

Left Alone Facing a Difficult Choice: An Expert Analysis of Websites Promoting Selected Privacy-Enhancing Technologies

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Abstract. The privacy community has invested considerable effort in understanding why motivated individuals do not adopt available solutions. As a result, several factors supporting individuals in adopting *Privacy Enhancing Technologies* (PETs) have been revealed. However, the adoption rate remains low. To contribute in changing this current state, we adopt an unexplored approach by analysing 69 online websites promoting four selected PETs: *Virtual Private Network* (VPN), Tor, private browser, and private search engine. In addition to considering the accessibility of these websites, we consider a set of 24 selected criteria grounded in the factors identified in the literature as supporting individuals in adopting PETs. These criteria aim to explore the presentation of PETs to individuals. For example, we consider the presentation of aspects of PET technology, such as coverage, limitations, and speed. Our results show that, on average, only about one-third of our criteria set are fulfilled by the analysed websites. Furthermore, our accessibility audit reveals issues that could create significant obstacles for impaired users. As a result, these websites miss their primary goal of effectively informing individuals about PETs by not utilising the identified supporting factors. These results indicate that individuals are left alone in making privacy choices and do not have sufficient support for adopting PETs. To address this situation, we propose two design templates incorporating supporting factors, offering a foundation for presenting PETs to individuals to assist them in adoption.

Keywords: Usable Privacy · Presentation of PETs · Accessibility Audit

1 Introduction

Numerous PETs are available to the public. For example, over 150 VPNs can be downloaded from the Apple App Store, and more than 30 private browsers

with various functionalities have been presented to individuals in the Android Google Play. However, the adoption rate of PETs remains notably low, despite individuals expressing privacy concerns [4, 23, 24, 30, 38, 50]. For example, the most popular VPNs in the App Store show 50 million downloads. As compared to the number of 3.3 billion Android users [13], this represents about 1.5%. Moreover, for instance, only 6% of the 257 participants of the study conducted in [4] had installed privacy-preserving applications on their mobile devices despite more than 80% expressed privacy concerns. The privacy community (i.e., researchers and privacy organisations) has invested considerable effort in understanding why motivated individuals do not adopt available solutions. A prominent outcome of these efforts shows the poor usability of PETs and the manner in which PETs are presented to individuals [1, 3, 4, 12, 44]. This indicates that the role of humans has not received adequate attention in the process of developing and presenting PETs. While the poor usability covers various aspects, a more multi-faceted approach is suggested in [1, 6, 7, 12, 41] to understand the influential factors contributing to PETs adoption. In this regard, fundamental factors, such as incomplete threat models and limited understanding of the technology, are presented in [29, 41, 51]. More factors such as individuals' personality traits and privacy concerns and knowledge are highlighted in [5–9, 18–20, 25, 28, 32]. Several works presented more fine grain influential factors. For instance, [28] shows that when people perceive an effective response to their actions, it strongly affects their intention to use PETs. This means that when the effectiveness of adopting a PET in addressing privacy concerns is clearly demonstrated, the likelihood of PET adoption significantly increases. Despite knowing these influential factors, the rate of PET adoption remains low. To gain deeper insights, in this paper, we focus on exploring online resources, such as websites, as they, in combination with blogs, are the primary sources where users inform themselves about improving their online privacy [32]. We aim to assess how the identified factors supporting adoption are communicated to visitors of websites promoting PETs. To this end, we have selected four PETs: *Virtual Private Network* (VPN), *Tor*, *Private Browser* (PB), and *Private Search Engine* (PSE). Our choice is motivated by [10], which highlights that stand-alone solutions are the least utilised compared to non-technology-based and built-in alternatives, emphasising the need for action. We next form our research question as follows: **RQ:** *What are the strengths and weaknesses of websites promoting PETs in supporting individuals in their decision?* Answering this question can shed light on how well (or not) PETs are being presented to individuals. Ultimately, our results can serve as the basis for future investigations of potential correlation with the current low adoption rate. This provides a foundation for better-supporting individuals in privacy preservation, which is the core objective of this paper.

In the following, we summarise the contributions of this paper.

- We, two domain researchers, have analysed 69 websites promoting four targeted PETs using an expert-oriented method. We have categorised these websites into two main categories: (1) *single-product*, which exclusively promotes one product, such as a single VPN application and (2) *comparing-*

product, which compares various products, such as seven VPN applications. To analyse these websites, we have compiled a list of 24 criteria primarily based on factors identified by academic research as supporting individuals in adopting PETs. We have classified these criteria into seven categories, including (1) *technology*, which refers to presenting technological aspects to individuals, covering criteria like coverage and limitation, and (2) *information*, which focuses on how information is presented, including criteria such as layout and variety. Furthermore, we have conducted an accessibility audit on the websites mentioned above, guided by the principles outlined in the Web Content Accessibility Guidelines (WCAG) 2 [52].

- Our analysis shows the average coverage across all criteria in *single-product* and *comparing-product* websites is approximately one-third. Additionally, our accessibility audit reveals a consistent pattern of neglecting accessibility guidelines, including easily fixable cases. This reflects that individuals are receiving, at best, one-third of what the privacy community has shown to be supportive in adopting PETs, highlighting a gap between academic knowledge and practical implementation. These results display that individuals are left alone without adequate support to make privacy decisions.
- Based on these results, we have developed two design templates, including factors identified in the literature. These templates intend to present PETs better to support individuals in making a decision to adopt PETs. We further contextualise our research findings within the existing academic resources.

This paper is organised as follows: Sec. 2. Explains the related work focusing on supporting individuals in adopting privacy solutions. Sec. 3. describes our methodology, the selection of websites and criteria, and the analysis process. A detailed explanation of our results is provided in Sec. 4. We propose design templates in Sec. 5. We further discuss our results in Sec. 6. Finally, we conclude our study in Sec. 7.

2 Related Work

In this section, we look into the relatively limited literature focusing on supporting people in adopting security and privacy solutions. These studies, along with our own work, ultimately aim to address the identified gap: low adoption rates of PETs despite users' express of privacy concerns [4, 23, 24, 30, 38, 50]. In the following, we present these works chronologically.

The first influential study related to our work is ENISA's report from 2015 [26]. ENISA conducted a study to analyse existing websites promoting the use of online privacy tools for the general public based on ten criteria. These criteria include tool selection methodology and frequency of content updates. While ENISA's goal for analysis is on the method used for selecting the proposed privacy tools and the overall quality of offered information, our goal differs. We aim to analyse our website samples in regard to factors supporting individuals in adopting PETs. Therefore, our set of 24 criteria focused on factors such as technology explanation, text readability, and accessibility. While ENISA focused

on 12 websites presenting multiple products, we examined 69 websites presenting a single PET or comparing multiple PETs. To the best of our knowledge, our analysis is the first to address the following aspects: (1) providing an overview of websites promoting PETs concerning their support for people in the adoption process and (2) evaluating the extent to which recommendations from academic research and domain experts are delivered to users via websites.

Similar to ours, the study [40] published in 2020 examines the support provided to individuals in adopting privacy and security solutions. The authors initially identified 374 distinct recommended behaviours about online security and privacy. Subsequently, they assessed the quality of these recommendations based on criteria such as comprehensibility and perceived actionability via a user study involving 1,586 participants and 41 professional security experts. While their focus was on analysing individual pieces of advice, our study takes a broader approach, examining the entirety of online websites. This includes various aspects of websites, such as presentation variety, provider information and comparison support. To our understanding, our study is the first to comprehensively analyse the presentation of PETs, encompassing the entirety of websites.

Introduced in 2022, the *Security and Privacy Acceptance Framework* (SPAF) [11] is the most recent related study. SPAF aims to encourage user adoption of security and privacy behaviours and also evaluate the presentation of privacy solutions to people. SPAF proposes a framework comprising three non-independent factors: *Motivation, ability, and awareness*. According to SPAF, these three factors must be present simultaneously for an individual to initiate a behaviour in this context, like adopting a PET. SPAF built this framework based on the fundamental behaviour model called Fogg Behavior Model [16]. Then, SPAF analyses prior academic works providing privacy and security solutions to users through the lens of these three factors. Their evaluation of 100 works revealed that almost all failed to cover these three factors simultaneously. The distinction between our work and SPAF lies in resources and criteria. While SPAF primarily examines academic works, our study focuses on the presentation of PET via websites that are available to the public. Although our criteria conceptually overlap with SPAF's, we have conducted our analysis by using fine-grainer criteria. To the best of our knowledge, our study is the first to analyse the delivery of fine-grained factors for supporting individuals in adopting PETs when they inform themselves online.

3 Methodology

To answer our research question (**RQ:** *What are the strengths and weaknesses of websites promoting PETs in supporting individuals in their decision?*), we first analyse "what" individuals are dealing with when they want to inform themselves about adopting PETs online. "What" means the content and form of websites promoting PETs. By identifying the strengths and weaknesses of the current presentation of PETs, our secondary goal is to propose design templates containing collective strengths and covering the current weaknesses (see Sec.5).

To this end, we follow an expert-oriented approach similar to the one applied by ENISA [26]. Our decision is also motivated by fundamental human-computer interaction resources [34, 45], which recommend an expert-oriented approach as highly valuable in the early stages when design concepts require validation prior to user involvement. As the basis for our analysis, we have first defined the context of the study (Sec. 3.1). Next, we have selected 69 websites (Sec. 3.2) and have developed a set of 24 criteria (Sec. 3.3). We finally detail our analysis process (Sec. 3.4).

3.1 Study Context

We have first made the following decisions that define the context considered in our study due to its importance in the field of privacy [35]. (1) Since the platform defines context [36], we have scoped for computer desktop platform. While mobile devices are comparably used for web browsing [17], we prioritise the desktop due to the larger screen size, allowing for a stable analysing environment. (2) Among the available privacy solutions, we concentrate on stand-alone solutions as shown in [10] to be the least used compared to non-technology-based and built-in solutions, thus calling for action. Consequently, we scoped out four PETs, named: (a) **VPN** as in [10, 27, 39, 46, 48], (b) the **Tor** considered in [10, 19, 20, 39, 48], (c) **PB** (e.g., DuckDuckGo as in [39], Ghostery in [10], Brave in [39]), and (d) **PSE** (e.g., Startpage mentioned in [39]).

3.2 Websites Selection

We focus on online searching for the names of four targeted PETs to identify the websites of our study. As shown recently in [32], searching for information online is a common method for individuals motivated to improve privacy. To minimise biases from search history, we utilise Tor [49] and DuckDuckGo [14] as the search browser and search engine, respectively. We gathered 120 websites by scanning the first three pages of search results for the names of each of the four PETs (*Virtual Private Network*, *Tor*, *Private Browser*, and *Private Search Engine*) as search terms. Typically, users do not go until the end of the third page of search results [42], as we did. However, websites that may appear on the third page might appear earlier in search results for queries with alternative terms. Therefore, we decided to include websites up to the end of the third page to ensure we would not miss potentially relevant websites. We excluded websites that were not in English, repetitive, or unrelated. After this filtering, 69 websites were left (see Appendix). We categorised these 69 websites into two main groups based on their content and purpose. The first group, called *single-product*, comprises websites exclusively promoting a single PET, e.g., Surfshark VPN. The second group, which we refer to as *comparing-product*, includes websites that compare multiple PETs of a similar type, for example, comparing ten VPN products.

Table 1. 24 criteria considered in our analysis. Criteria marked with \star are exclusive to *single-product*, while others marked with $\star\star$ apply solely to *comparing-product* websites.

Category	Criterion	Description
Technology The technology aspects of the PET	Explanation	Explanation of the functionality of a PET. Understanding the PET functionality enhances users' perception of its usefulness [6, 8, 39, 41].
	Coverage	Communicating the effects of adopting a PET and how it meets users' needs [15, 28].
	Limitations	Communicating the PETs limitation i.e., the threats not addressed [21, 29, 41, 51, 51].
	Easiness	Showing the easiness of PET adoption and usage, increasing the likelihood of adoption [6].
	Speed\star	Presenting evidence of the low impact of the PET on speed [46].
Trust The role of trust in various aspects in the adoption of PET	Provider	Providing information about the PET provider (e.g., the producer company) or the analyser of comparison [19].
	Product	Showing evidence of PET trustworthiness [7].
	User feedback	Delivering other people's opinions about PET. [46] demonstrates that user reviews and ratings influence how people choose a VPN to install.
	Interpersonal	Utilising interpersonal diffusion channels, such as peer recommendations, group and family plans [7, 11, 12, 43].
Information The information and its presentation to individuals	Layout\star	Presenting information in the page layout: appropriately titled, categorised, and easily understandable.
	Presentation variety	Offering information in various formats (e.g., videos, diagrams) to enhance engagement and accommodate different browsing habits.
	Gap coverage	Covering knowledge gaps rooted in jargon and industry-specific language, e.g., text links and teaching in time by information icons.
	Language formality	Avoiding informal and complicated language [47].
Usability The user interaction usability [1, 4, 12]	Visual design	Offering professional-looking, minimal design, and visual aesthetic interface [33].
	Demo	Showing PET environment, e.g., via screenshots or screen recording.
	Interaction	Considering individuals' needs and concerns, avoid statistic presentation of information [33].
Comparison$\star\star$ The styles and elements of comparing PETs	Review per product$\star\star$	Providing a detailed review for each PET.
	Key benchmarks$\star\star$	Educating individuals on the parameters to consider in choosing PET.
	Snapshot$\star\star$	Offering a comparison of various PET products at a glance, e.g., via a table to improve comprehension, easier assessment of the pros and cons.
	Rating per product$\star\star$	Accompanying each PET by the reviewer rating.
Readability The readability of the text	Reading ease	Estimating the ease of understanding the text by Flesch-Kincaid tests [22].
	Grade level	Estimating the required educational level to comprehend the text by Flesch-Kincaid tests [22].
Price The price range [46]	Start\star	Providing easy start via free version or trial period.
	Availability$\star\star$	Displacing the price range for each discussed PET.

3.3 Criteria Selection

To establish our criteria, we first analysed existing academic resources in the domain. The objective was to identify factors that have been recognised as influential in supporting individuals in adopting security and privacy solutions, such as providing easy-to-understand technology explanation [6, 8, 39, 41] referred to as the explanation criterion in what follows. Then, we have considered usability factors [31, 37, 51] like the interaction criterion in what follows. Last, we have also

incorporated criteria based on our own experiences, such as the demo criterion, which looks into the availability of the demonstration of the PET environment. In total, we have collected a set of 24 criteria grouped into seven categories detailed in Tab.1. Among these, speed, layout, and start criteria apply to *single-product* only, and review per product, key benchmarks, snapshot, rating per product, and availability criteria apply to *comparing-product* only. This discrepancy stems from the difference in the characteristics of websites. For example, the criteria review and rating per product only apply to *comparing-product* websites.

3.4 Analysis Process

After compiling our website list and defining the criteria set, we conducted a pre-analysis. This pre-analysis focused on evaluating the criteria on a small sample of websites to ensure the analysis was applicable and measurable. After several iterations, we finalised our analysis material. Subsequently, two of the authors, as independent domain researchers, evaluated the selected websites and rated them against the criteria. Next, we implemented a structured discussion process that involved comparing ratings to identify specific areas of disagreement. We then conducted collaborative reviews of the websites, focusing on the criteria where differences arose. Through these reviews, we discussed the evidence and reasoning for the ratings until an agreement on the rating was reached. This process finished at the end of March 2024.

Rating Measuring Scale. We have introduced a measuring scale for each criterion to ensure the accuracy of our analysis. Our primary aim was not to assign fine-grain points to each criterion but to ensure that the criterion was met fully, partially, or not at all. Therefore, we maintained a three-level measuring scale: full (assigned score: 1), half (assigned score: 0.5), and none (assigned score: 0). In the following Tab.2 and Tab.4, we have aggregated the rating results obtained for each of the four PET types, thus averaging and rounding them. To increase the readability of the tables, we omitted the repeated presentation of the number 0 before the decimal, meaning that, e.g., .5 is equivalent to 0.5.

Automatic Evaluation. In addition to the above-mentioned manual analysis conducted by two of the authors, we have used automatic tools to analyse the *readability* and *accessibility*. For *readability*, we have used Webfx [55], which supplied us with scores for reading ease and grade level criteria based on Flesch-Kincaid tests [22]. The reading ease criterion ranges from 0 to 100, with higher scores indicating easier readability. In contrast, the grade level criterion ranges from 0 to 12 with lower scores indicating easier readability as they correspond to lower school grades. For the *accessibility* audit, we have applied Accessi [2], which provided us with the violations of Web Content Accessibility Guidelines (WCAG) 2 [52] by our website samples.

4 Results

We present the results of analysing 69 websites against a set of 24 criteria and the result of the accessibility audit in three subsections. The analysis of the *single-product* websites is presented in Sec. 4.1, while the analysis of the *comparing-product* websites is detailed in Sec. 4.2. We then focus on our accessibility audit result in Sec. 4.3, before summarising our results in Sec. 4.4.

Table 2. Mean score of 45 *single-product* websites. The higher the score (the darker the blue), the better the criterion fulfilled. \bar{x} : weighted mean, - : not applicable.

Number of websites PETs		Categories															\bar{x}	
		Technology					Trust				Information			Usability				
		Explanation	Coverage	Limitation	Easiness	Speed	Provider	Product	User feedback	Interpersonal	Layout	Presentation variety	Gap coverage	Language formality	Visual design	Demo		Interaction
20	VPN	.4	.2	.1	.3	.6	.5	.5	.9	.3	.6	.3	.4	.5	.8	.6	.0	.4
11	Tor	.5	.2	.2	.2	.3	.5	.3	.2	.0	.4	.3	.2	.5	.5	.5	.0	.3
4	PB	.0	.6	.0	.4	.4	.8	.6	.6	.0	.8	.6	.1	.4	.8	.5	.0	.4
10	PSE	.2	.4	.0	-	.1	.3	.4	.2	.0	.5	.4	.1	-	.5	-	.0	.4
\bar{x}		.4	.3	.1	.3	.4	.5	.4	.5	.1	.5	.3	.3	.5	.7	.6	.0	$\approx \frac{1}{3}$

4.1 Single-product Websites

Based on the search strategy outlined in Sec. 3.2, we have identified 45 websites exclusively presenting a single PET. They comprise 20 websites presenting a VPN, eleven Tor, four PB, and ten PSE. The variation in the number of identified websites per PET mainly stems from differences in product availability. Next, we analysed these websites based on the 19 criteria that apply to this category of websites (see Tab.1). Note that three out of the 19 criteria did not apply to PSE websites due to their specific characteristics. For instance, we could not assess the language formality criterion for PSE, as these websites commonly offered minimal text, making it impossible to evaluate this aspect. Tab.2 shows the average scores for each criterion for *single-product* websites except for the *readability* and *price* category, shown in Tab.3. In the following, we elaborate on the notable findings.

Criteria-based Insights. We first consider various aspects of PET *technology* being presented to individuals. On average, 4 out of 10 websites explained the technology behind the PET they presented and clarified its effect on the connection speed. This number is slightly lower when objectively communicating what a PET can cover for one’s privacy upon adoption. On the other hand,

showing what a PET can not cover is down to 0.1. This means that our sample of websites does not transparently familiarise individuals with the functionality and limitations of PETs. Such a situation can develop unrealistic expectations about the effectiveness of a PET. In some cases, even misleading information about the coverage of a PET is presented, such as "*The One-Click Solution for All Your Privacy Needs*". This misleading information further complicates the adoption process as it creates the unrealistic belief that only one tool, like a VPN, can bring full privacy protection to the adopter. This result sheds light on the findings of [4], highlighting a clear gap between users' perceived privacy risks and the defences they employ. In addition, only one-third of our sample addressed the ease of adopting or using a PET. Failing to communicate the time or technical skill required creates uncertainty and can reduce users' perceived ability.

Looking into the *trust* category, half of our sample does not present any information about the PET provider, such as the producer company. In addition, less than half of them present some information about the trustworthiness of the PET. Some websites provide quotes like "*No log policy*", which may not be convincing for users concerned about PET itself privacy threats. In other examples, we have found statements like "*VerSprite has also tested the security of our IOS app and proved it to be completely safe.*" However, the question arises: how qualified is VerSprite to make such a statement? The potential of interpersonal connections to increase the adoption rate, such as peer promotions and friends and family plans, is also neglected. Therefore, the potential of trusting through human-to-human connections is not supported.

Within the *information* category, one of the most neglected criteria is the presentation variety. This indicates that diverse formats, such as video, demo, voice, and diagram, are not widely utilised. Instead, a significant portion of the websites heavily rely on text to present information, making it less engaging and more challenging for individuals to learn about and ultimately adopt PETs. In some poorly designed cases, large blocks of text lacking detailed sectioning were presented. However, bullet points, bold font, underlining and highlighting were leveraged in better cases. Another criterion with the same low score is gap coverage. This score indicates that our sample does not effectively explain the meaning of jargon and technical terminologies. These technical terminologies can be, e.g., "*IP address*". Without an adequate explanation, users may encounter confusion and uncertainty, resulting in abandoning the adoption process.

In the *usability* category, the visual design criterion received the highest average, while the interaction criterion received the lowest. For the former, this means that the design of the interfaces was evaluated as minimal and professional-looking in most cases. For the latter, we did not find evidence of interaction or personalisation in presenting information to individuals. This indicates that the websites are not engaging in dialogue with users and mainly offer information in monologue. A practical interaction could start with gathering users' needs to deliver tailored information.

Tab.3 shows a reading easy score of 62, which indicates moderately easy readability. PB falls behind the other three PET types as it uses more complex

explanations and terminologies. The grade level score was 6, suggesting that the content was accessible to individuals with a sixth-grade reading level. For all PETs of this study, either a free version or a free trial was available.

Comparison between Considered PETs.

The average coverage scores per PET in Tab.2 are similar among all four PETs, Tor being slightly lower. Indicating that only about one-third of the identified criteria supporting the adoption of PETs are effectively conveyed to individuals by each of the PET types.

Table 3. Mean score of readability and price of 45 *single-product* websites

Number of websites	PETs	Readability		Price
		Reading ease	Grade level	Starting
20	VPN	65	6	free
11	Tor	63	6	free
4	PB	49	4	free
10	PSE	61	5	free
\bar{x}		62	6	free

Table 4. Mean score of 24 *comparing-product* websites. The higher the score (the darker the blue), the better the criterion fulfilled. \bar{x} : weighted mean.

Number of websites	PETs	Categories															\bar{x}			
		Technology				Trust				Information			Usability			Comparison				
		Explanation	Coverage	Limitation	Easiness	Provider	Product	User feedback	Interpersonal	Presentation variety	Gap coverage	Language formality	Visual design	Demo	Interaction	Review per product	Key benchmarks	Snapshot	Rating per product	
6	VPN	.7	.5	.6	.1	.8	.3	.0	.0	.8	.3	.2	.7	.4	.0	.8	.9	.6	.7	.5
8	PB	.0	.1	.3	.1	.9	.1	.0	.0	.3	.4	.5	.5	.6	.0	.6	.3	.2	.1	.3
10	PSE	.1	.2	.2	.1	.8	.4	.0	.1	.3	.4	.5	.7	.5	.0	.7	.5	.4	.1	.3
\bar{x}		.2	.2	.3	.1	.8	.3	.0	.0	.4	.4	.4	.6	.5	.0	.7	.5	.4	.3	.2

4.2 Comparing-product Websites

In this section, we focus on a total of 24 websites, comprising six for VPN, eight for PB, and ten for PSE identified and analysed as described in Sec. 3.2. Unlike in Sec. 4.1, these websites do not concentrate on a *single-product* but present a comparison of multiple products of one PET type (e.g., comparing seven VPNs). It is worth noticing that Tor is a singular product and is therefore omitted in this analysis. We hence analyse these websites based on the 21 dedicated criteria shown in Tab. 1. The average scores for each criterion for *comparing-product* websites shown in Tab. 4, and Tab. 5 shows their *readability* and *price* categories.

Criteria-based Insights. In the *technology* category, the highest score is 0.3 for the limitation criterion, while the lowest is 0.1 for easiness. In one case, a limitation

was explained using an example: "*while using a VPN and providing credentials to an online web page, your privacy will be at risk, and a VPN cannot protect you.*" Such examples enhance users' understanding of risks. The explanation and coverage criteria scored slightly higher but remained low, indicating insufficient efforts to educate users about PET and its privacy benefits objectively.

Considering the *trust* category, we observed that the provider criterion has the best score across all criteria. This means the users have been informed of the person or organisation that provided the comparison analysis. However, the websites do not rely on user feedback or interpersonal connections, meaning they do not count on the community, also observed by [11], which neglects excellent potential [43]. For instance, when websites compare multiple PBs, no comment or rating of other users about the comparing analysis of PET products was observed.

Within the *information* category, we observe that our sample mainly relies on text, with other communication formats not included. In addition, we found repetitive examples of technical words that did not accompany an explanation. For instance, in the case of PSE, "*Features: SSL encryptions*".

In the *usability* category, approximately half of our sample provides a demo of the PET environment, such as a screenshot, video, or animation. However, we could not find any evidence of websites interacting with individuals. This further shows that interaction and receiving users' needs for presenting relevant information about PETs to them are missing.

Looking into the *comparison* category, which is exclusive to *comparing-product* websites, review per product scores the best. In about two-thirds of the cases, we found detailed analyses for each PET, rather than just mentioning the name with brief pros and cons. Half of our samples provided key benchmarks of what elements to consider when adopting a specific PET to empower individuals in decision-making and increase awareness. We only found evidence for the snapshot criterion, e.g., in the form of a table, which is usually a more efficient way to compare different PET products in less than half of the cases. For example, a common format we observed presents PETs sequentially: Name, explanation, and pros and cons for each. This layout requires extensive scrolling and makes comparing parameters between PETs time-consuming and mentally demanding.

As shown in Tab. 5, the average reading ease score is 61, indicating moderately easy readability. Again, we observe that the reading ease is lower for the websites comparing PB as compared to the other PETs. Additionally, the overall average grade level score was 6, suggesting that the content was accessible to individuals with a sixth-grade reading level same score as in *single-product*. Regarding the price availability criterion, only about 3 out of 10 websites provided pricing information when comparing PET products. Notably, most PETs offer a free version or trial in the *single-product* section,

Table 5. Mean score of readability and price of 24 *comparing-product* websites

Number of websites	PETs	Readability		Price
		Reading ease	Grade level	Availability
6	VPN	65	7	0.6
8	PB	53	6	0.2
10	PSE	65	6	0.3
\bar{x}		61	6	0.3

yet this information is often not communicated to the users in comparison websites.

PETs-based Insights. When comparing the average scores across all criteria per PET, we observed minimal variation among the three PETs. On average, only one-third of the factors that support adoption are applied to the 24 *comparing-product* websites. Recall that it is the same ratio as for *single-product* websites (see Sec 4.1).

4.3 Accessibility

Tab.6 shows the average number of accessibility issues found using Accessi [2], categorised as high, medium, and low impact per type of PET. Based on the WCAG 2 guideline [52], high-impact errors severely obstruct or block access to content for users with disabilities. Medium-impact errors create significant difficulties but do not make access impossible. Low-impact errors cause minor inconveniences or slow down interaction but do not prevent access.

As shown in Tab.6, there is an average of 18 high-impact issues per website. In addition, the average sum of all issues per website is 147. Interestingly, VPNs have the highest number of issues, while PSE websites have the lowest. This difference can be due to PSE websites having considerably less content and web pages than other types. In the following, we present the two most frequent issues observed across all the reviewed websites.

Table 6. Mean score of observed **accessibility issues**

Number of websites	Issues PETs	Impact			Sum
		High	Medium	Low	
26	VPN	22	33	143	198
11	Tor	16	17	82	115
12	PB	20	27	97	144
20	PSE	12	25	62	99
69	\bar{x}	18	27	73	147

Violation of 1.3.1 Guideline: "Structure your website so that content is read by a screen reader in the same way it is presented visually" [53]. An example is headings. When a large, bold font precedes an article, it visually suggests it is a heading for the following text. However, without proper coding to designate a heading level, this visual cue is not conveyed to individuals using screen readers. This means that individuals relying on screen readers do not hear the headlines as headings, making navigating the websites difficult.

Violation of 4.1.2 Guideline: "For all user interface components (e.g., forms, links, scripts, controls), the name and role of those components should be coded in" [54]. For example, while forms may visually indicate their function, this is not conveyed to screen reader users unless properly coded. This issue also affects elements like drop-down lists and progress bars. In our study, some websites used progressive disclosure to enhance readability, but if this feature is not coded correctly, users relying on auditory cues may miss important content.

Solving the above issues can be low-cost in time and resources for providers. For example, easy fixes are assigning a heading level in code to meet the 1.3.1 guideline or providing roles for interface components to meet the 4.1.2 guideline.

4.4 Summary

When considering the average criteria coverage of both *single-product* and *comparing-product* websites, we observe that approximately one-third of the influential supporting factors recommended by academic findings have been effectively provided to individuals. Additionally, our accessibility audit revealed that even easily fixable issues were overlooked, potentially posing significant obstacles for impaired users. These results highlight a lack of optimal support and even difficulties that users interested in protecting their privacy may encounter when informing themselves to choose a PET to install. This shows great potential for improvement in presenting PETs to motivated individuals and supporting the adoption process.

5 Design Templates

Based on our observations and results presented in Sec. 4, we propose two design templates, illustrated in Fig. 1 for a single product and Fig. 2 for comparing multiple products, for effectively presenting PETs to individuals. These templates are grounded in (1) our analysis of the strengths of the best-rated websites per criteria and per PET and (2) the integration of relevant design elements to ensure current practices to address neglected criteria. The yellow boxes provided on the two design templates refer to the related criteria.

Supplementary Considerations for Effective Implementation. While the two design templates serve as a foundational framework, additional considerations to ensure a more effective design implementation are: (1) Use diverse formats like videos, diagrams, and animations to present information effectively. (2) Organise the page layout with clear titles and proper categorisation subsequently coded. (3) Avoid informal language; keep content jargon-free and easy to read. (4) Opt for a minimalist, professional, and visually appealing user interface design. (5) Provide an explanation on the spot of the potential unknown terminologies. (6) Conduct accessibility audits regularly.

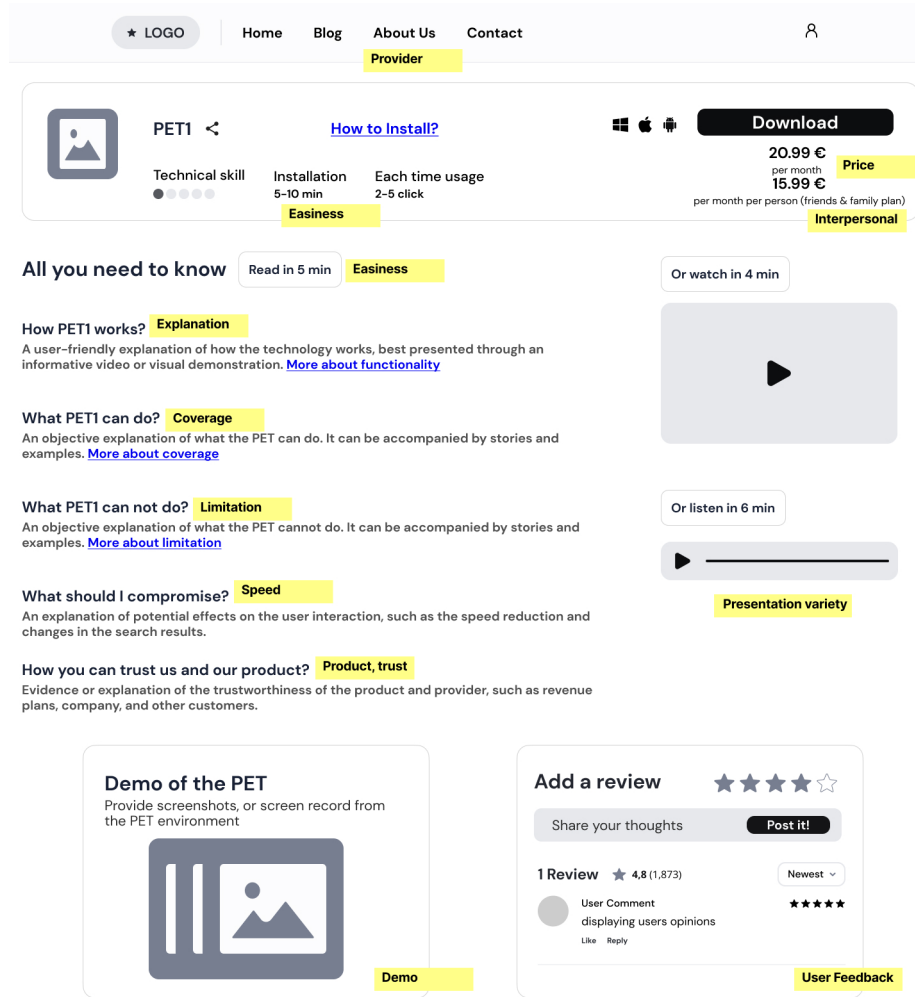


Fig. 1. Design template for a single product.

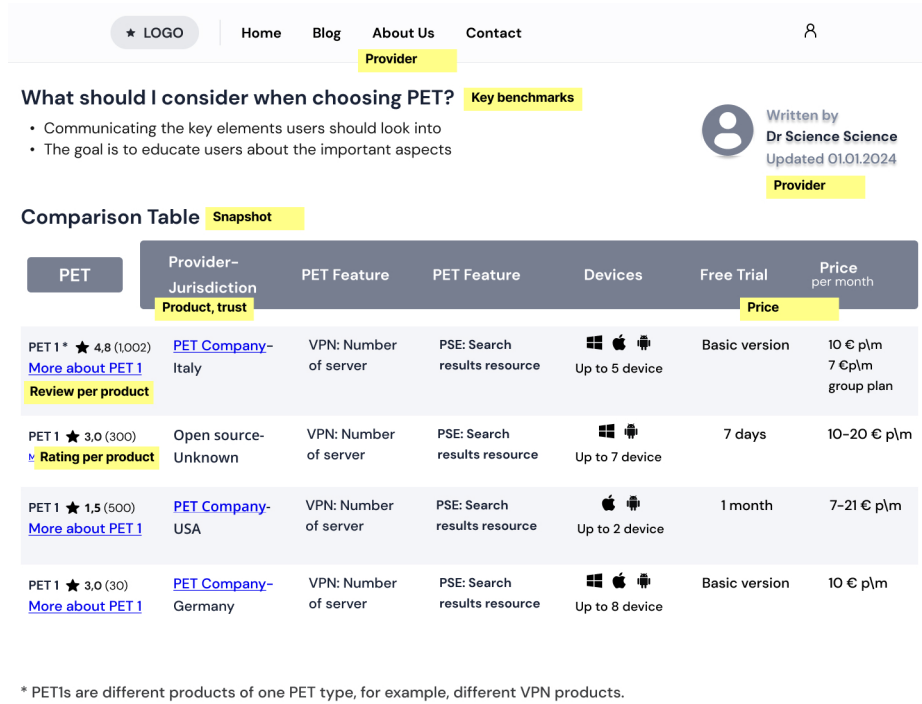


Fig. 2. Design template for comparing multiple products.

6 Discussion

Our results indicate a widespread disregard for following the supporting factors and accessibility guidelines in our sample. This section further compares our results with existing works in Sec. 6.1, the scope and limitations of our work in Sec. 6.2, and the future works in Sec. 6.3.

6.1 Comparative Analysis of Our Findings with Existing Works

As mentioned in (Sec. 2), a recent fundamental work related to our study is SPAF [11], which outlines awareness, motivation and ability as crucial factors for users to accept security and privacy behaviour, such as adopting a PET. Awareness refers to users' understanding of privacy risks and mitigation strategies. SPAF identifies training, digital literacy, and social engagement as influencing awareness. Our analysis indicates shortcomings in addressing these factors with criteria such as explanation, limitation, user feedback, and interpersonal. Motivation encompasses the willingness of individuals to enhance privacy. SPAF identifies perceived advantages, trial ability, and compatibility as motivation factors. Our analysis shows weaknesses in addressing these factors with criteria such as coverage. However, we could find evidence of a free version or trial for all PET

types considered in this study, supporting the recommended trial ability. Ability highlights the challenge of translating intentions into protective actions, influenced by usability and accessibility [11]. Although the visual design and demo are partly applied in our study, the interaction criterion is not respected. Furthermore, our analysis reveals widespread accessibility issues. Our results confirm, with SPAF, that users are left without adequate support for adopting a PET.

In their 2020 study, Redmiles et al. [40] emphasise the importance of providing users with actionable privacy recommendations. Their research highlights that many available websites lack practicality. Our findings support this, as we observed a lack of comprehensive coverage in criteria such as easiness, gap coverage, demo, presentation variety, and interaction. Redmiles et al. also identified a crisis in advice prioritisation. However, our study focused on the specific goal of choosing one PET and not prioritising multiple PETs.

As a result, our exploration confirms the differing outcomes of SPAF [11] and Redmiles et al. [40] in practice while extending their work by analysing additional factors such as trust in providers and products, presentation of information to end users, and accessibility. Furthermore, we introduce design templates to help bridge the gap between academic recommendations and practical implementation, ultimately supporting users in making privacy decisions.

6.2 Scope and Limitations

The scope of this study is limited in several ways. Firstly, we have only analysed the websites on a desktop display. Accessing them on mobile devices may lead to different results. Future analyses on various screen sizes may reveal other challenges that need to be addressed, given the increasing prevalence of mobile browsing. Secondly, while this study focused on analysing four specific PETs, it is important to note that there are other PETs available that users may seek information about through online resources, such as encrypted messaging services or ad-blockers, which require attention to provide a more comprehensive understanding of the landscape. Lastly, our approach involved using the names of PETs as search terms in an online search engine to access websites. However, we recognise that users may discover websites through various means, such as advertisements or recommendations from friends. These alternative pathways to access websites can impact users' adoption experiences.

6.3 Future Work

While our current study focuses on expert perspectives, gathering insights directly from users can help us understand the obstacles they encounter. Combining both methods will provide a more thorough understanding of the gaps between users' desire to protect their privacy and their actual behaviours. Future research could involve conducting in-depth interviews and user studies with diverse groups to uncover their specific challenges. Combining these user-centred findings with our expert-driven results provides a strong foundation for developing strategies or design recommendations to support the adoption of PETs. Moreover, as privacy

concerns are global, and websites in other languages could vary in how they present information, analysing websites in different languages can be followed as future work.

7 Conclusion

Despite individuals expressing privacy concerns, only a fraction of them actively adopt PETs, which raises questions about the effectiveness of the presentation of the PETs. To understand the reasons behind this situation, we conducted a comprehensive analysis of 69 websites that promote four specific PETs. Our expert-driven analysis, guided by a set of 24 criteria, showed that websites, on average, cover only about one-third of the identified supporting factors. This likely contributes to PETs' persistently low adoption rates. Additionally, our accessibility audit showed the repeated presence of issues that create obstacles for impaired users. To address these issues, we have proposed two design templates that comprise supporting factors to help individuals adopt PETs. These measures can help in steps fostering greater adoption of PETs among individuals who are informing themselves about PETs online.

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Appendix

Tab. 7 shows the websites included in our study.

Table 7. The 69 websites included in our study

		Single-product Websites		
		VPN	Tor	Private browser
	VPN	Surfshark: https://surfshark.com/ Atlas: https://atlasvpn.com/ Express: https://www.expressvpn.com/ Cyberghost: https://www.cyberghostvpn.com/ Ip Vanish: https://www.ipvanish.com/ Pure: https://www.purevpn.com/ Ivacy: https://www.ivacy.com/ Norton: https://de.norton.com/ Private: https://privatevpn.com/cybernews/ Nord: https://nordvpn.com/download/ Proton: https://protonvpn.com/ Hostspot Shield: https://www.hotspotshield.com/ Avira: https://www.avira.com/ Veepen: https://veepn.com/ Hide Me: https://hide.me/ Avast: https://www.avast.com/c-vpn-f or-pc Turbo: https://turbovpn.com/download/windows Touch: https://touchvpn.net/ Unlimited: https://www.vpnunlimited.com/downloads/mac Privado: https://privadovpn.com/	Tor Project: https://www.torproject.org/ Softonic: https://tor-browser.en.softonic.com/ Techradar: https://www.techradar.com/how-to/how-to-get-started-with-tor-browser Techspot: https://www.techspot.com/downloads/5183-tor-browser.html PCMag: https://www.pcmag.com/reviews/tor-browser Wikipedia: https://www.en.wikipedia.org/wiki/Tor_(network) CSO: https://www.csosonline.com/article/565798/what-is-the-tor-browser-how-it-works-and-how-it-can-help-you-protect-your-identity-online.html Microsoft: https://www.microsoft.com/en-us/microsoft-365-l ife-hacks/privacy-and-safety/what-is-tor VPN Overview: https://vpnoverview.com/privacy/anonymous-browsing/tor/ Free Download Manager: https://en.freownloadmanager.org/Windows-PC-Tor-Browser-FREE.html Source for Age: https://sourceforge.net/projects/tor-browser.mirror/	Duckduckgo: https://duckduckgo.com/ - Brave: https://brave.com/ - Epic: https://www.epicbrowser.com/ - Aloha: https://alohabrowser.com/
	Private search engine	Start Page: https://www.startpage.com/ - Brave: https://search.brave.com/ - Privacia: https://privacia.org/ - Ghostery: https://www.ghostery.com/private-search - GoGo Private: https://www.gogoprivate.com/ - One Search: https://www.onesearch.com/ - Privacy Wall: https://www.privacywall.org/ - Metager: https://metager.org/ - Lukol: https://www.lukol.com/ - Seekly: https://www.seekly.net/		
		VPN	PCMag: https://www.pcmag.com/picks/the-best-vpn-services Techradar: https://www.techradar.com/vpn/best-free-vpn - Tomsguide: https://www.tomsguide.com/best-picks/best-vpn - Forbes: https://www.forbes.com/advisor/business/software/best-vpn/ - Cnet: https://www.cnet.com/tech/services-and-software/best-free-vpn/ - Privacy Tool: https://www.privacytools.io/	
Private browser		PCMag: https://uk.pcmag.com/browsers/134703/stop-trackers-dead-the-best-private-browsers-for-2021 - Brave: https://brave.com/learn/best-private-browser/ - Vpninsights: https://vpninsights.com/privacy/browsing/best-private-browsers/ - Hongkiat: https://www.hongkiat.com/blog/private-browsers-windows-11/ - Restor Privacy: https://restoreprivacy.com/browser/secure/ - Pro Privacy: https://proprivacy.com/privacy-service/comparison/most-secure-browsers - Blokt: https://blokt.com/guides/best-secure-browsers-for-private-browsing - IP Vanish: https://www.ipvanish.com/blog/best-private-browsers-2022/		
Private search engine		Restore Privacy: https://restoreprivacy.com/private-search-engine/ - Privacy Savvy: https://privacysavvy.com/security/safe-browsing/private-search-engines/ - Panda Security: https://www.pandasecurity.com/en/mediacenter/security/best-private-search-engines/ - Comparitech: https://www.comparitech.com/blog/vpn-privacy/best-private-search-engine/ - VPN Overview: https://vpnoverview.com/privacy/anonymous-browsing/best-private-search-engines/ - Surfshark: https://surfshark.com/blog/private-search-engines - GUR99: https://www.guru99.com/private-search-engines-anonymous-no-tracking.html - USA Today: https://eu.usatoday.com/story/tech/columnist/komando/2020/11/21/6-internet-search-engines-respect-your-privacy/6306467002/ - Pro Privacy: https://proprivacy.com/privacy-service/comparison/private-search-engines - VPN Mentor: https://www.vpnmentor.com/blog/best-private-search-engines-true-no-log-services/		

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