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Key user experience principles in designing computer interfaces for emotionally vulnerable user groups

Solett du Preez[1], Kalley Coleman[1] and Hanlie Smuts[1]
[1] University of Pretoria, Pretoria, South Africa
Solett.dupreez@gmail.com, kalley.kcoleman@gmail.com,
hanlie.smuts@up.ac.za

Abstract

The highly integrated Society 5.0 enables a ubiquitous computing world driven by exponential growth of digital technologies. User interface designers must therefore find new architectures and -designs in order to compete in a digital world. User experience (UX) design is the overarching term that expresses the philosophies, approaches, tools and techniques related to the two distinct yet overlapping fields of human-computer interaction (HCI) and user-centered design (UCD). In order to create reliable and realistic representations of key audience segments, personas are used as a mechanism to simulate the engagement with the computer interface. Personas for distressed and vulnerable users take cognizance of a user's emotional state and potentially unique interaction with the computer interface. The purpose of this study is to consider the key UX principles in designing computer interfaces for vulnerable user groups. Two datasets, consisting of a systematic review of the literature and eye-tracking data, were collected and analyzed. We established 5 key UX principles relevant to vulnerable users entailing simplicity, support, action, engagement, look and feel, and constraint. By applying the key UX principles for vulnerable user groups, designers can ensure that a potentially emotional experience is managed well via the computer interface.

1 Introduction

In 2019, in the 5th Science and Technology Basic Plan, Japan described Society 5.0 as a "human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space" (Society 5.0 Definition, 2019). With its human-centered philosophy and aim on social aspects, the digital technologies referred to as Industry 4.0, enforces the requirement to consider human factors as people and technology are working together to the benefit of all in the new society (Chiang, Lin, Kreifeldt, & Lin, 2021). When faced with the goal

of designing for people and technology interfaces driven by persuasion, emotion, trust, etc., organizations must consider experiences in the design as an integral part of people's lives (Smit & Melissen, 2018). Therefore, the design, evaluation and automation of the next generation of transformative and convergent personal and social human-machine systems, must be considered to ensure inclusive, and human-centered, design (Shneiderman, 2021).

However, the construction of experiences as user stories from moment-by-moment experience is not straightforward (Hassenzahl, 2013). Scholars report many barriers in terms of experience design such as technology adoption, cost of technology, fear of harm (Chu, Biss, Cooper, Quan, & Matulis, 2021; Melles, Albayrak, & Goossens, 2021), risk and uncertainty, resistant to change, inability to accept new ideas (Baha, Ghei, & Kranzbuhler, 2021), lack of user engagement and participative design (Norman et al., 2021). Designers therefore need to get a comprehensive understanding of user needs and -problem areas and apply methods to extensively test and validate solutions. Two of the most common UX design tools, are personas and scenarios. Personas refer to fictional, hypothetical users constructed from purposeful research identifying goals, values, needs, and actions embedded within the persona, while assisting designers to develop empathy and interest for a variety of users and user contexts during or scenarios early on in the design process (Minichiello, Hood, & Harkness, 2018).

Therefore, the focus of this paper is to establish user experience (UX) key principles for vulnerable user groups, by applying the following research question: "*What are the UX key principles when designing computer interfaces for vulnerable user groups*?" We reflect on this research question by considering an overview of user experience design and in particular, an overview of the profile of vulnerable users.

In this paper, we firstly provide an overview of literature in section 2. The approach to the research study is highlighted in section 3, followed by a discussion of the data and analysis of findings in Section 4. Section 5 details the contribution of the study and Section 6 concludes the paper.

2 Background

Several scholars have considered design principles in the context of the user interacting with a computer interfaces such as Babich (2019), Nielsen (1994: updated November 15, 2020), Shneiderman et al. (2016), Rogers, Sharp, and Preece (2011) and Preece, Pauw, and Clegg (2019). These scholars identified basic design fundamentals involving navigation, text, color, and screen placement as they apply to human-computer experience and highlighted best practices as value-neutral based on the premise that these fundamentals may be deployed as easily to inform and respect as it is to deceive and exploit (Goodman, 2021).

In this section, we consider user experience design in general and the persona of a vulnerable user in particular.

2.1 User experience design

UX design is an all-encompassing term referring to the philosophies, approaches, tools, and techniques, related to the two distinct yet overlapping fields of human-computer interaction (HCI) and user-centered design (UCD). HCI and UCD are commonly applied by organizations to make market, product and user data accessible to potential customers, in a way that is easily understood and meets user needs (Minichiello, Hood, & Harkness, 2018). UCD is a design philosophy which envisages product design executed as a cyclical process consisting of steps such as general requirements analysis, contextual task analysis, system prototyping, early evaluation, and iterative design (Oury & Ritter, 2021). The focus of HCI is largely on studying the interaction of humans and computers well beyond the design of human-computer interfaces and considers emotional, aesthetic, pragmatic, and socio-cultural aspects of a human–computer experience (Minichiello, Hood, & Harkness, 2018). Furthermore,

both UCD and HCI considers the evolution of computers out of the workplace into the ubiquitous computing environment of everyday private and public life (do Nascimento, Machado, Maran, & de Oliveira, 2021).

Scholars report different techniques for evaluating UX. These methods include the "think aloud" method (user explain cognitive process as engaging with the user interface) (Basri, Adnan, & Baharin, 2019), an interaction experience questionnaire (Souza et al., 2021), usability, comprised of effectiveness, efficiency, satisfaction, learnability, and attractiveness (Schwaiger, Hammerl, Florian, & Leist, 2021) and usefulness, related to achieving the outcome the user set out to do (Chatzimina et al., 2021). Another measurement mechanism is eye-tracking where an eye-tracker device measures the point of gaze and the motion of the eye relative to a specific position on a computer interface e.g. web page, mobile application, etc. The eye-tracking data is visualized in two formats: a heat map (represents the gaze duration in a range of red-amber-green colors) and gaze plots (represented as circles, and gaze saccades represented as lines). The warmer (redder) the heat map colour and the larger the diameter of a gaze plot circle, the longer the duration of the fixation (Burger, Guna, & Pogačnik, 2018).

For the purpose of this study, we applied eye-tracking as a measurement mechanism.

2.2 Emotionally vulnerable user profile

The purpose of personas is to create reliable and realistic representations of key audience segments for a particular organization (Minichiello, Hood, & Harkness, 2018). As our study relates to a debt-counseling organization, we now consider the user profile of vulnerable users as a persona in the debt-counseling context. A vulnerable user is a person that is primarily influenced in a negative way by their emotional status and these emotions may be impacted and enhanced by certain design aspects when they engage with your platform or website (Leung et al., 2019). Some scholars refer to this emotional state as "mental health issues" in severe instances (Mulvale, Miatello, Hackett, & Mulvale, 2016).

Designing for vulnerable users implies that a wide variety of people from different backgrounds and different emotional states must be considered (O'Brien, Fossey, & Palmer, 2021). Important factors to consider is how the user would feel about and experience a certain design element such as a page that takes too long to load, as this may cause further anxiety (Leung et al., 2019). The reason for this anxiety is that a person, that are already emotionally vulnerable, are much more susceptible to small triggers in their emotional change (Heginbotham et al., 2022).

In order to support an emotionally vulnerable person, the platform or website they engage with, needs to make them feel secure with the product or service provided (Chen & Pu, 2010; Leung et al., 2019). This will lessen the anxiety and encourage them to share their information if the platform requires them to do so (Heginbotham et al., 2022). Another UX element that is a key consideration in the context of vulnerable users is the content. The content needs to be simplistic (Jones, 2018; Snider & Takeda, 2008) and without clutter or jargon (O'Connell et al., 2021), as unnecessary, complex content raises the anxiety levels of emotionally vulnerable people. Furthermore, the application of images and iconography may, depending on the emotional vulnerability of the user, create negative associations and sensitivity (Corps, 2003; Waddell, 2020). For an anxious user, the platform needs to be easy to navigate (Mulvale et al., 2016) and the user needs to know clearly what to do next and where to go pre-supposing that all elements need to be delineated clearly (Waddell, 2020) with standard naming conventions enabling ease of use (Martz, Miller, Carpenter, & Miller, 2009). While some of these factors can be alleviated by incorporating design principles stated by Nielson and Shneidermann, these principles are not always applied and the emergence of 'dark patterns' in UX design can further take advantage of vulnerable users (Gray, Kou, Battles, Hoggatt, & Toombs, 2018; Nielsen, 1994; Shneiderman et al., 2016).

A number of factors may lead to vulnerability such as socioeconomic status, gender, disability, health status or in adverse circumstances unable to cope with and organizations providing human-

computer interfaces based on business models that support potentially vulnerable users, need to acknowledge the impact it has on design (George, Daniels, & Fioratou, 2018).

3 Research approach

The aim of this research study is to investigate key UX principles to be applied when designing for vulnerable user groups. In order to execute this study, we collected two sets of data. Firstly, we created a dataset of UX design principles relevant to vulnerable users by executing a systematic literature review (SLR). We executed our SLR by applying the 3-step process suggested by Keele (2007) which consists of planning the review, conducting the review and reporting the review.

In terms of planning the review, we executed a Google Scholar search using the keywords "user experience" and "key considerations" and "vulnerable" as our study focuses on UX design principles for vulnerable users. We defined inclusion criteria such as academic, peer-reviewed publications consisting of journal papers, conference proceedings, technical reports and books. Our exclusion criteria pointed to non-English papers. Figure 1 depicts the outcome of planning the review.

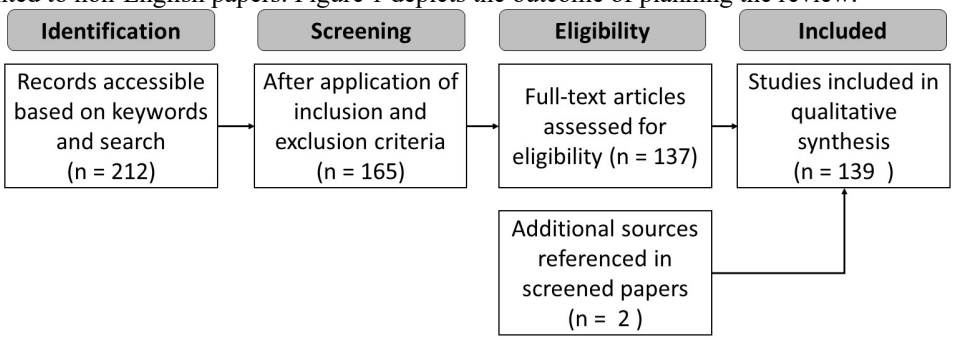

Figure 1: Systematic literature review dataset

Two-hundred and twelve papers were accessible by executing the search criteria where after we applied our inclusion and exclusion criteria and removed 47 papers from the dataset. We then screened the titles and abstracts and excluded 28 papers that were not relevant e.g. no relevance to the research questions as it dealt with physical experience, packaging design, cybercrime, etc. We analyzed 137 papers in detail, extracting the UX design principles for vulnerable groups and through the analysis process, added in 2 relevant papers that were referenced in our initial dataset.

The next step was to conduct the review and we created a dataset consisting of the UX principle and the reference, creating a dataset of 91 principles. This dataset was the input to the third step of the SLR, i.e. reporting the findings. In order to report the findings, we considered the scholars that presented generic design principles in the context of the user interaction as discussed in Section 2. We chose the principles shared by Rogers, Sharp and Preece (2011) as they integrated design-, usability- and user experience goals providing a broad base for us to map our 91 UX principles extracted for vulnerable users to.

According to Rogers, et al. (2011), design principles are prescriptive suggestions to help designers to explain or improve their designs. Instead of telling the designer exactly how to design an interface, they inspire careful design, telling the designer what will work and what not. Their focus is on making people's interaction with technology effective and enjoyable as the user's experience with technology irrespective of its efficiency, or effectiveness, is important for its acceptance. Positive experiences may therefore be created by attempts to make the product satisfying, enjoyable, engaging, exciting, entertaining, helpful, motivating, rewarding, surprising, etc. Avoid features that make a product boring,

frustrating, or annoying. A summary of these design goals, experience goals and design principles are summarized in Table 1, including a short description of the particular design goal.

Goal	17 design goals in interaction design, namely usability goals and user experience goals
Aesthetically pleasing	Provide professionally designed, uncluttered, simplistically beautiful interfaces.
Affordance	How effectively an object tells users how to use it. Text or objects that are not meant for interaction should not invite interaction. Elements that can be interacted with must be designed to convey this.
Consistency	Likeness in input-output behavior arising from similar situations or tasks.
Constraints	Restrict user actions to avoid user errors.
Effectiveness	It should be easy for users to locate any information
Efficiency	Provide the required information in the quickest, most effortless way.
Engaging	Provide users with easy-to-use tools that allow them to explore in creative ways.
Feedback	Provide noticeable information about actions performed and the effect of those actions. Display error messages close to where the problem occurred.
Helpful	Provide ways to do things that would otherwise have taken time and effort to do.
Learnability	Capabilities of electronic documents should simplify.
Mapping	Logical relationships between interface elements and their effect on the system.
Memorability	Employ suitable metaphors and exploit prior knowledge (of e.g. manual system) to enhance memorability.
Rewarding	Reduce banking fees if they choose e-statements and emphasize that they are doing the environment a favor.
Safety	Protect customer information and provide a secure environment to explore account history and activities.
Satisfying	Let clients easily access information that would help them.
Utility	Allow users to obtain all their information in different formats to serve all their different needs.
Visibility	The more visible the available functions the easier users will perform their next task. Place search fields and interactive elements at the top of the screen. If scrolling is required, indicate that invisible content is available below the screen border.

Table 1: Design goals collated from (Rogers, Sharp, & Preece, 2011)

We used the 17 design goals to map our 91 UX principles for vulnerable users to and the detailed findings are discussed in the next section.

The second set of data collected in our study, was eye-tracking data (heat maps and gaze plots) where a debt-counseling website was accessed based on the notion that users of this website are in a vulnerable position. Non-probability, purposive sampling was applied to identify 10 participants to evaluate the debt-counseling website. The participant profile consisted of 60% mail and 40% female participants with the range of ages between 29 and 65, and an average age of 39 years. The debt-counseling company indicated that they have not yet consulted with a client younger than 28 years. All participants were aware of what debt-counseling is. Each participant provided informed consent and eye-tracking sessions were facilitated with individual participants. We used a Tobii static eye-tracker[*] to collect the user experience data. The data and analysis of the eye-tracking data are discussed in the next section.

[*] www.tobii.com

4 Data analysis and findings

The objective of this research study is to investigate the UX principles in designing computer interfaces for vulnerable user groups. We identified 91 principles through an SLR and mapped the principles to the 17 interaction goals defined by Rogers, Sharp, and Preece (2011) as shown in Table 2.

Themes	UX considerations for vulnerable groups	Reference
Aesthetically pleasing	simple and intuitive use; affordable design; corporate social responsibility; graphics and visualisation; avoid jargon; complicated and effortful user interfaces	(Corps, 2003; Leung et al., 2019; O'Connell et al., 2021; Watkins, 2014)
Affordance	size and space for approach and use; clear labels; action on object	(Snider & Takeda, 2008; Waddell, 2020; Watkins, 2014)
Consistency	bandwidth shaping (rate limits to ensure consistent UX); term conformity; standard naming conventions	(Hargreaves, Chilvers, & Hargreaves, 2015; Martz et al., 2009; Witkowski, Valley, & Pugh, 2017)
Constraints	smart card logical access (hide back-end changes); age (children)	(Alliance, 2004; Cheng, Wei, Tan, Tan, & Lei, 2022; Gupta & Quamara, 2019; Korte et al., 2021)
Effectiveness	localised for context; flexibility in use; perceptible information; culturally sensitive design; design for communities; design for the needs of the developing world; design for the “other 90%”; ethical design; inclusive/universal design; localisation; personal meaning; social justice; wellbeing; equitable use; choice; clear choices and imagery; clear and simple imagery; straightforward navigation	(Corps, 2003; Ei, Soon, & Tan, 2021; Hargreaves, Chilvers, & Hargreaves, 2015; Snider & Takeda, 2008; Watkins, 2014; Yingta, Abdelnour-Nocera, Brew, & Rehman, 2021)
Efficiency	design for true need; emotionally durable design; perceptible information; appropriate quality measures (defined up front); ethics; values; design for true need; perceptible information; human rights; irrelevant, and inappropriate content is upsetting; reminders of upsetting experiences; malfunctioning websites; frictionless experience; energy efficient (wearable devices, cognitive assistants)	(Cooke & Veen, 2016; Ei, Soon, & Tan, 2021; Leung et al., 2019; Preum et al., 2021; Raftopoulos, 2016; Snider & Takeda, 2008; Watkins, 2014)
Engaging	co-design and co-creation; participatory design; co-designing on-line; interactive and contextual (cognitive assistant)	(Cooke & Veen, 2016; Kennedy et al., 2021; Khaled & Hassan, 2017; Korte et al., 2021; Moore, Wilding, Gray, & Castle, 2019; Preum et al., 2021; Watkins, 2014)
Feedback	alert features; asking for feedback	(Ei, Soon, & Tan, 2021; Khaled & Hassan, 2017; Preum et al., 2021; Villumsen, 2019)
Helpful	tolerance for error; low physical effort; tolerance for error; low physical effort; simple-to-use contactless cards (payment method); convenience	(Ei, Soon, & Tan, 2021; Snider & Takeda, 2008; Sushra, Iyengar, Shah, & Kshirsagar, 2022; Watkins, 2014)
Learnability	plug and play support; develop personas; simplicity	(Alliance, 2004; Raftopoulos, 2016; Sushra et al., 2022)
Mapping	site map; flow theory; system / application needs to behave as expected	(Dwivedi et al., 2021; Mulvale et al., 2016; Permadi, 2018; Yingta et al., 2021)
Memorability	flexibility in use; conscious about the goal of the user	(Ei, Soon, & Tan, 2021; Snider & Takeda, 2008; Yingta et al., 2021)

Rewarding	best end-user experience with the highest level of end-to-end security.	(Witkowski, Valley, & Pugh, 2017; Yingta et al., 2021)
Safety	password synchronization (single sign-on); self-service password; identity management; public key infrastructure ; design against crime; identity management; trust; building trust; safety controls, privacy of personal data	(Alliance, 2004; Catteddu & Hogben, 2009; Chen & Pu, 2010; Korte et al., 2021; Leung et al., 2019; Mostert, 2010; Watkins, 2014; Witkowski, Valley, & Pugh, 2017)
Satisfying	simple and intuitive use; fast interface	(Snider & Takeda, 2008; Yingta et al., 2021)
Utility	equitable use; social equity; audio information ; persona - people with disabilities; combat ageism; design for all; audio cues; voice control and remote control; audio (technauriture)	(Ei, Soon, & Tan, 2021; Mostert, 2010; Shaw, Leones, Smith-Evans, & Aucelluzzo, 2020; Watkins, 2014)
Visibility	relevant symbols; choose large input buttons and graphics; touchscreen; relevant icons; concise due to the limited space (wearable devices); contrast colour blocks; boldface text; combination of verbal and non-verbal communication	(Cooper, Di Fava, Vivas, Marchionni, & Ferro, 2020; Ei, Soon, & Tan, 2021; Kong, Luo, Huang, & Yang, 2019; Shaw et al., 2020; Waddell, 2020)

Table 2: UX key principles in designing computer interfaces for vulnerable user groups (mapped to (Rogers, Sharp, & Preece, 2011))

Aesthetically pleasing refers to the interface that needs to be simplistic and uncluttered, all the elements should support the content. Complicated designs trigger anxiety in emotional users. *Affordance* describes how objects that warrant interaction, such as buttons, needs to be visible (as it needs to be interacted with) and clearly marked. On the other hand, objects that should not attract interaction should not look like they can be interacted with. *Consistency* keeps the design together across multiple pages and applications and includes elements of design such as fonts, font sizes, colours, imagery, icon styles, and terminology. Furthermore, the data presented in the user interface needs to be consistent and not fluctuate to cause periods of waiting, or uncertainty, for the user. *Constraints* limit the interaction to only the necessary elements. If values are selected, it needs to be validated to avoid user error keeping the task simple and efficient for emotional users. *Effectiveness* points to the user interface content that needs to be easily located and accessible, while appreciating social and cultural differences. *Efficiency* means that the user interface communicates the content effectively to users, while taking the users' backgrounds and emotional sensitivity into account (to the emotional user, irrelevant information is upsetting). The user interface should load quickly and seamlessly. *Engaging* ensures that the users' experience is greatly improved with tools to allow them to engage with content e.g. an interactive graph, a gif, etc. Such tools show users how their lives may improve by applying the content. In addition, these tools need to have a positive reward so it does not cause anxiety for emotional users. Provide *feedback* based on the action the user performed e.g. when a value is selected in a search, the search output changes to show the action performed. The user interface should *help* the user achieve their goal by interacting in a simple and efficient manner, as irrelevant content or errors increase anxiety in emotional users. *Learnability* refers to the fact that the user interface should not be difficult to use and may be achieved by including users in the design process to improve the experience. *Mapping* facilitates a clear understanding of where elements are and what function and effect they have on the user interface and solution. Elements that fit together, need to look alike and the system needs to be mapped out in a logical way. *Memorability* informs designing with the user's goal in mind and helps fast-track the user experience. By completing tasks easily and including information to accommodate a wide range of preferences and abilities, help make the user interface memorable enticing the user to return. The experience needs to be *rewarding* to the user as they need to be able to see what the product or service can do for their quality of life. The *safety* principle emphasizes that it is important for the user interface to build trust with the user, disclose what happens with their information and how their

information is protected. Sensitive or emotional users need to have a sense of security from engaging with the user interface. Relevant information for the user needs to be easy to find. When the user leaves the user interface, they need to feel *satisfied* that they obtained the correct information. *Utility* highlights the principle that the user interface needs to be able to provide information for people with profiles and diverse backgrounds e.g. elements need to be visible to the elderly, or visually impared, audio functions can be added to accommodate those with disabilities. Interactive elements need to be *visible* for the user to perform the tasks required. Relevant symbols and icons need to indicate the correct task such as more information, search or download. This also takes into account the different user demographics that need to perform the task e.g. display large buttons for the elderly.

The second dataset collected in our study, consisted of eye-tracking data where participants were asked to complete 5 tasks on the debt-counseling website. All participants could complete the tasks and their responses, as well as eye-tracking data, were analyzed.

There was some participant hesitance in giving out their personal information. Participants reflected that they would prefer to talk to a "human" or see a human, who preferably worked for the company, before handing over their personal information. Participants stated that incorporating user reviews and success stories, as well as photos of the actual employees, would help them feel as though a 'human' was on the other side of the call back form and would make them feel more at ease.

Pertaining to the home page, participants' gazes were strongly drawn towards the two header images (a fist bump or the dancing couple). Participants highlighted that the fist bump image reflected a sense of power and encouragement while one participant said it was intimidating. The dancing couple image was slightly more negatively received as participants mentioned that they were not sure why they were dancing and it seemed opposed to the emotions the participants were experiencing. Participants were unsure what an NCR number was and why it was so prominent. They stated that the menu was hard to read due to the colour usage. Reading intensity veered off as they scrolled further down the page and only icons and headings caught their attention. Users mentioned that some of the elements should be moved higher up on the page, such as the two pages that had icons and brief text descriptions of the services of the company.

With reference to services, participants had to study text explaining debt-counseling. Although they felt that the information provided was credible, some text was very small and illegible, and some of the images were not clear. Figures 2 and 3 focus on the task where a user had to register to be contacted by a debt counselor. When navigating on this website page, participants reflected on their emotions and verbalized it through terms such as feeling desperate, frustrated, awkward, like a failure, displeased, try to find a way out of situation, vulnerable, embarrassed, under pressure, unhappy, depressed, unworthy and "not great".

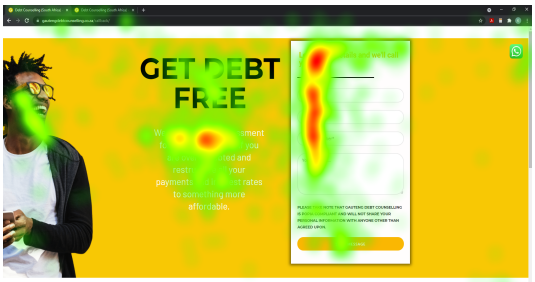

Figure 2: Eye-tracking heat map of debt-counseling website

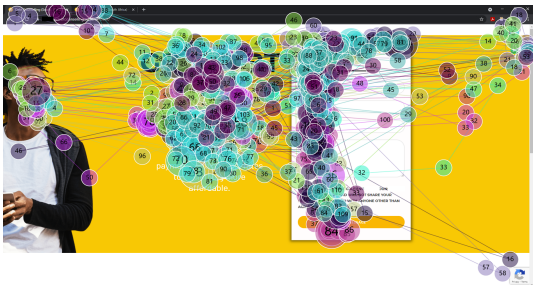

Figure 3: Eye-tracking gaze plot of debt-counseling website

Figure 2 shows the eye-tracking heat map and it can be observed that participants fixated on the text below the label "get debt free" as well as on the data fields to be captured to register for debt-counseling. Participants glanced at the image, but it was not a significant fixation. Figure 3 highlights the gaze plots

and here two additional glances are visible, to the top right and bottom left of the website screen. In the top right corner was a WhatsApp button as the website allow users to register for debt counseling via sending a WhatsApp. None of the participants opted for this option, although they glanced at the icon.

The results of the "longer glance" (red part of heat map) show an increased focus on the explanation text as well as on the textboxes and their labels. However, there was no link to the company on this page, prompting users to ask whom they are entrusting their information to. Almost all participants expressed this concern. Furthermore, there was an image of a man laughing on the left side of the screen and some users felt as though the man was laughing at them for being in a place of debt. Participants also stated that they think they would enter their details onto the form, despite the points above because, "I'm desperate and really want to get out of my situation." Ultimately, participants stated that they would like to use this form as it seems to want to help them get out of their debt situation, however they feel it is untrustworthy due to the fact that this screen does not display which company it belongs to or how there, very sensitive data, will be handled.

Post the eye-tracking sessions, participants completed a system usability scale (SUS) questionnaire consisting of 10 statements evaluated with a 5 point Likert scale. The average SUS score for the website was 76.8% which constitutes a good usability score.

5 UX key principles in designing computer interfaces for vulnerable user groups

The objectives of this research paper is to consider UX key principles in designing computer interfaces for vulnerable user groups. Two datasets were created – one dataset was the output of an SLR conducted by analyzing academic literature and the second dataset was created by an eye-tracker where a solution where users are vulnerable i.e. a debt-counseling website, was accessed. By integrating the two datasets, we propose the UX key principles in designing computer interfaces for vulnerable user groups shown in Figure 4.

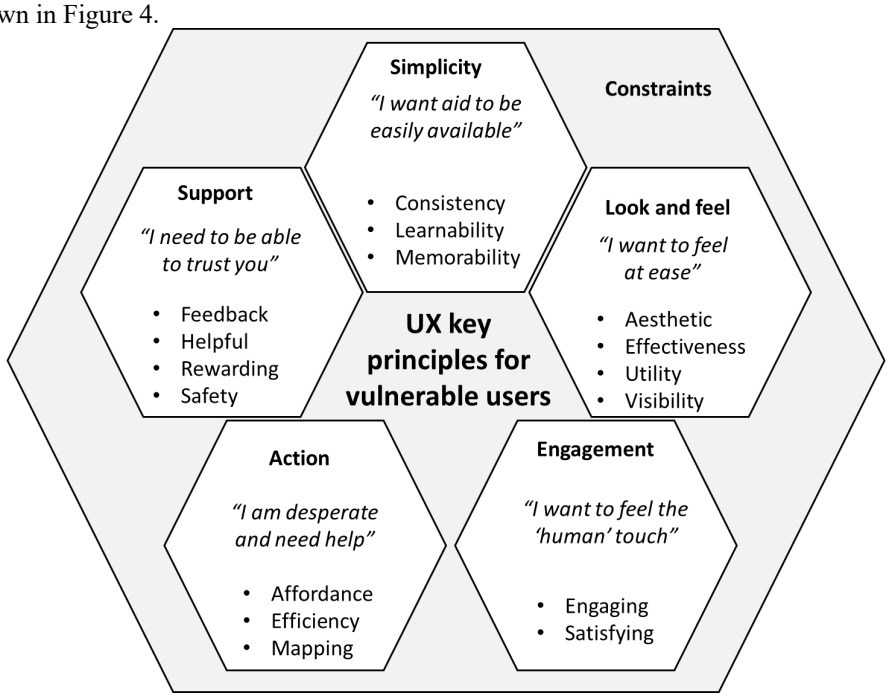

Figure 4: Key UX principles in designing computer interfaces for vulnerable user groups

In the integration of the 2 datasets, we simplified the number of principles initially used (Rogers, Sharp, & Preece, 2011) and focused specifically on the descriptions and sentiment highlighted by the eye-tracking participants. The eye-tracking participants highlighted 5 major sentiments. The *simplicity* key principle must assist them to easily find the information they are looking for, while the *support* key principle must reassure them and instill trust. The *action* key principle must guide them that they will ask for (and get) help and the *engagement* key principle must humanize the interaction. *Constraint* is an overarching key principle and is context specific e.g. dealing with children, addicts, etc.

We acknowledge that these UX design principles for vulnerable users will not be easily be met in totality and we therefore recommend incorporating as many as possible into the UX design.

6 Conclusion

The purpose of this research study is to investigate key UX principles to be applied when designing computer interfaces for vulnerable user groups. UX is a multidisciplinary field that considers every element that shapes an user's experience, how it makes the user feel, and how easy it is for the user to accomplish the desired tasks. In an instance where a user is vulnerable, deep emotion is at play and designers must take cognizance of this emotional state when designing the elements for the computer user interface. This is a key consideration as the highly integrated Society 5.0 drives a ubiquitous computing world and due to the exponential growth of digital tools, designers across all sectors must find new architectures and -designs in order to compete in a digital world.

We conducted an SLR to extract and report on key UX principles related to vulnerable users. A dataset, consisting of a systematic review of the literature was concluded resulting in a set of key UX principles for vulnerable users. We collected a second dataset with a Tobii eye-tracker based on the eye-tracking of a debt-counselling website. We integrated the two datasets to define the key UX principles for designing for vulnerable user groups. We found 6 key UX principles relevant to vulnerable users entailing simplicity (*"I want aid to be easily available"*), support (*"I need to be able to trust you")*, action ("*I am desperate and need help"*), engagement (*"I want to feel the 'human' touch"*), and look and feel (*"I want to feel at ease"*). The 6th principle is constraint as a designer need to understand the constraints pertaining to the particular user group they are designing for such as restrictions related to children, images used for drug addicts, size of buttons used for the elderly, etc. By applying the key UX principles for vulnerable user groups, designers can ensure that a potentially emotional experience is managed well via the computer interface.

As this study concludes with the proposed key UX principles for designing computer interfaces for vulnerable users, further research is required to evaluate the designed key principles. In addition, the evaluation may include comparing the emotion and experience of different vulnerable groups in order to better understand synergies.

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