

Enhancing user interaction through the design of digital information environments in information services

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Abstract

The interface computer systems are adaptive and context-aware in order to enhance user engagement in online information environments, such as Ukrainian digital services, such as Diia, and library systems based on VuFind. The discovery of the usability perceptions, critical design aspects, and cultural influences is conducted through a qualitative thematic analysis through an analytical sample and in-depth interviews with 10-20 users of digital platforms in Ukraine. The study proposes a context-aware UX framework (CAUXF), which has adaptive interface design, environmental, behavioural, and cognitive-emotional characteristics, and user modelling with personalisation. The proposed model consists of a user context profile, a context information manager, a conversation supervisor, a context-awareness service manager, and embedded mobile services. The researchers concluded that 45% of digital platform users in Ukraine rated them as being moderately challenging to use, half of them recognised key elements of design such as simplified user interfaces, and 60% desired the capability to customise it. The cultural and contextual analysis of the Ukrainian-language interfaces in the current study revealed that 80% of them were preferred. The paper highlights the relevance of user-centred design considerations that meet the needs of Ukrainian digital users in their technological and cultural contextual environment by using more simplified interfaces, mobile compatibility, language localisation, and infrastructure issues.

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1. Introduction

Digital-user interaction needs to be enhanced not just by proper design of digital systems, but also by an interface that is responsive, accessible, and customized to suit the needs of a particular user. When these interfaces are more location and use-specific, they get more personalised and become more natural. Hence, to develop a useful user interface that is easy to use, attractive, and dynamic, and that accommodates varying user goals and contextual needs, a good grasp of user behavior, a sustained feedback system, and a commitment to the iterative process are essential. Different types of interaction, including speech, gesture, touch, and facial recognition, enable smoother communication between users and systems and are an essential way to improve the user experience [1], [2]. A combination of virtual reality (VR), augmented reality (AR), and smart wearable technologies has led to greater human immersion and engagement by incorporating interactive frameworks into people's lives, thereby enhancing human-computer interaction.

The main objective of human-computer interaction (HCI) is to minimize the distance between humans and technology by providing user interfaces that are both user-friendly and usable. User experience (UX) is an overall concept comprising several interrelated factors, among them usability, visual design, emotional appeal, and accessibility, all of which need to be combined to form a fulfilling experience [3], [4]. Moreover, aesthetics and visual design are critical for drawing a user's attention and ensuring engagement. Similarly, anthropological emotional aspects such as comfort, pleasure, and frustration have been shown to play a significant role in user retention and adoption of a digital system [5].

The digitalization of state services, including the creation of digital libraries, education services, and the government portal Diia, etc., is increasing in Ukraine at an incredible pace. Nonetheless, there are various limitations to these online information spaces, including low usability, information overload, and a lack of user orientation. This is specifically pronounced with government portals such as Diia, which are usually not designed in a friendly manner. Although there are numerous studies of user interaction in digital environments in other countries, there are few studies related to the Ukrainian context. Most likely, the cultural, linguistic, and technological peculiarities of Ukraine may affect user preferences and perceptions of usability, but the literature provides only limited information on these issues.

Thus, this study aims to explore the behavior and attitudes of Ukrainian users toward digital information spaces in public services and to examine how design can enhance their user experience. The main research questions to guide this study are as follows:

RQ1: What are the perceptions of digital users in Ukraine on the usability of digital information environments in public services?

RQ2: Which computer design features do digital users in Ukraine consider essential for successful engagement within digital information spaces?

RQ3: How do cultural and contextual factors influence digital users' preferences regarding the design of digital information environments in Ukraine?

1.1. Conceptual framework

The paper is dedicated to human-centered design, including special attention to usability and cultural models. There are a variety of user-interaction research studies of digital systems that have universally utilized international models, including Nielsen usability heuristics and conventional user experience (UX) models of interface design. A wide variety of theoretical frameworks have been used to inform user experience design, with user-centered design (UCD) among the most popular. UCD can be used to create systems that consider users' preferences and needs, making them more usable and satisfying. Therefore, it offers a good model of examining how to render digital interfaces useful and relevant to particular user groups. Nevertheless, there is a lack of studies with a specific orientation to the Ukrainian digital environment, e.g., Diia, public libraries, and

educational services. This is particularly evident in qualitative studies, which prioritize the user perspective in the quest to achieve effective engagement with digital information environments.

However, interaction designers often have difficulty analyzing rapidly changing user groups who use rapidly changing technologies. Therefore, the technology acceptance model (TAM) is often used to investigate technology adoption, with a focus on perceived error and inefficiency as factors that could impede it. Although TAM can be of significant value, interactive system research is inherently grounded in the principles of human-centered design. The goal of researchers in this area is to focus on user purposes, behaviour, and constraints to develop systems that allow natural and intuitive interaction [6].

The inclusion of human contributions in the design process enables digital systems to be simpler and more user-friendly, especially as technology increasingly shapes our everyday lives. Patterns of interface design have been extensively studied to improve usability. These design patterns provide solutions to common interaction problems, offer reusable, simpler-to-use interfaces, enhance predictability and consistency, and ultimately make systems easier to comprehend and use [7]. A feedback mechanism can have a strong impact on the systems and how users perceive and interact with them. Relevant feedback provides the user with confidence, less ambiguity, and a better understanding of the consequences of their actions. Effective feedback, whether tactile, visual, or auditory, enhances the user experience to enable the successful accomplishment of tasks [8].

Similarly, the cognitive load is an important feature of the interactive system design. When systems help to reduce unwanted mental work, users can work more effectively and with fewer errors. Studies have shown that a clear visual hierarchy, user-friendly layouts, and the concise presentation of information can significantly reduce cognitive load [9]. User satisfaction is also highly influenced by emotional factors, rather than by system performance and functionality, which are important factors. Positive emotional reactions, including enjoyment, attention, and comfort, enhance engagement and retention. By implication, emotionally sensitive interfaces and those that can respond to human feelings and preferences will foster more meaningful, emotional engagement [10].

1.2. Design strategies for improved mobile interaction

Research into digital interaction highlighted the importance of an adaptable design style, such as a gesture-based navigation system and a simple layout, which can adjust to user behaviour and environmental factors [11]. Also, multimodal interaction incorporates multiple forms of input, such as speech, touch, and gesture, to create a more natural and accommodating interface. The hypothesis of [12] was that in systems which enable multimodal interaction, users can interact with digital environments as they wish, anytime, with better accessibility and contextual flexibility. Gamified systems can be used to promote more active, valuable user interaction by adding features such as progress tracking, levels, and incentives.

According to research by [13], gamification, when used wisely, improves learning effectiveness and time-on-task. Another important element of the user experience is accessibility. Hence, interfaces designed to support users with physical, sensory, or cognitive disabilities will improve system reach and inclusiveness. As explained in [14], voice commands, screen readers, and adjustable font sizes are features in digital systems that allow users to act more freely and effectively within them.

1.3. Personalization

Productivity increases with customized interfaces that remove redundant information and display data aligned with each user's goals and behavior [15]. Practical evaluation techniques that encompass quantitative (performance measurements and satisfaction scales) and qualitative (user interviews and observation) methods are essential for determining the consequences of design choices on usability [16]. Moreover, its usability testing provides direct insights, as actual users can be observed using the system [17], [18].

Thus, proactive identification and resolution of usability problems are enabled through repeated digital system testing. As stated by [19], the presented information is better received through well-designed data visualization

(charts, dashboards, and infographics) rather than plain text, and therefore complex data can be received and interacted with more easily. Also, there is a growing trend toward interactive systems with social interaction capabilities, where users can engage, contribute, and co-create content, build community, and sustain interaction. In the meantime, recent research by [20] and [21] has revealed that online platforms that incorporate social features generally exhibit greater rates of continued usage and user penetration.

1.4. Aesthetics and visual design role in user engagement

When it comes to visual appeal and functional readability, factors such as color harmony, typography, layout, and visual balance come into play, underscoring the significant role of aesthetic and visual elements in how users interpret a system. Visually appealing interfaces are also likely to make a better impression and increase users' willingness to interact [20].

1.5. Intuitive design & integrating interactive elements in digital education

Findings from research by [22] and [23] indicate that students would be more active on platforms that support different learning styles and skill levels through intuitive navigation, multimodal content, and responsive design. A study by [24] suggests that user interfaces can be made more intuitive to improve the learning process and the productivity of future designers through the use of creative software. Academic performance and engagement can be enhanced through interface elements that collect, visualize, and respond to behavioral data [25]. In the meantime, [26] reported the significance of the complexity of search tasks, the structure of the content, the relevance of links, and familiarity with navigation systems in users' satisfaction and their assessments of digital resource systems. Also, the digital libraries have become more sensitive to individual needs and consumption trends by incorporating artificial intelligence and adaptive systems [27], [28], [29], [30].

1.6. Digital engagement in cultural spaces & usability

According to the study conducted by [31], they suggested that digital layering on traditional maps and augmented features of reality could be integrated with interactive systems to guide tourists and provide contextual information based on their current position and preferences. In the meantime, other cultural institutions, including museums, have also embraced digital technologies that use touchscreen displays, interactive guides, and immersive virtual experiences, allowing historical or artistic content to be brought to life in new forms to reach a wider audience, such as [32].

A study carried out by [33] examining digital markets for cultural products found that technology helps people produce symbols and exchange the value of creative outputs. It stated that digital systems must be easy to use, brand, content-curate, and support the management of digital rights. Moreover, virtual exhibitions have also used gesture-based interfaces, such as mid-air gesture recognition, allowing users to naturally engage with exhibits without a touchscreen in places that may not be conveniently located, such as communal areas (where touchscreen interfaces are less useful) [33] [34].

On the same note, a systematic review of digital technologies in museums by [35] suggests that the most significant factor in success is effective user experience design, with intuitive, responsive, and context-sensitive systems most appropriate for visitor interaction. According to a study on the quantitative analysis of content layouts by [36], the simple structure of content layouts positively increases understanding, reduces bounces, and promotes further use of platform features. In a separate related study by [37], it was established that communication theories also recognize many forms of interactivity, including interaction with content, the medium itself, and other users, and discuss the role of these forms in interpretation and engagement.

Although perceived interactivity has been found to promote user enjoyment, especially when the surroundings are artistic or exploratory, a study by [38] reveals that pleasure is not always associated with the user's identity or brand loyalty, which makes UX design a complicated task. Similarly, studies by [39], [40] on portal media interfaces reveal that internal content structure has more influence on user retention compared to home page

design, and that users with an interactive content structure, one that can be searched and effectively layered, are likely to be more occupied.

Interfaces that propose similar artifacts or rearrange content based on visitors' interests can improve the learning experience and the emotional response to the exhibit [41]. Mobile and embedded systems have been used to develop frameworks for capturing and analyzing visitor behavior at cultural institutions, thereby helping institutions refine exhibit design based on data-driven insights into visitor movement, attractions, and duration of stay [42]. Lastly, works on physical personal interfaces by [43], [44] imply that design techniques can be rethought by merging digital information with physical matter, such as clay, sand, or other textures, which encourages new interrogation and allows easier manipulation.

2. Research method

The research examines the notions, experiences, and inclinations of Ukrainian users when they engage with digital information environments, including digital libraries, government portals, and educational websites, using a qualitative research design. Information-gathering was carried out in the form of in-depth or group interviews, which were realized through the procedure of analytical sampling, and the sample, which consists of students, librarians, educators, and professionals, namely, users of the Diia platform and the library systems based on Vufind that were used in Ukraine in particular. To reach data saturation, the range of experiences and problems faced by Ukrainian users is to be captured by involving 10 to 20 people in the research.

The interviews have taken place online via Zoom and in person, lasting about 30 to 60 minutes, as participants preferred to share their thoughts and availability while in Ukraine. The information derived from the interviews was examined using transcription, data coding, and theme identification [43]. To maintain high ethical standards, the study was conducted in accordance with Ukraine's data protection laws, with informed consent to ensure that participants were aware of the study's aim, their right to withdraw at any time, and that their data would be used. The identity of the participants was not archived, and their anonymity was maintained. The second design is known as Adaptive interaction design.

2.1. Adaptive interaction design

Adaptive design is designed to make digital interfaces usable and operable across a variety of monitors, environments, and devices, including computers, mobile phones, and wearables, and to adapt their functionality and design to offer a consistent and valuable user experience. For example, if the task organizer sees a complex graph on the computer and opens simpler lists on the smartwatch, he or she will still be able to perform the necessary tasks (Figure 1). Therefore, this will contribute to the inclusivity of digital systems by removing the obstacles caused by technological constraints.

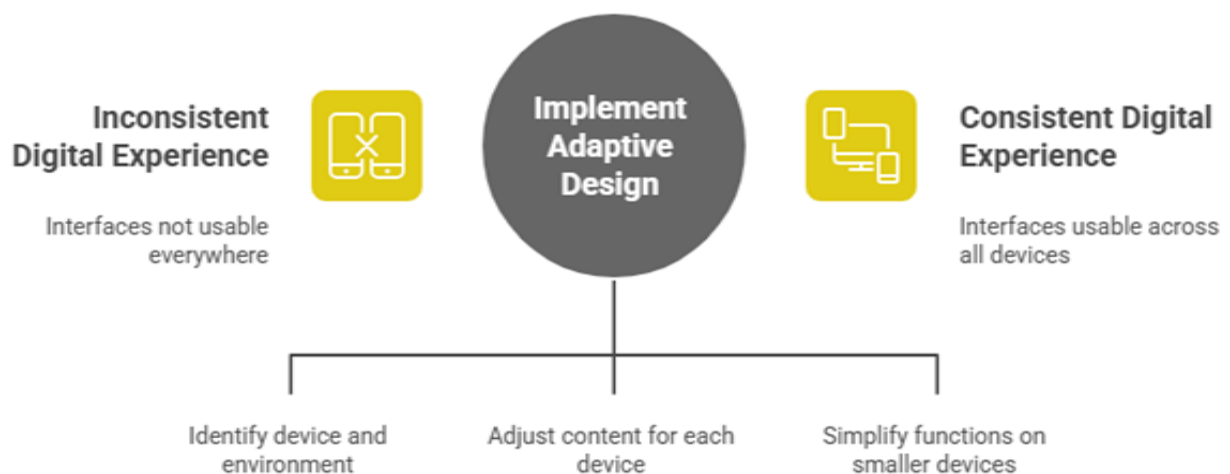


Figure 1. Adaptive interaction design

2.2. Awareness of context

Context awareness refers to the ability of digital systems to determine the location, time, and manner of device usage and to modify system activity to the prevailing circumstances. Unlike sensor-only systems, the proposed architecture in the present study uses a hybrid solution that combines sensor-based approaches (GPS, motion sensors, time-related information, and environmental factors) and user-based approaches (preferences, activities, social roles, and emotional needs). Under this approach context is organized into three fundamental dimensions which are the environmental dimension which refers to the physical location of the user, time, and motion; behavioral dimension which describes how and when the user interacts with the system during the activities; and the third dimension is the cognitive-emotional dimension which reflects the mental state of the user, priorities, and tolerance of interruptions.

2.2.1. User modeling and personalization

User models are built through unrelenting learning and combine different sources of information to capture usage patterns that elucidate what users do and when they take their steps and preferences, which are formed explicitly or implicitly when a user interacts with it. Besides this, there are behavioral clusters that form patterns of interaction over time and space. As one might have supposed, with the development of artificial intelligence capabilities, the process of user routine development is natural, and the user model automatically adjusts to these shifts. Hence, the suggested CAUXF is presented as a unifying framework of applying these principles, as shown in Figure 2.

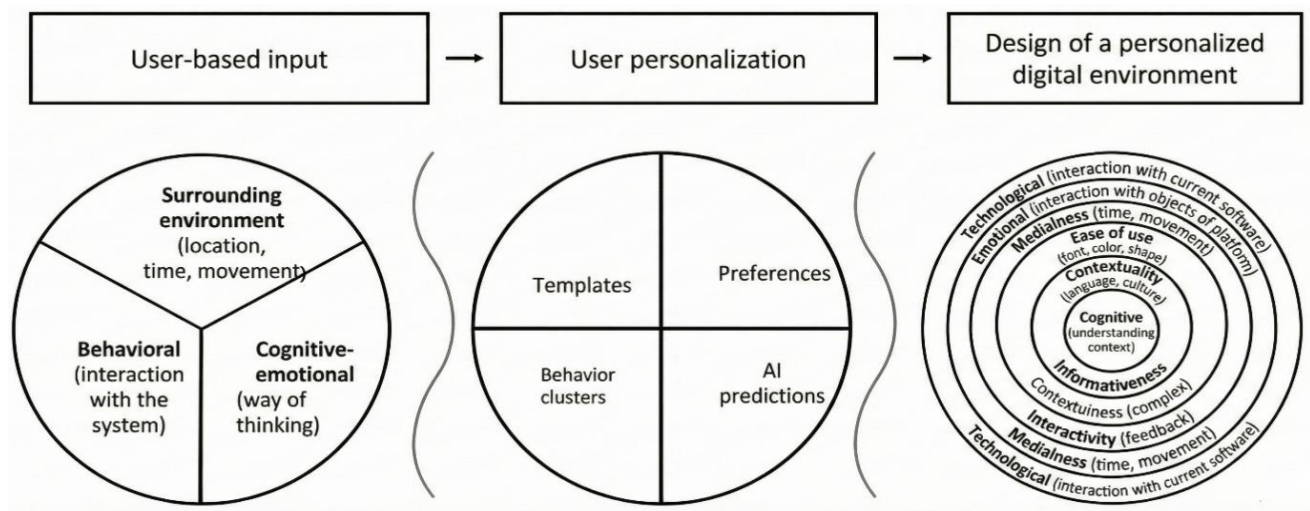


Figure 2. Designing a digital environment using a modular UX architecture

A modular, adaptable architecture consisting of five essential components that, together, enable intelligent, flexible user interaction and incorporate context-aware, adaptive elements into user interfaces forms the foundation of the proposed approach.

2.2.2. User context profile (UCP)

The user context profile in digital systems allows users to clearly define personal contexts, such as identifying certain places as work or home, and what they like doing in those contexts, such as turning off notifications during a meeting or conference. Accordingly, the system can accommodate situational and individualized behavior. Similarly, the context information manager (CIM) in a digital system is tasked with regulating and sustaining relationships among various contextual conditions, such as tasks, time, and location. Over time, the system can begin to extract recurrent patterns and respond to them in an intelligent and flexible way.

2.2.3. Conversation supervisor

The conversation supervisor provides feedback loops and simple prompts to help the user check, verify, or edit their settings, ensuring a smooth, open flow of information between the system and the user. To illustrate, if a user stays in the same place and the system detects it, the user can be asked a question: "Would you like to save this as a new place?" The context-awareness service manager (CASM) is a context-aware service that supports proactive behaviour, e.g., controlling notification preferences, proposing tasks, or automatically launching applications without explicit user input.

2.2.4. Embedded mobile services

The structure is integrated into mobile services already on the market, such as messaging applications, calendars, and GPS systems. Consequently, it is not a one-sided solution but will be an inherent part of the user's digital life, making it easier to use and accept. In addition, the user interface is modified to provide or assist with selections based on certain conditions of use. Smart indicators are introduced to send the user timely, interest-based notifications, and task recommendations are provided in real time based on temporal and spatial context. Lastly, overall usability is evaluated relative to the context, using relevant parameters such as user satisfaction, error rates, and perceived ease of use.

3. Results and discussion

3.1. Results

The findings from this study are presented below to address the aforementioned research questions.

3.1.1. Usability perception (RQ1)

The initial theme explored in this research concerns Ukrainian users' perceptions of the usability of online platforms, particularly ease of use. Almost half of the respondents, or about 45%, stated that the websites were not so easy, but still manageable. Participants, however, indicated that improving navigation could be achieved by making the interface less complex. A significant number of respondents, that is, 30%, indicated that the online platforms were friendly.

Furthermore, the platforms were well-designed, which also led to a good user experience overall. Although they are generally useful, 25% of respondents reported problems with these platforms and attributed them primarily to the interface's complexity and poor navigation, as shown in Table 1.

Table 1. Usability perception of system usability

Usability Perception	Percentage (%)
Easy to Use	30
Somewhat Challenging	45
Difficult to Navigate	25

The above distribution indicates that, while some (about 30%) users are satisfied with current design solutions, this is not the case for all participants. Therefore, usability challenges persist in digital services.

3.1.2. Critical design elements (RQ2)

The second research question aimed to determine which design features Ukrainian users perceive as important for engagement with the digital information environment. The study results have suggested three design factors that seem especially significant: user interface clarity, customization, and mobile compatibility. Approximately 50% of respondents, or half, opined that a plain user interface is a fundamental requirement for application performance and further stated that a clear, straightforward design would go a long way toward enhancing their interaction with the site. Also, 30% of users said the number of pop-ups is excessive, and the design in general

must be simpler because it is challenging to navigate platforms with too many interface elements. Figure 3 represents the spread of these responses (see Figure 3).

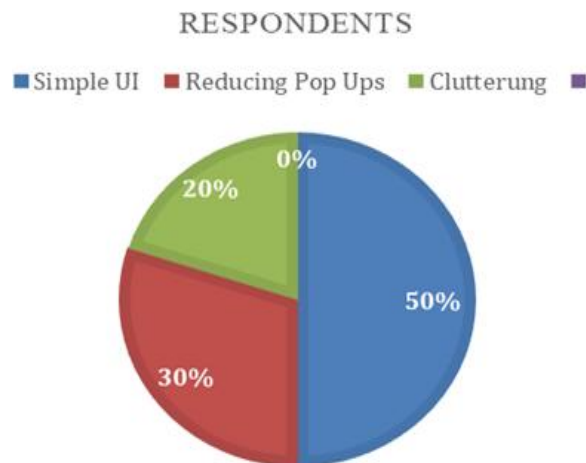


Figure 3. Critical design elements vs respondents

3.1.3. Customization options

Most respondents (60) stated that they should have more control over themes and layouts, e.g., have the option to use dark mode, change font size, etc. Moreover, 40% of the respondents added that the options would enhance their engagement with the sites, since mobile compatibility, according to 70% of the participants, is the most important design element due to the widespread use of mobile devices. In contrast, in the desktop version, 30% of participants reported satisfaction, but most added that the mobile version needed improvement to be more responsive and user-friendly on small screens (see Figure 4).

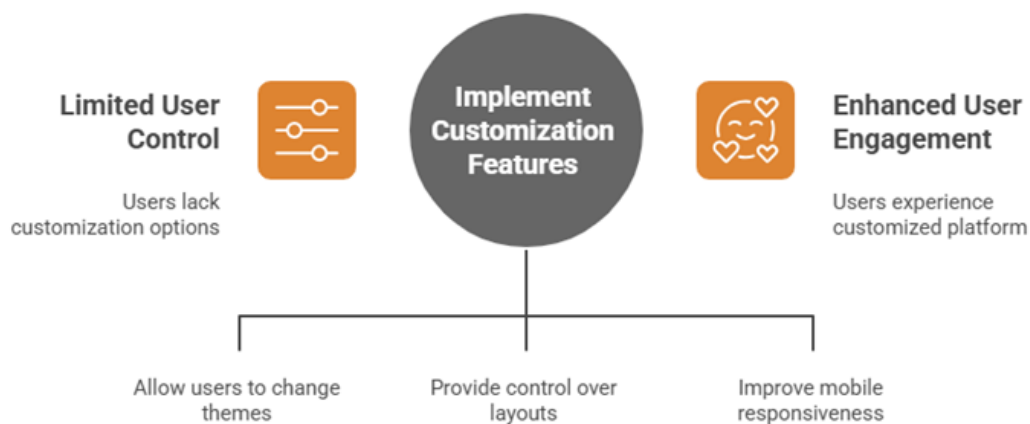


Figure 4. Enhancing user engagement through customization

3.1.4. Cultural and contextual influences (RQ3)

According to the role of culture and context in shaping user preferences for digital information environment design, the thematic analysis of the data from this research study identified two common themes: language and technology.

3.1.4.1. Language preferences

Most respondents (80%) used Ukrainian as their primary language when accessing local services, especially government portals and electronic libraries. A fifth of the respondents (approximately 20) said that they felt comfortable with English interfaces. A significant number of participants expressed a strong desire to work in Ukrainian, indicating the enduring importance of linguistic accessibility in the Ukrainian workplace.

3.1.4.2. Technological infrastructure

Poor internet speed (reported by many participants, up to 65%) is another factor that impedes effective use of digital platforms. Contrastingly, 35% of respondents noted that their devices are compatible with the platforms, but network speed and connectivity remain impediments to their use. The results indicate that the majority of users do not have many problems with platform functionality on their devices, and that the internet infrastructure is a critical factor in overall usability (see Figure 5).

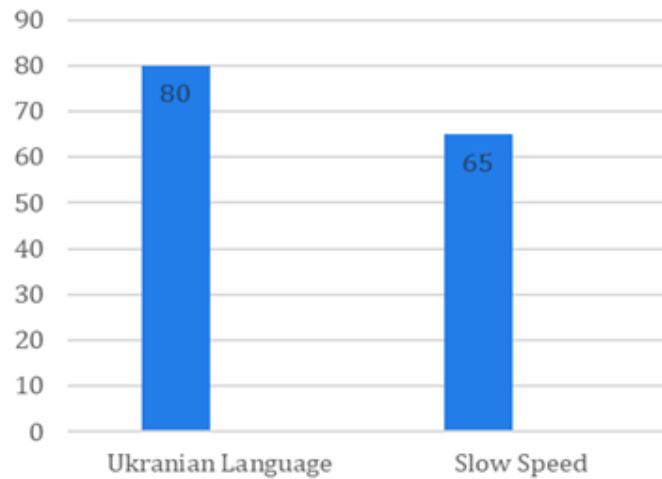


Figure 5. Cultural & contextual influences

3.2. Discussion

This study demonstrates that users on Ukrainian digital platforms bear a heavy cognitive load, and most cannot process visual images or interface logic while engaging in an action. Diia and other Ukrainian websites have a medium level of perceived usefulness. Still, perceived ease of use is low, leading to user frustration, mistakes, and a lack of confidence in the digital government. As stated in [41], effective HCI in a public service setting requires a critical concern for users' cognitive processing abilities. That information suggests Ukrainian platforms have been inconsistent in applying these concepts, creating interfaces that do not meet basic usability criteria.

A recent study has shown that personalization is a significant contributor to customer satisfaction [13]. The values emphasized by Ukrainian users include individualization and simplicity, as well as low cognitive load, which emphasizes low design and is informed by UX research. This difference can signify the transformation of Ukraine's digital realm.

Respondents favored interfaces using real Ukrainian words, indicating that a language interface emphasizes identity over functionality. This research contributes different knowledge aspects. The former is the first section to contain empirical evidence of the usability trends in post-Soviet, conflict-ridden Europe, which is underrepresented in the HCI literature. Second, the research indicates the impact of infrastructure constraints, cultural influences, and language factors on design requirements, which are lacking in the model presented. The findings suggest that contextual resilience and cultural-linguistic factors should be incorporated in new theoretical frameworks. Third, this paper provides platform-specific design best practices for the Ukrainian platform.

This study has several disadvantages. A small urban sample was employed in the study, which underrepresented rural users who likely have greater infrastructural limitations. In this qualitative research study, no quantitative usability test was conducted based on predefined criteria. Qualitative depth in measurement, combined with a quantitative approach, provides a more holistic evaluation, as suggested by [12] and [14]. The extent to which the results of this study reflect long-term preferences rather than situational adjustments is unknown, as the study was conducted in the context of military hostilities in Ukraine in 2024-2025. Lastly, the research is

narrowed to the study of Diia- and Vufind-based library systems in Ukraine, which may limit transferability. Despite these shortcomings, the results indicate that digital service providers ought to focus on mobile optimization, use culturally authentic Ukrainian interfaces, ensure visual clarity grounded in psychological HCI, and incorporate customization within simplified designs. The latter could also be covered by policies that specify requirements for usability and require routine evaluation using validated tools.

4. Conclusions

This study proposes a workable guideline for improving user interaction in the online space in Ukraine by designing more flexible, situation-responsive interfaces for online systems. Even though Ukrainian digital platforms have major usability problems, they are not terminable. Even more so, it is hoped that, based on lessons learned from current HCI research, developers will be able to develop digital services that are usable and acceptable to the culture by applying the principles of user-centered design in the context of Ukraine's cultural, linguistic, and infrastructural realities. With further digitalization in Ukraine, user experience quality will become crucial to the platform's success and the development of trust in digital governance. Currently suggested context-aware UX framework (CAUXF) of the present paper turns digital technology into the tools that learn along with users and adapt to their behavioral patterns, which goes beyond the functional aspect, and allows implementing the aspects of digital features that address user needs, such as informing users in real-time, providing them with the option to define their preferences and carefully designed layouts of the interface.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

The contribution to the paper is as follows: O. Borysenko, M. Diachenko: study conception and design; M. Diachenko, I. Diachenko: data collection; O. Borysenko, M. Diachenko, I. Diachenko. O. Kravchenko: analysis and interpretation of results; O. Kravchenko, Y. Shunevych: methodology development; O. Borysenko: draft preparation; M. Diachenko, I. Diachenko, Y. Shunevych: critical revision of the manuscript for important intellectual content. All authors approved the final version of the manuscript.

Declaration of use of AI in the writing process

During the preparation of this manuscript, the authors utilized AI-assisted tools exclusively for grammar and stylistic verification of American English, as none of the authors are native English speakers. Leading international style guides and grammar references were integrated into the AI system to ensure linguistic accuracy and compliance with academic writing standards. The manuscript was additionally reviewed and approved by a professional philologist. All conceptual content, research design, data analysis, interpretation of results, and intellectual contributions remain entirely the work of the authors. The AI tools were used solely as language enhancement instruments and did not contribute to the generation of research ideas, methodology, or conclusions. The authors take full responsibility for the accuracy and integrity of all content presented in this manuscript.

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