	5	5	4	5	5	5	5
4	4	5	4	5	4	4	5
5	4	5	4	5	5	5	5
6	4	5	3	5	4	4	5
7	4	5	4	5	4	4	5
8	5	5	4	5	4	4	5

9	5	5	3	5	5	5	5
10	5	5	4	5	5	5	5
11	5	5	3	5	5	5	5
12	5	5	3	5	5	5	5
13	5	5	3	5	5	5	5
14	5	5	4	5	5	5	5
15	5	5	4	5	5	5	5
16	5	5	4	5	5	5	5
17	5	5	4	5	5	5	5
18	5	5	4	5	5	5	5
19	5	5	4	5	5	5	5
20	5	5	4	5	5	5	5

Table 18:Questionnaire Responses for prototype 2

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	2	3	5	2	3	2	4
2	2	3	5	2	3	2	4
3	2	3	5	2	4	2	3
4	2	3	5	2	3	2	3
5	2	3	5	2	3	2	4
6	2	3	5	3	3	2	4
7	2	3	5	3	3	2	4
8	2	3	5	3	3	3	4
9	2	3	5	3	3	3	4
10	2	3	5	2	3	3	4
11	2	3	5	2	4	3	4
12	2	3	5	2	4	3	4
13	2	3	5	3	4	3	3
14	3	3	5	3	3	2	4
15	3	3	5	3	3	2	4
16	2	3	5	3	3	2	4
17	3	3	5	2	2	2	3
18	2	3	5	2	3	3	4
19	3	3	5	3	3	3	3
20	2	3	5	2	3	3	4

Table 19: Questionnaire Responses for Prototype 3

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	4	4	1	4	3	1	1
2	4	4	1	4	3	1	1
3	4	4	1	4	3	1	1
4	4	4	1	4	3	1	1
5	3	4	1	4	3	1	1
6	3	4	1	4	3	1	1
7	4	4	1	4	3	1	1
8	4	4	1	4	3	1	1
9	4	4	1	4	3	1	1
10	3	4	1	4	3	1	1
11	4	4	1	3	3	1	1
12	4	4	1	4	3	1	1
13	4	4	1	4	2	1	1

14	3	4	1	3	2	1	1
15	3	4	1	4	2	1	1
16	3	4	1	3	3	1	1
17	3	3	1	4	3	1	1
18	4	4	1	4	3	1	1
19	4	4	1	4	3	1	1
20	3	4	1	3	3	1	1

Table 20:Questionnaire Responses for Prototype 4

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	4	5	1	1	2	1	4
2	4	5	1	1	2	1	4
3	4	5	1	1	2	1	4
4	4	5	1	1	2	1	3
5	4	5	1	1	2	1	4
6	2	4	1	2	2	1	4
7	2	4	1	2	2	1	3
8	4	4	1	1	2	1	4
9	2	4	1	1	2	1	4
10	4	4	1	1	2	1	4
11	4	4	1	1	2	1	4
12	2	3	1	1	2	1	3
13	3	3	1	1	2	1	3
14	3	3	1	1	2	1	3
15	4	3	1	1	2	2	4
16	3	4	1	2	1	1	4
17	4	4	1	2	1	1	4
18	4	4	1	1	2	2	4
19	4	3	1	2	2	2	4
20	4	3	1	1	2	2	3

Table 21:Questionnaire Responses for Prototype 5

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	5	5	4	5	5	4	4
2	5	5	4	5	5	4	4
3	5	5	4	5	5	4	4
4	5	5	4	5	5	4	4
5	5	5	4	5	5	4	4
6	5	5	4	5	5	4	4
7	5	5	4	5	5	4	4
8	5	5	4	5	5	5	3
9	5	5	4	5	5	5	3
10	4	4	4	5	4	4	3
11	5	5	4	5	5	5	3
12	5	5	4	5	4	5	3
13	5	5	5	5	5	5	3
14	4	5	5	5	4	5	4
15	5	5	5	5	4	5	3
16	5	4	4	5	5	4	3
17	5	5	5	5	5	5	3
18	5	5	5	5	5	5	4
19	5	5	5	5	5	5	4
20	5	5	5	5	5	5	4

Table 22:Questionnaire Responses for Prototype 6

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	2	2	1	1	2	2	3
2	2	2	1	1	2	2	2
3	2	2	1	1	2	2	2
4	2	2	1	1	2	2	3
5	1	2	1	1	2	1	2
6	1	2	1	2	2	2	2
7	1	2	1	2	2	2	2
8	2	2	1	2	2	1	2
9	2	2	1	2	2	2	2
10	2	2	1	2	2	2	2
11	1	2	1	2	2	2	2
12	2	1	1	2	2	2	2
13	2	1	1	1	2	1	3
14	2	2	1	1	2	2	2
15	2	2	1	1	2	1	2
16	1	2	1	1	2	1	2
17	2	2	1	1	2	1	2
18	1	2	1	2	1	2	2
19	1	2	1	2	1	2	2
20	2	2	1	1	1	1	1

Table 23:Questionnaire Responses for Prototype 7

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	4	5	2	4	4	4	3
2	4	5	2	4	3	4	3
3	4	5	2	4	3	4	3
4	4	5	2	4	3	4	3
5	4	5	2	4	4	4	3
6	4	5	2	4	4	4	3
7	5	5	3	4	3	3	3
8	4	4	2	4	3	3	3
9	4	4	3	4	3	4	4
10	5	5	2	4	4	4	3
11	4	4	4	4	4	4	4
12	4	4	4	4	3	4	3
13	4	5	3	5	3	4	3
14	4	5	3	4	3	4	4
15	5	5	3	4	3	4	4

16	4	4	2	4	4	4	3
17	4	4	2	4	4	4	3
18	4	4	3	4	4	4	3
19	5	5	2	4	4	4	3
20	4	4	3	4	4	4	3

Table 24:Questionnaire Responses for Prototype 8

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	3	2	1	2	2	2	4
2	3	2	1	2	2	2	4
3	2	2	1	2	2	2	4
4	2	2	1	2	2	2	4
5	2	2	1	2	2	2	4
6	3	3	1	2	2	2	4
7	3	2	2	2	2	2	4
8	4	3	2	2	3	2	4
9	2	2	1	2	2	2	4
10	2	2	1	2	2	2	4
11	2	2	1	2	2	1	4
12	3	2	1	2	3	1	4
13	3	2	1	2	2	1	4
14	3	2	1	2	2	1	4
15	3	2	1	2	1	1	4
16	2	2	1	2	1	1	4
17	2	2	1	2	1	1	4
18	2	2	1	2	1	1	4
19	2	2	1	2	1	1	4
20	4	3	2	2	2	1	4

Table 25:Questionnaire Responses for Prototype 9

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	3	4	5	2	2	1	1
2	3	4	5	2	2	1	1
3	3	4	5	2	2	2	1
4	3	4	5	2	2	2	2
5	3	4	5	2	2	2	2
6	3	4	5	2	2	2	2
7	3	4	5	2	2	2	1
8	4	4	5	3	3	1	1
9	4	4	5	2	3	1	1
10	3	3	5	2	2	1	1
11	4	3	4	2	3	1	1
12	3	4	5	3	2	1	1
13	3	3	4	2	2	2	1
14	3	4	5	2	3	1	1
15	4	3	5	2	3	1	1
16	4	4	5	2	2	1	1
17	4	3	5	2	3	1	1
18	3	3	4	2	3	1	1
19	4	3	5	2	3	1	1
20	4	3	5	2	3	1	1

Table 26:Questionnaire Responses for Prototype 10

11.Appendix D

11.1 Prototypes screenshots

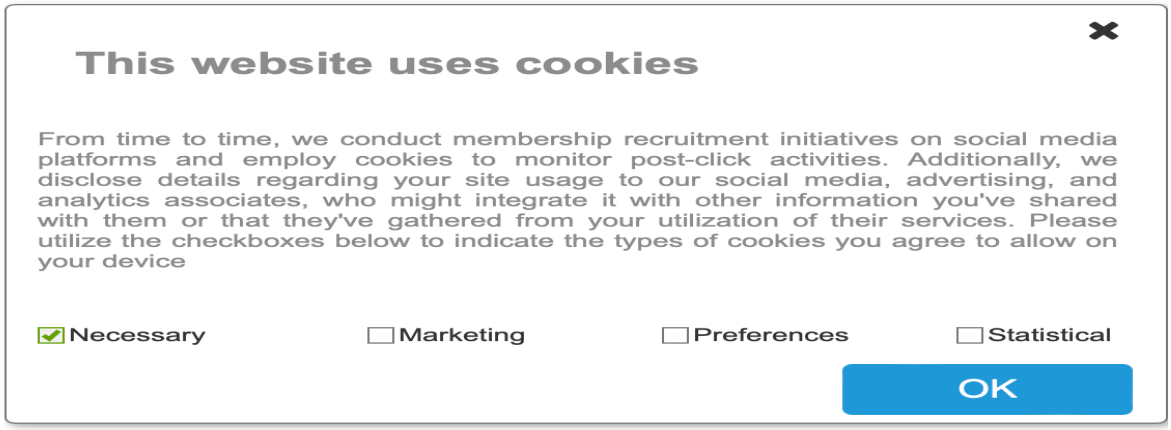

Figure 11:Screenshot of the prototype 4

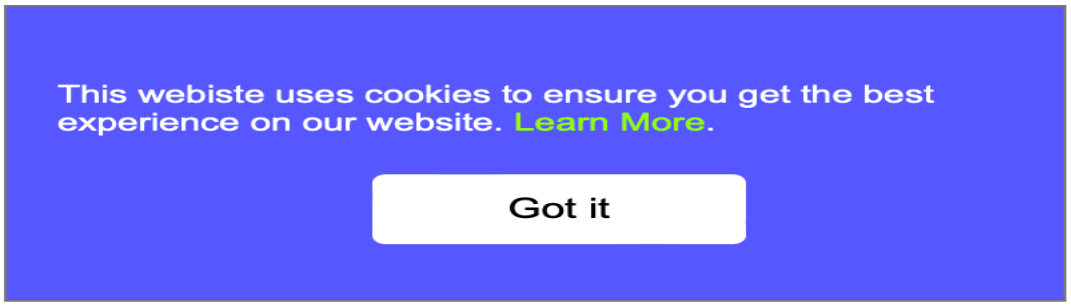

Figure 12:Screenshot of the prototype 5

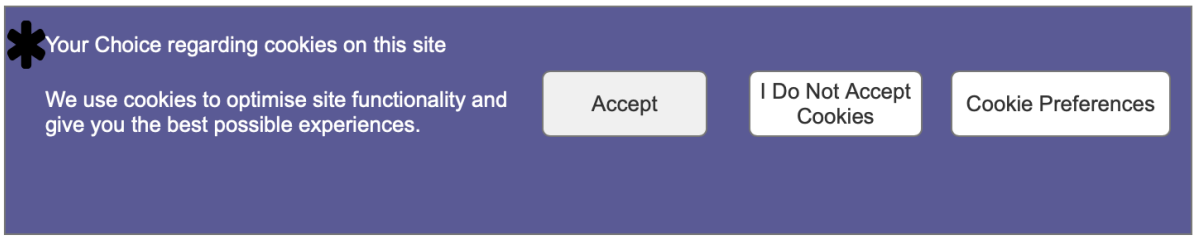

Figure 13:Screenshot of the prototype 6

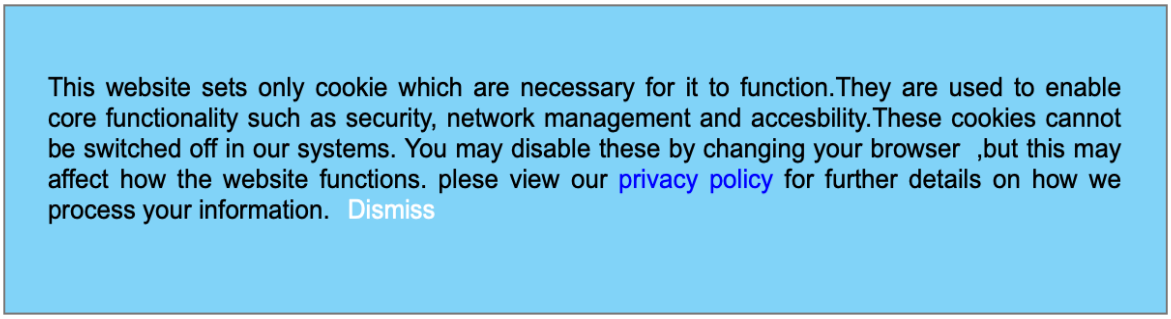

Figure 14:Screenshot of the prototype 7

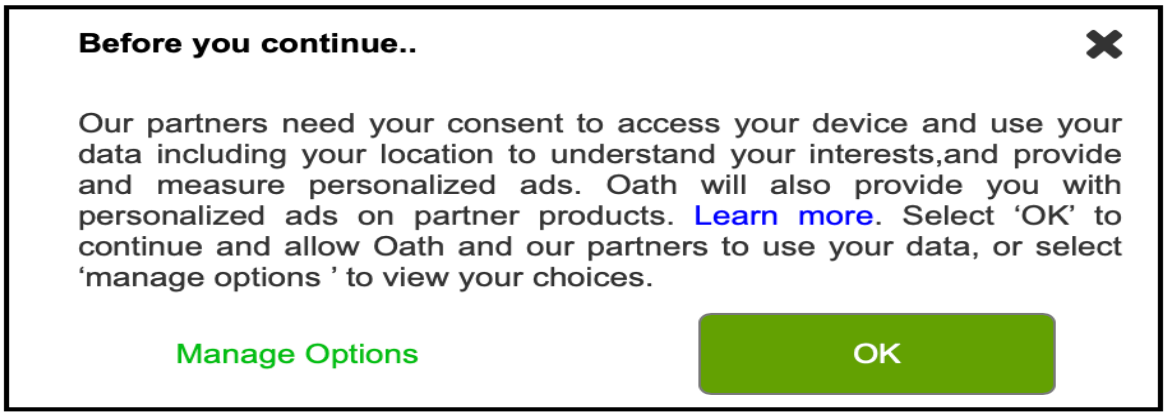

Figure 15:Screenshot of the prototype 8

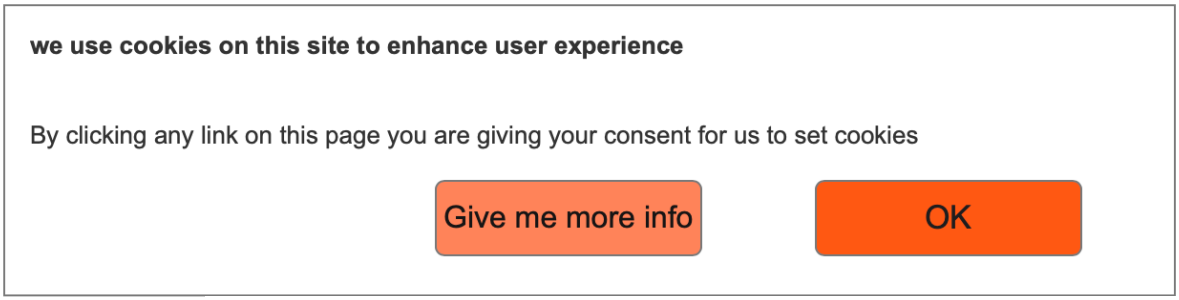

Figure 16:Screenshot of the prototype 9

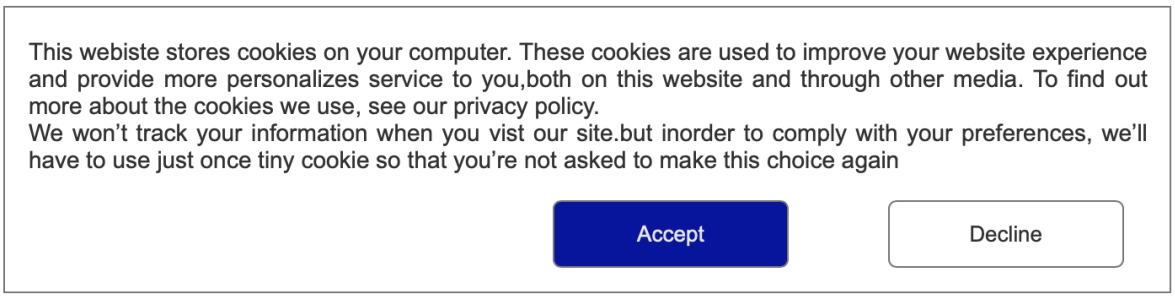

Figure 17:Screenshot of the prototype 10

12. Appendix E

12.1 Draft of Research Paper

An investigation into usability and universal design of website cookie settings interfaces

Abstract:
This study aimed to examine the usability and universal design of cookie consent interfaces to enhance user understanding and control over personal information. Motivated by growing privacy concerns and the need for efficient user interactions, this research has significant implications for international privacy regulations, such as GDPR. The study focused on evaluating current cookie consent interfaces and suggesting improvements based on universal design principles, ensuring usability for all users, including those with challenges. The study revealed major design flaws, including a lack of transparency and ease of use, by combining a qualitative approach with quantitative Likert-questionnaire metrics. This paper suggests specific improvements to make cookie consent interfaces more comprehensible and inclusive, ultimately improving user understanding, control, and satisfaction while ensuring legal compliance.

Keywords: Usability, Universal Design, Cookie Consent Interfaces, User Privacy, GDPR Compliance

1. Introduction

Cookies play a vital role in the way users interact with websites in our highly interconnected technological environment, but they are also a subject of controversy and disagreement. Users' devices save these small data packets, essential for customizing user experiences, managing personal information, and enabling advanced website features, particularly in e-commerce.(Alharbi et al., 2023) Cookies support the smooth functioning of personalized services, such as preserving goods in a shopping cart across different sessions or retaining login information.(Sanchez-Rola et al., 2020) Nevertheless, the same methods created to simplify and improve user engagement also give rise to significant privacy concerns.(Kulyk et al., 2018) The fundamental duality of cookies, serving as both enablers of improved user experience and possible threats to user privacy, positions them as the primary topic of continuous discussions among users, developers, regulators, and researchers(Habib et al., 2022).

The introduction of strict privacy legislation, such as the General Data Protection Regulation (GDPR) in the European Union, highlights the growing significance of effectively handling and protecting personal data.(Sanchez-Rola et al., 2019) These regulations compel websites to seek display and informed consent from users before collecting any personal data, including cookies. (Sanchez-Rola et al., 2019)However, the implementation of these legislative obligations has resulted in the widespread presence of "cookie consent interfaces" that consumers commonly come across. (Kretschmer et al., 2021).These interfaces aim to give users options regarding their data privacy but frequently fail to provide genuine control or understanding.

Despite attempts to regulate them, numerous cookie consent interfaces remain complicated and hard to navigate, presenting significant usability obstacles for users with or without any conditions(Gray et al., 2018). The widespread existence of designs that intentionally confuse, deceive, or manipulate users into providing consent, commonly referred to as "dark patterns," worsens these problems even further. (Gray et al., 2018)These misleading actions not only weaken users' control over their own choices, but also violate the values of equality and transparency that form the basis of privacy rules such as the GDPR.(Habib et al., 2022)

This research focuses on the critical examination of cookie consent interfaces through the lenses of usability and universal design. The aim is to pinpoint the main usability challenges users encounter and investigate how the principles of universal design can improve the usability and simplicity of these interfaces. Universal design principles facilitate the creation of products and environments that are universally usable, minimizing the need for modification or specialized design.(Persson et al., 2015) This study aims to improve the effectiveness of cookie consent interfaces by following these concepts. The goal is to make these interfaces accessible to a wider range of people, including those with any conditions.

The significance of this research lies in its potential to bridge the gap between legal compliance and the actual user experience. The existing differences between the intended functionality of cookie settings interfaces and user engagement highlight the immediate need for improvement. This research tries to offer design adjustments that prioritize user privacy and freedom of choice while still complying with legal criteria. That focuses on usability and universal design.

The primary objectives of this research are threefold:

Identify Usability Challenges: The goal is to systematically investigate and document the usability difficulties that users encounter when engaging with cookie consent interfaces. This involves investigating the possibilities for confusion or deception in these interfaces and identifying common barriers that prevent users from making well-informed choices about their privacy.

Best Practices for Design: The goal is to create a set of guidelines based on the most efficient methods and principles for creating interfaces that secure user consent for cookies. This involves finding elements of design that maximise clarity, increase user engagement, and facilitate understanding of the provided information.

Integrating Universal Design Principles: This study aims to explore the integration of universal design principles into cookie consent interfaces, ensuring their accessibility for all users, including those with disabilities. This objective aims to ensure that these interfaces not only meet legal standards but also provide genuine usability for a wide range of users.

To achieve these objectives, the research heavily employs qualitative research techniques with some quantitative elements to analyse the data from the Likert-scale questionnaire. This methodological framework allows for a comprehensive analysis of cookie consent interfaces, drawing on both empirical data and user feedback.

Prototype Development and Testing: The study involves designing and developing multiple prototypes of cookie consent interfaces. We craft these prototypes to vary in complexity and accessibility features to test a range of interaction patterns.

User Testing: We recruited 20 participants from diverse backgrounds to interact with these prototypes. We designed the user testing to gather data on participant performance, focusing primarily on navigation and understandability, and utilizing the presented cookie settings options.

Task-based observations, semi-structured interviews, and Likert-scale questionnaires combine to collect data. We then analyse this data to identify patterns and themes in user interactions and preferences.

Expected Contributions:

The design of this research aims to make two distinct contributions. The primary objective is to gather empirical information on the efficiency of existing cookie consent interfaces and identify the specific shortcomings that prevent them from satisfying user requirements and regulatory standards. Furthermore, it aims to provide concrete suggestions for creating

cookie consent interfaces that are user-friendly and accessible while maintaining the principles of universal design.

A range of stakeholders, including web developers, UX/UI designers, policymakers, and, ultimately, end-users, will benefit from these contributions. By improving the design of cookie consent interfaces, the study aims to enhance user autonomy, increase compliance with privacy regulations, and promote a more inclusive digital environment.
The paper will be structured as follows: firstly, a comprehensive review of the existing literature will be conducted to provide a contextual framework for the discussion, considering the current understanding and regulatory environment. Secondly, the research methodology will be explained in detail. Thirdly, the research findings will be presented. Finally, the implications of these findings for the development of more efficient and empowering cookie consent interfaces will be discussed.

2. Background and Related work

This section reviews the evolution of cookies, emphasizing their role in technology and the development of cookie consent interfaces. It discusses the dual functions of these interfaces: fulfilling operational requirements and addressing complex issues of user consent and privacy, particularly concerning dark patterns in cookie consent. The section also examines usability and universal design principles aimed at improving transparency and user-friendliness. The literature review details the studies conducted for this research and identifies significant gaps in understanding how user behaviour interacts with interface design. These gaps underlie the fundamental research questions driving this study.

Evolution of cookies and their purpose:

Web cookies, introduced by Netscape programmer Lou Montulli in 1994, were designed to manage state in the stateless HTTP protocol, revolutionizing e-commerce by enabling functionalities like shopping carts (Cahn et al., 2016). Derived from the computer science term "magic cookie," these data snippets allowed servers to store information on a user's computer unobtrusively.
Initially, cookies facilitated session management, user customization, and tracking, especially for advertising purposes(Cahn et al., 2016). However, their proliferation by the late 1990s raised privacy concerns, prompting regulations like the EU's e-privacy Directive (2002) and

the General Data Protection Regulation (GDPR) in 2018, which mandated user consent for identifiable cookies.

Despite technological advances, the core functionality of cookies remains largely unchanged. Today, they are integral to modern web applications, supporting user authentication and personalized content and ads. Cookies are categorized based on duration and domain scope into first-party or third-party cookies, and as session or persistent cookies based on their longevity (Internet cookies, 2021; Rasaii et al., 2023; Trevisan et al., 2019).Understanding these types is crucial for recognizing their role in enhancing the user experience and the privacy challenges they pose.

Cookie consent interfaces

Cookie consent interfaces are tools that inform users about the use of cookies on websites and seek their permission to store personal data(*What Is a Cookie Banner?*, n.d.). These interfaces, mandated by privacy regulations like the European Union's GDPR and privacy Directive, typically appear as pop-ups or banners when a user first visits a website. They detail the types of cookies used and offer options such as accepting all cookies, rejecting all, or customizing settings, thus allowing users control over their personal data.

Effective consent interfaces are clear, informative, and user-friendly, enhancing legal compliance, privacy protection, and user satisfaction. Common consent options include opt-in (accept) and opt-out (reject). Some designs may subtly encourage opting in, making it challenging to find the opt-out option, highlighting the importance of clear information to empower user choice. Websites employ various consent types—opt-out, opt-in, custom, implied, and notice-only—to manage user data preferences.

No option interface: These interfaces offer no options to accept or decline cookies, making it less reliable for user consent.

Confirmation only: such interfaces offer just single option like “ok”, “I agree”, “I accept” etc.

Binary interfaces: These interfaces have two options for example, to accept or to decline the cookies on websites.

Category interfaces: It provides options to select or decline cookies by category, like advertising or analytics.

Dark patterns in Cookie Consent

Many website designs employ manipulative tactics, known as dark patterns, to influence user decisions regarding privacy. Coined by (Berghel, 2013)and further explored by (Alharbi

et al., 2023), these designs trick users into unwittingly consenting to tracking and data sharing. Common dark patterns include misleadingly highlighted buttons, pre-selected options, and consent walls that block content access unless users agree to terms. These deceptive practices not only confuse user autonomy and privacy, but they also frequently violate regulations like GDPR. Studies such as those by (Gray et al., 2018) have categorized various dark patterns and highlighted their impact on user decision-making.

Some of the dark pattern's examples are discussed below:

No Rejection Option: Interfaces lack a straightforward way to decline cookies, influencing user decisions and raising digital privacy concerns.

Obstruction: In this pattern it deliberately complicates tasks; for instance, hiding the opt-out option behind an accept button or adding unnecessary steps (Gray et al., 2018).

Highlighted Buttons: Uses color to draw attention to certain options, encouraging users to select specific actions.

Disclaimer with No Choice: Displays a disclaimer without providing options, misleading users about their cookie choices.

Forced Actions: Designs that coerce users into accepting cookies to proceed with using the website.

Usability concept in cookie interfaces

Usability in consent interfaces refers to how easily users can understand, navigate, and interact with these digital tools. Key factors include clear information, user-friendly design, and overall satisfaction. According to ISO, usability is defined as the effectiveness, efficiency, and satisfaction with which specified users can achieve specified goals in a particular context (Jokela et al., 2003).

Good usability is crucial for consent interfaces as it significantly influences user understanding and decision-making, ensuring compliance with privacy laws like the GDPR (Kretschmer et al., 2021). Poor usability can lead to user frustration, manifested in issues like complex language, hidden options, and intrusive designs that push users towards certain choices (Habib & Cranor, 2022)

Effective design principles, as outlined by (Wang & Huang, 2015), include visibility, ease, efficiency, and enjoyment. These principles help make interfaces intuitive and user-friendly, allowing users to make informed privacy choices with minimal effort and higher satisfaction.

Universal design concept in user interface of cookie settings

Universal design aims to create products and environments that are accessible and usable by everyone, regardless of age, ability, or circumstance. This approach is especially important in designing cookie consent interfaces, ensuring they are understandable and manageable for all users(Persson et al., 2015). Universal design emphasizes inclusivity, offering everyone an equitable opportunity to control their online privacy without needing special modifications or technology. According to (Andersson, 2019; Kurtishi, 2018; Persson et al., 2015) various researchers outline the goal of creating interfaces that everyone can easily access and use, adhering to a set of guidelines that promote usability, flexibility, and simplicity. These principles ensure that no one faces barriers when interacting with digital environments, like cookie consent settings.

Here are the key aspects of universal design applied to cookie consent interfaces(*National Disability Authority*, 2024):

Equitable Use: The interface should provide equal usability for everyone, with accessible options to accept, reject, or customize settings, such as keyboard navigation and screen reader compatibility.

Flexibility in Use: The design should accommodate a wide range of individual preferences and abilities, offering different interaction methods, such as simplified layouts or adjustable text options.

Simple and Intuitive: Interfaces should be easy to understand, regardless of the user's experience, knowledge, or concentration level. We should use plain language to clearly explain options.

Perceptible Information: Important information should be easily perceivable under various conditions, utilizing high contrast colors and providing alternative text for images.

Tolerance for Error: Designs should minimize risks and adverse outcomes from accidental actions, offering ways to verify choices and correct errors easily.

Low Physical Effort: The interface should require minimal effort, reducing the number of steps or clicks needed to express preferences.

Size and Space for Approach and Use: The design should be responsive, ensuring usability on various devices, including desktops, smartphones, and tablets.

Legal and Ethical Considerations

Since May 2018, the General Data Protection Regulation (GDPR) has required that websites in Europe obtain explicit and informed consent from users before collecting personal data. Cookie consent interfaces, which inform users about potential data sharing with third parties and provide options to accept or reject this data collection, have become widespread due to this regulation. Key GDPR requirements include that consent must be clear and easily withdrawn. By default, consent notices should not use pre-checked boxes and should present in clear language to ensure accessibility and understandability (Bermejo Fernandez et al., 2021; Degeling et al., 2019; Matte et al., 2020).

Related work

Recent studies have critically evaluated the usability and design of cookie consent interfaces. Habib et al. (2022) investigated 191 websites using a two-stage methodology, identifying that certain design choices significantly influence users' understanding and control over their privacy settings. Their study found that interfaces that fail to offer inline cookie options lead to forced cookie acceptance, whereas providing a persistent modification option improves interface usability.3

This research explored user preferences for different designs of cookie consent notices using a comparative survey and a browser extension. The study identified that users significantly prefer slider designs for their ease of use and clarity, underscoring the importance of customizable and straightforward consent interfaces for enhancing engagement and compliance.

Addressing the complexities of cookie consent interfaces, this study proposed a comprehensive framework for evaluating usability across seven aspects: user needs, effort, awareness, comprehension, sentiment, decision reversal, and avoidance of nudging. We designed the framework to enhance the effectiveness of consent interfaces in fulfilling a variety of user needs.

Further analysing cookie interfaces across e-government websites in 50 countries, this study highlighted the prevalence of dark patterns and variances in compliance with usability and privacy regulations. It emphasized the need for privacy by design principles to ensure transparency and user control, noting that many sites still fail to offer comprehensive privacy policies.

The study by Sanchez-Rola et al. (2019) critically evaluates how the General Data Protection Regulation (GDPR) impacts user privacy and web tracking, uncovering significant challenges. The analysis found that many websites continue to track users without clear consent and often provide misleading information, complicating user decisions. It also highlighted usability issues with cookie opt-out mechanisms, which are typically complex and not user-friendly, contradicting universal design principles that favour simplicity and intuitiveness. Even non-EU websites adjusted their practices due to the global influence of GDPR, highlighting the need for universally accessible and easily understandable cookie interfaces. The study advocates for substantial improvements in presenting cookie settings and privacy information more transparently and simply.

The study by Xue (2020) analyzed data collection practices on 300 highly ranked Chinese websites to understand user awareness and compliance with the Chinese cybersecurity law. The study, through manual evaluation and experiments involving over 200 participants, revealed that most users lacked knowledge about cookies and struggled to make informed choices due to the websites' unclear information. Furthermore, many of these sites did not fully comply with national cybersecurity regulations.

Degeling et al., 2019: This study analysed 500 European websites, using automatic scans and reviews to evaluate GDPR compliance. It found that many sites lacked transparency, failing to adequately inform users about the use and sharing of their data. Additionally, it identified a need for better mechanisms in cookie consent interfaces, as many did not offer clear options to delete or block cookies.

Fouad et al., 2020: To assess legal compliance with cookie interfaces, this study evaluated over 20,218 third-party cookies. Results showed that 95% of cookies did not clearly declare their purpose, failing to meet consent law requirements. Only 5% of interfaces adequately described cookie purposes, and 30% provided confusing information.

Barth et al. (2023) conducted a systematic review of online privacy practices, examining 15 privacy attributes aligned with 14 Privacy by Design principles through an online survey of 646 participants. The study shed light on the collection, control, and sharing of personal data, revealing discrepancies between expert recommendations and real-world user experiences.

Santos et al., 2020: Analysed GDPR compliance and legal requirements in cookie banner designs. Using both manual and technical evaluations, they identified 17 different requirements essential for valid consent, assessing how well current designs meet these standards.

Sakamoto and Matsunaga (2019): Focused on online behavioural advertising (OBA) and user privacy, the study examined cookie usage on the top 100 news sites. Findings revealed that after GDPR, 50% of these sites stopped tracking users who opted out, although some advertisers retained opt-out cookies for future use, showing minimal changes in privacy practices pre- and post-GDPR.

This literature review emphasizes the critical role of usability in cookie interface design, illustrating how design impacts user interactions and privacy decisions. Clear and straightforward interfaces enhance user compliance and engagement, while many still employ 'dark patterns' that compromise privacy, pointing to a need for clearer regulatory and design guidelines.

A research question (RQ1) that explores usability challenges to enhance long-term user engagement is based on the review's identification of gaps in our understanding of how user behaviour changes in response to cookie interfaces.

Another research question (RQ2), which focuses on identifying best practices for clear and intuitive design, arises from discrepancies in the effectiveness of compliance features in interfaces.

Lastly, the predominance of studies on Western websites highlights a gap in how cultural and regional differences affect usability, leading to a third research question (RQ3) that investigates universal design principles to ensure global applicability.

3. Methodology

This section of our research paper focuses on examining the usability and universal design of cookie notification pop-ups on websites, with the goal of making these interfaces both user-friendly and accessible to everyone, regardless of their abilities. We use empirical data collection and analysis methodology to assess how different users interact with various cookie settings, evaluate their effectiveness, and identify any usability barriers.

Our study involved developing prototype cookie interfaces that incorporated different design elements aimed at improving usability and accessibility. We conducted user testing

with 20 participants from diverse backgrounds, assessing the effectiveness of these interfaces and their compliance with privacy standards.

The research primarily utilized qualitative methods supplemented by some quantitative data from Likert-scale questionnaires. Data collection included semi-structured interviews, task-based observations, and Likert scale questionnaire data, allowing us to gather detailed insights into user interactions with the cookie interfaces. This mixed-methods approach was chosen to thoroughly evaluate user experiences and the practicality of the designs in real-world settings.

Approach for the Study

In this study, we conducted a detailed evaluation of our cookie interface prototype through user engagement sessions, focusing on qualitative data collection. This method involved direct interactions with users to gather insights on enhancing interface usability and user experiences. (Karat et al., 1992) support this evaluative approach as effective for identifying a range of interface issues. Our research was primarily observational, centred on user behaviours and reactions during tasks related to cookie consent and management. We designed these tasks to reveal real user actions in a natural setting, offering structured insights into the functionality, user-friendliness, and effectiveness of the interface. The qualitative approach yielded deep insights into usability, highlighted design challenges, and informed potential improvements.

Research design Process.

This study investigates participant interactions with ten different cookie-setting interface prototypes using questionnaires and task-based evaluations. As discussed in Section 3.3.4, participants initially provided their initial reactions to the interfaces, followed by more detailed task-based insights to assess interface performance, preferences, and experiences. Using a within-group design, 20 participants each interacted with all the prototypes across six diverse tasks. This approach allowed for comprehensive feedback on each interface, capturing detailed responses as participants completed tasks and answered subsequent questions. The upcoming sections will discuss further details on the prototype designs, participant demographics, task environments, and the methods used.

Prototype Design

For this study, I developed ten sets of prototype cookie settings interfaces using a systematic approach to ensure ease of use and adherence to universal design principles. Each prototype

was carefully crafted, incorporating features such as adjustable font sizes and high-contrast color schemes to accommodate users with diverse abilities. The settings were logically categorized (e.g., necessary and other cookies) to facilitate easy management based on user preferences.

The prototypes had the following key features:

- Personalization options for cookie settings.
- Clear information on cookie usage.
- There are some intentionally unfriendly interfaces to gauge user reactions.
- Some prototypes have full user control, allowing users to easily revoke consent.

We created these prototypes using the Axure RP10 tool, renowned for its powerful prototyping capabilities and flexibility. The tool's ability to create interactive, dynamic, and realistic representations, essential for accurate usability testing, drove this choice. Features such as button clicks, page navigation, and option selection were critical in observing how participants interacted with the interfaces.

To interact with the prototypes, please visit https://m40bm2.axshare.com

Participants

For my study, I aimed for a diverse sample of twenty participants (12 males and 8 females) from various sources, including Oslomet University, friends, family, and individuals recruited from public spaces. These participants varied in age, gender, and educational background. Each participant served as their own reference, allowing for individual comparisons of task performance and experience. Each participant underwent a three-stage investigation process, which included an introduction, a series of tasks, and a combination of a short questionnaire and an interview, all within a 15-minute session. This approach helped in gathering detailed insights into the participants' experiences and preferences.

Procedure

The evaluation procedure for each participant was standardized to ensure consistency. Initially, we greeted the participants, provided a detailed introduction to the study's purpose, and educated them on the concept of a cookie interface on websites. All participants were required to read and sign a consent form, detailed in Appendix A, as a prerequisite.

Participants then filled out an introductory questionnaire to collect demographic data and assess their familiarity with cookie interfaces. The evaluation process involved both basic

and more complex tasks related to adjusting cookie settings, and participants noted any challenges they encountered. I recorded these observations for later comparison with my notes.

Additionally, the evaluation included a Likert-scale questionnaire and a semi-structured interview (detailed in Section 3.3.7) to deepen understanding of participants' experiences and perceptions, which were instrumental in identifying usability challenges and informing best design practices.

Here's a tabular representation of the tasks performed by participants to evaluate the cookie setting prototypes, suitable for inclusion in your research paper:

Task No.	Task Description	Purpose
Task 1	Initial Impression: First impressions on interface usability.	To capture intuitive responses to the design.
Task 2	Cookie Rejection: Attempt to reject cookies.	To assess usability challenges with opting out.
Task 3	Customization: Set personal cookie preferences.	To evaluate ease of navigation and setting modifications.
Task 4	Information Access: Access detailed cookie information.	To test transparency and user education on data use.
Task 5	Check Clarity: Identify confusing elements.	To determine if the interface misleads users into consenting.
Task 6	Confirm Saved Preferences: Ensure preferences are saved.	To verify that changes are recognized and preserved by the system, ensuring a reliable experience.

Questionnaire & Interview

For the study, participants filled out questionnaires both before and after engaging with the prototype tasks to collect background information and task-related feedback. Initially, participants answered questions about their experience with cookie interfaces and their demographic details to ensure privacy. Post-task, a Likert scale questionnaire gauged their specific experiences with the interface, focusing on usability challenges, design layout, and elements needing improvement.

Interviews conducted were semi-structured, allowing for flexible, in-depth discussions on user experiences with cookie interfaces. This method provided valuable insights into usability issues, design preferences, and overall satisfaction. Key interview questions explored participants' experiences with managing cookies, difficulties encountered, and specific design elements that either aid or hinder the usability of cookie interfaces.

4. Results and Analysis

This section of the research presents the findings and analysis of the data gathered from user observations, interviews, and Likert scale questionnaires. The initial subsection will encompass the examination of the participant responses utilizing the content analysis methodology. Similarly, the second subsection will consist of the examination of the interview and questionnaire. Lastly, the final subsection presents the findings from the analysis.

Analysis of Participants responses from observations

Content Analysis Methodology

In this study, content analysis was employed as a systematic method to analyse qualitative data from participant interactions with cookie settings interfaces. This method enabled the organized transcription and categorization of raw data, including verbal responses and field notes. Data were segmented according to predefined themes—such as clarity, ease of use, and customization—that aligned with the study's objectives.

Processes and insights

The analysis progressed through several stages:

Organization and Preparation: Data were compiled and transcribed to capture all relevant information.

Categorization and Coding: To facilitate structured analysis and identify emerging patterns, I coded responses by themes.

Pattern and Theme Identification: Analysis across various tasks revealed key insights into user experiences and preferences, highlighting issues like the need for clearer interfaces and more robust customization options.

Comparative and In-Depth Analysis: I compared responses with the researcher(own) observations that gave deeper interpretation of the data yielded actionable insights into design improvements.

Task Results Overview

The research employed tasks to assess various aspects of cookie settings interfaces, highlighting user experiences and design efficacy. Below are the summarized results:

Initial Impressions (Task 1): Users noted clarity and ease of understanding in several prototypes 2, 4, 6, and 8, commending their straightforward design. However, issues with

visual appeal and limited customization were flagged in others, indicating a need for enhanced aesthetic and functional flexibility.

Cookie Rejection (Task 2): Participants often struggled to locate cookie rejection options in prototypes 3, 6, and 10, suggesting a design tendency to obscure these settings. This revealed a significant usability concern, emphasizing the need for more transparent and accessible rejection features.

Customization Options (Task 3): There was a notable variation in the availability and user-friendliness of customization options. While some prototypes (2, 6, and 8) offered easy and intuitive customization, others lacked these features, negatively impacting user satisfaction.

Task 4: Information Accessibility: The analysis revealed varying outcomes in the presentation of information about cookies. Prototypes 2, 3, 5, 7, 8, and 9 successfully provided clear and accessible information, whereas others failed, potentially hindering informed user decisions.

Interface Clarity (Task 5): This task highlighted prototypes 1,2,3,6,8 and 10 that succeeded in delivering clear and unambiguous interfaces, aiding users in making informed choices about their cookie settings. However, some interfaces incorporated confusing elements or manipulative design tactics that could mislead users.

Confirming Saved Preferences (Task 6): We observed variability in the ease of confirming saved preferences. Some interfaces (prototypes 2,6 and 8) clearly supported user decisions with easily navigable options, while others did not, leading to user frustration and a diminished sense of control.

Analysis of Participants responses from semi-structure interview

The analysis of semi-structured interviews was integral to understanding user interactions with cookie interfaces. I manually recorded and meticulously transcribed the data from the interviews to ensure accuracy. I structured the analysis process into five systematic steps:

Data Preparation and Transcription: I noted interviews manually with consent and transcribed detailed notes to create a comprehensive textual dataset.

Data Familiarization: Multiple readings of the transcript allowed for a deep understanding of participant responses, helping identify initial patterns and themes.

Coding: I coded the data based on usability challenges, user preferences, and design elements. This facilitated the organization of data into manageable segments for detailed analysis.

Theme Development: I grouped similar codes to form themes that reflect significant patterns relevant to the study's questions. We then reviewed and refined the themes to ensure they accurately represented the data.

Finalizing Themes: Themes were clearly defined and named, providing structured insights into user experiences and design implications.

Here are the summarized responses to the key questions:

1. **Experience with Managing Cookies:**

Frequent Encounters: Participants frequently encountered cookie pop-ups, often opting for default settings due to convenience, highlighting an acceptance of and desensitization to these interfaces.

Theme Identified: "Interface Intrusiveness and Management Frequency" which reflects the routine and often intrusive nature of cookie interactions affecting the user experience.

2. **Challenges with Cookie Interfaces:**

Complexity and Clarity Issues: Users reported difficulties due to complex settings and unclear terminology.

Theme Identified: "Usability Challenges in Cookie Settings," emphasizing the need for simpler, more transparent designs to reduce user frustration.

3. **Confusing Aspects of Cookie Interfaces:**

Participants noted that technical language and inconsistent layout across sites caused confusion.

Theme Identified: "Confusion Due to Technical Complexity and Inconsistent Design," underscoring the necessity for standardized and user-friendly designs.

4. **Frustrations with Adjusting Cookie Preferences:**

Manipulative Design and Control Issues: Common frustrations included manipulative design elements and a lack of simple rejection options.

Theme Identified: "User Dissatisfaction with Cookie Interface Manipulations," pointing to the negative impact of design practices that obscure user control and choice.

5. **Design Elements Enhancing Cookie Settings Usability**:

Simplicity and Accessibility: We highlighted clear labels and straightforward navigation as essential for usable designs.

Theme Identified: "Effective Design Elements for Enhancing Usability," stressing the importance of design elements that support easy navigation and understanding.

6. **Experiences with Poorly Designed Cookie Interfaces:**

Design flaws impacting usability: People frequently discussed issues like hidden decline options and overly complex settings.

The theme identified is "Challenges Posed by Poor Design Practices," which indicates the critical areas where cookie interfaces fail to effectively meet user needs.

Analysis of Responses from Likert-Scale Questions

Participants assessed their satisfaction and overall experience with each prototype using a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Each participant evaluated ten prototypes, providing a comprehensive dataset.

Analysis Criteria:

Positive Feedback: Mean > 3.6

Moderately Positive Feedback: Mean 2.6 - 3.5

Negative Feedback: Mean < 2.

Statement 1: Interface was visually appealing

Table 1: Descriptive statistics for statement 1 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	2	3	2.75	.44426
2	20	4	5	4.8	.41039
3	20	2	3	2.2	.41039
4	20	3	4	3.6	.50262
5	20	2	4	3.45	.82557
6	20	4	5	4.9	.30779
7	20	1	2	1.65	.48936
8	20	4	5	4.2	.41039
9	20	2	4	2.6	.68055
10	20	3	4	3.4	.50262

Prototypes 2, 4, 6, and 8 demonstrated high visual appeal and Prototypes 3, and 7 received lower scores.

Statement2: Interface was easy and clear to understand.

Table 2: Descriptive statistics for statement 2 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	2	4	2.6	.68055
2	20	5	5	5	0

3	20	3	3	3	0
4	20	3	4	3.95	.22360
5	20	3	5	3.95	.75915
6	20	4	5	4.9	.30779
7	20	1	2	1.9	.30779
8	20	4	5	4.6	.50262
9	20	2	3	2.15	.36634
10	20	3	4	3.6	.50262

Prototypes 2, 4, 5, 6, 8, and 10 were rated highly for clarity and ease of understanding.

Statement 3: It was easy to locate the option to reject cookie.
Table 3: Descriptive statistics for statement 3 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	1	1	0
2	20	3	4	3.75	0.4442
3	20	2	3	4.2	.41039
4	20	1	1	1	0
5	20	1	1	1	0
6	20	4	5	4.35	.48936
7	20	1	1	1	0
8	20	2	4	2.55	.68633
9	20	1	2	1.15	.36634
10	20	4	5	4.85	.36634

Prototypes 2,3,6 and 10 found it relatively easy to locate the reject option.

Statement 4: It was easy to customize your cookie settings.
Table 4: Descriptive statistics for statement 4 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	1	1	0
2	20	4	5	4.85	0.3663
3	20	2	3	2.45	.51041
4	20	3	4	3.8	.41039
5	20	1	2	1.25	.44426
6	20	4	5	4.7	.47016
7	20	1	2	1.45	.51041
8	20	4	5	4.05	.22360
9	20	1	2	1.6	.50262
10	20	2	3	2.1	.30779

Prototypes 2, 4,6, and 8 scores shows that they were relatively easy to use for customizing settings.

Statement 5 interface was user-friendly

Table 5: Descriptive statistics for statement 5 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	2	1.45	.51041
2	20	4	5	4.8	.41039
3	20	3	4	3.15	.48936
4	20	2	3	2.85	.36634
5	20	1	2	1.9	.30779
6	20	3	4	3.15	.36634
7	20	1	2	1.85	.36634
8	20	3	4	3.5	.51298
9	20	1	2	1.85	.58714
10	20	2	3	2.45	.51041

Prototypes 1, 5, 7, 9 and 10 scored below 2.5 which shows these interfaces are unfriendly however, Prototype 2 stands out with a mean score of 4.8 showing a high level of user-friendliness.

Statement 6: You are confident that your preferences were successfully saved
Table 6: Descriptive statistics for statement 6 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	1	1	0
2	20	4	5	4.8	.41039
3	20	2	3	2.45	.51041
4	20	1	1	1	0
5	20	1	2	1.2	.41039
6	20	4	5	4.55	.51041
7	20	1	2	1.65	.48936
8	20	3	4	3.9	.30779
9	20	1	2	1.5	.51298
10	20	1	2	1.3	.47016

Prototypes 1, 3,4, 5, 7, 9, and 10 failed to provide the confidence for successfully saving user preferences.

Statement 7: It was easy to find detailed info about cookies, their purposes and implications.
Table 7: Descriptive statistics for statement 7 for 10 prototypes

Prototypes	N	Minimum	Maximum	Mean	SD
1	20	1	4	3.3	.7326
2	20	4	5	4.6	.5026
3	20	3	4	3.75	.4442
4	20	1	1	1	0
5	20	3	4	3.7	.4701
6	20	1	3	2.4	.5982
7	20	1	3	2.1	.4472
8	20	3	4	3.2	.41039

9	20	2	4	3.35	.6708
10	20	1	2	1.15	.3663

Prototypes 2,3 and 5 were found easy to access detailed information about cookies.

Summary of findings

The analysis from observations, interviews, and questionnaires reveals significant usability and design issues in cookie interfaces, emphasising the need for more intuitive, transparent, and user-friendly interfaces that meet user expectations and privacy standards. Findings highlighted inconsistencies and confusion due to varied designs, difficulties in managing preferences, and frequent, intrusive cookie pop-ups. Users complained about complex and unclear options, hidden rejection features, and poor support for customisation, which limited their control over data privacy. Conversely, prototypes with clear layouts, well-marked options, and effective feedback mechanisms received higher satisfaction and confidence scores. We also noted variability in accessing detailed cookie information, as well as a strong demand for clearer, jargon-free explanations of data usage. Ethical concerns arose from manipulative design practices that seemed to force consent by obscuring alternatives or emphasising acceptance, as observed in qualitative feedback. Implementing the suggested improvements could significantly enhance user satisfaction, trust, and compliance with data protection regulations, thereby improving the overall user experience.

5. Discussion

This study explores the usability and universal design of cookie consent interfaces, highlighting the need for more transparent and user-friendly designs considering evolving digital privacy and interface design standards. While previous research has focused on legal compliance (Habib & Cranor, 2022), this thesis reveals significant user dissatisfaction with current designs, emphasising the need for interfaces that truly meet usability and accessibility criteria. The findings align with Habib et al. (2022) but go further by providing a detailed analysis for redesigning interfaces to adhere to universal design principles, ensuring both legal compliance and genuine user accessibility. This research not only confirms previous studies but also proposes future directions for enhancing digital interface design.

Interpretations of Results:

This study reveals how users perceive and interact with cookie consent interfaces, highlighting significant implications for usability and universal design ethics. By using various

prototypes, we identified key issues and barriers faced by users, aiding in answering our research questions and enhancing our understanding of these interfaces.

RQ1: Usability Challenges in Cookie Consent Interfaces

Participants faced several usability challenges with cookie settings interfaces, highlighting the need for improvement in user control and accessibility.

Key Usability Challenges:

Lack of Opt-Out Options: Difficulty finding reject options, hidden in prototypes 1, 4, 5, 7, and 9, reduces user control and causes frustration.

Limited Customization: Variability in customization options across prototypes, with some lacking flexibility and clarity, is noted in prototypes 1, 5, 7, and 9.

Complexity and Cognitive Overload: Complex interfaces and technical language increased cognitive load and confusion, affecting user navigation and decision-making.

Difficulty Accessing Cookie Information: Poorly presented or complex cookie information in prototypes 4, 6, and 10 hindered informed decision-making.

Navigation Challenges: Issues with finding and confirming preferences, inconsistent labelling, and complex paths in prototypes 1, 4, 5, 7, 9, and 10 led to user frustration.

RQ2: Best Practices and Design Patterns for Cookie Interfaces

To identify best practices and design patterns for clear and intuitive cookie settings interfaces, we analysed participant feedback on interface clarity, customization options, and information accessibility.

Key Best Practices:

Clear Presentation of Options: Participants preferred interfaces with easily distinguishable and visually appealing options.

Prototypes 2, 6, and 8 were favoured for their clear and accessible option presentation, aiding navigation, and decision-making.

Standardized Customization Features: Users appreciated quick, easy, and consistent customization options. Prototypes 2, 6, and 8 offered superior customization features, simplifying the modification of cookie preferences.

Transparent information provision: Clear, detailed explanations of cookies and their implications were valued. Prototypes 2 and 8 excelled in providing accessible information, enhancing user understanding and trust.

Summary: The best practices emphasize clarity, usability, and transparency. Implementing these principles can lead to intuitive, user-friendly interfaces that support informed decision-making based on privacy preferences.

RQ3: Key Principles of Universal Design for Interfaces

This research highlights essential universal design principles for creating clear, accessible, and transparent cookie settings interfaces.

Key Principles:

Equitable Use:

Design interfaces to be usable by users with diverse abilities.

Ensure options are not hidden or overly complex (e.g., prototypes 1, 2, 3, 6, 10).

Flexibility in Use:

Offer customization options to suit various user preferences.

Prototypes 2, 6, and 8 effectively provide customization choices.

Simple and Intuitive Use:

Eliminate unnecessary complexity and align with user expectations.

Prototypes 2, 6, and 8 excel in intuitive navigation and interaction.

Perceptible Information:

Present essential information clearly and in multiple modes (visual, verbal).

Prototypes 2 and 8 are noted for clear information presentation.

Tolerance for Error:

Minimize risks of accidental actions and provide fail-safe features.

Prototypes 4, 5, and 7 need clearer rejection options and error warnings.

Summary:

Incorporating these principles into cookie settings interfaces enhances usability, making them more inclusive and user-friendly.

6. Conclusion

This study evaluated cookie consent interfaces, revealing significant usability issues and manipulative tactics that compromise user freedom and privacy. With a focus on digital security, it is crucial to design interfaces that comply with legal requirements and enhance the user experience. The study found that cookie consent interfaces often had complex designs, causing user confusion and less informed consent. Users manipulated privacy

choices by using dark patterns, which included hiding rejection options and emphasizing consent. Inconsistencies across designs further confused users. However, users appreciated clear information about cookies, which aided in making informed decisions. These findings highlight the need for better design standards to protect privacy and improve the user experience. Emphasising universal design principles is crucial for accessibility and compliance with legal standards.

References

Alharbi, J. A., Albesher, A. S., & Wahsheh, H. A. (2023). An empirical analysis of E-governments' cookie interfaces in 50 countries. *Sustainability*, *15*(2), 1231.

Andersson, S. (2019). *Universal Design Of Smartphone User interface Interaction in Stressful Situations*.

Berghel, H. (2013). Toxic Cookies. *Computer*, *46*(9), 104–107.

Bermejo Fernandez, C., Chatzopoulos, D., Papadopoulos, D., & Hui, P. (2021). This Website Uses Nudging: MTurk Workers' Behaviour on Cookie Consent Notices. *Proceedings of the ACM on Human-Computer Interaction*, *5*(CSCW2), 1–22. https://doi.org/10.1145/3476087

Cahn, A., Alfeld, S., Barford, P., & Muthukrishnan, S. (2016). An Empirical Study of Web Cookies. *Proceedings of the 25th International Conference on World Wide Web*, 891–901. https://doi.org/10.1145/2872427.2882991

Degeling, M., Utz, C., Lentzsch, C., Hosseini, H., Schaub, F., & Holz, T. (2019). We Value Your Privacy ... Now Take Some Cookies: Measuring the GDPR's Impact on Web Privacy. *Proceedings 2019 Network and Distributed System Security Symposium*. https://doi.org/10.14722/ndss.2019.23378

Gray, C. M., Kou, Y., Battles, B., Hoggatt, J., & Toombs, A. L. (2018). The Dark (Patterns) Side of UX Design. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 1–14. https://doi.org/10.1145/3173574.3174108

Habib, H., & Cranor, L. F. (2022). Evaluating the usability of privacy choice mechanisms. *Eighteenth Symposium on Usable Privacy and Security (SOUPS 2022)*, 273–289. https://www.usenix.org/conference/soups2022/presentation/habib

Habib, H., Li, M., Young, E., & Cranor, L. (2022). "Okay, whatever": An Evaluation of Cookie Consent Interfaces. *CHI Conference on Human Factors in Computing Systems*, 1–27. https://doi.org/10.1145/3491102.3501985

Internet cookies. (2021, November 26). *All About Internet Cookies*. CookieYes. https://www.cookieyes.com/blog/internet-cookies/

Jokela, T., Iivari, N., Matero, J., & Karukka, M. (2003). The standard of user-centered design and the standard definition of usability: Analyzing ISO 13407 against ISO 9241-11. *Proceedings of the Latin American Conference on Human-Computer Interaction*, 53–60. https://doi.org/10.1145/944519.944525

Karat, C.-M., Campbell, R., & Fiegel, T. (1992). Comparison of empirical testing and walkthrough methods in user interface evaluation. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 397–404. https://doi.org/10.1145/142750.142873

Kretschmer, M., Pennekamp, J., & Wehrle, K. (2021). Cookie Banners and Privacy Policies: Measuring the Impact of the GDPR on the Web. *ACM Transactions on the Web*, *15*(4), 1–42. https://doi.org/10.1145/3466722

Kulyk, O., Mayer, P., Volkamer, M., & Käfer, O. (2018). A concept and evaluation of usable and fine-grained privacy-friendly cookie settings interface. *2018 17th IEEE International Conference On Trust, Security And Privacy In Computing And Communications/12th IEEE International Conference On Big Data Science And Engineering (TrustCom/BigDataSE)*, 1058–1063. https://ieeexplore.ieee.org/abstract/document/8456017/?casa_token=8BZZAqutJOYAAAAA:D9cZmZ3wrFa3c8bSHqYR6s_6pu_dzuH-AxhhyI0WjH8_LUEqerfYvmD49Z6Kexfk46WNHLtU3nZi

Kurtishi, R. (2018). *Universal design of intelligent personal assistants*.

Matte, C., Bielova, N., & Santos, C. (2020). Do cookie banners respect my choice?: Measuring legal compliance of banners from iab europe's transparency and consent framework. *2020 IEEE Symposium on Security and Privacy (SP)*, 791–809. https://ieeexplore.ieee.org/abstract/document/9152617/

National Disability Authority. (2024). Centre for Excellence in Universal Design. https://universaldesign.ie/about-universal-design/the-7-principles

Persson, H., Åhman, H., Yngling, A. A., & Gulliksen, J. (2015). Universal design, inclusive design, accessible design, design for all: Different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects. *Universal Access in the Information Society*, *14*(4), 505–526. https://doi.org/10.1007/s10209-014-0358-z

Rasaii, A., Singh, S., Gosain, D., & Gasser, O. (2023). Exploring the Cookieverse: A Multi-Perspective Analysis of Web Cookies. In A. Brunstrom, M. Flores, & M. Fiore (Eds.), *Passive and Active Measurement* (Vol. 13882, pp. 623–651). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-28486-1_26

Sanchez-Rola, I., Balzarotti, D., & Santos, I. (2020). Cookies from the Past: Timing Server-side Request Processing Code for History Sniffing. *Digital Threats: Research and Practice*, *1*(4), 1–24. https://doi.org/10.1145/3419473

Sanchez-Rola, I., Dell'Amico, M., Kotzias, P., Balzarotti, D., Bilge, L., Vervier, P.-A., & Santos, I. (2019). Can I Opt Out Yet?: GDPR and the Global Illusion of Cookie Control. *Proceedings of the 2019 ACM Asia Conference on Computer and Communications Security*, 340–351. https://doi.org/10.1145/3321705.3329806

Trevisan, M., Traverso, S., Metwalley, H., & Mellia, M. (2019). Uncovering the Flop of the EU Cookie Law. *Proceedings on Privacy Enhancing Technologies*, *2019*(2), 126–145. https://doi.org/10.2478/popets-2019-0023

Wang, C.-M., & Huang, C.-H. (2015). A study of usability principles and interface design for mobile e-books. *Ergonomics*, *58*(8), 1253–1265. https://doi.org/10.1080/00140139.2015.1013577

What is a cookie banner? (n.d.). Cookie Information. Retrieved April 23, 2024, from https://cookieinformation.com/cookie-banner/