Rethinking Usability Assessment: Integrating UX and Information Architecture

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Abstract: Evaluating software usability in the early stages of development is important, thus avoiding costs associated with future changes and dissatisfied users. Current usability inspection techniques may be limited in scope as they do not embrace concepts such as User Experience (UX) and Information Architecture (IA). This paper presents a new set of heuristics based on Garrett's elements of UX to be used in usability inspections, aiming to create systems that prioritize UX and IA aspects as an alternative to existing heuristic sets. The set was developed based on Garrett's planes of UX, resulting in the creation of 14 heuristics organized according to each UX plane. We conducted an empirical study to analyze the technique's feasibility. The results indicate that the new heuristics set can detect a reasonable amount of defects within an appropriate time frame. Additionally, we received feedback on the heuristics themselves, allowing for slight modifications. Finally, the paper concludes by discussing future directions for the new heuristics set.

1 INTRODUCTION

Usability can be defined as the ease of use of a system and acceptance from a specific group of users, and it is important to evaluate it in the early stages of the project, thus avoiding possible costs and difficulties in redesigning the software (Holzinger, 2005). Taking this into consideration, one low-cost way of assessing system usability is through usability inspection methods, which rely on interface review by experts rather than direct interaction with users (Novick, 2007).

Heuristic Evaluation (HE) is an inspection method introduced by Nielsen and Molich (1990) . In this technique, a group of usability experts analyzes a system's interface based on a set of principles known as heuristics. During the evaluation, the experts identify usability issues and assess their severity (Novick, 2007). This method is widely used and is commonly based on the set of 10 heuristics proposed and tested by Nielsen and Molich in 1990 .

To conduct a HE, it is recommended that the evaluation not be done by just one specialist, but rather by 3 to 5 assessors individually (Nielsen, 1990). Furthermore, HE offers several advantages, such as being cost-effective, intuitive, and not requiring prior planning (Nielsen and Molich, 1990).

Although HE provides a valuable approach to detecting usability issues and certain advantages, its applicability may be limited in scenarios where the system emphasizes user interaction (Masip et al., 2011).

Similar to usability, User Experience (UX) is considered a quality attribute of software, broadening the aspects of the user's interaction with the system. Norman (1995) was one of the first researchers to use the term UX, with the intention of encompassing all aspects of the user's experience with a system. Norman coined the term UX because he believed that usability was too narrow or limited to represent a comprehensive view of human-computer interactions (Norman et al., 1995).

UX is a multifaceted concept encompassing the interaction between users and products or services, emphasizing both the immediate and evolving nature of these interactions. Hassenzahl highlights UX as a temporal, evaluative feeling driven by the fulfillment of fundamental human needs such as autonomy, competency, stimulation, and relatedness (Hassenzahl, 2008). The Nielsen Norman Group expands this definition by framing UX as the holistic experience, integrating various disciplines to ensure usabil-

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ity, satisfaction, and efficiency beyond just the visual interface (Norman and Nielsen, 1998). Garrett (2011) further complements this perspective by focusing on the real-world behavior and context of use, emphasizing that UX extends beyond functionality and aesthetics to include the broader experiential and situational aspects.

In addition to defining UX, Garrett (2011) introduces the concept of Information Architecture (IA), which focuses on how users cognitively process information by creating organizational and navigational structures that facilitate efficient content navigation. Building on these ideas, Garrett presents a five-plane framework, each addressing specific purposes and elements to guide the design process, ensuring a system that provides a positive user experience.

In this sense, conducting research to evaluate UX and address IA issues in the early stages of system design is crucial for creating user-centered systems that deliver meaningful and efficient interactions. That way, designers can ensure the system aligns with user expectations and emotional responses, reducing the risk of costly redesigns later in the process. Since IA focuses on how users process and navigate information, enabling the creation of intuitive organizational and navigational schemes, the early-stage attention to IA ensures that the system's structure supports clear and efficient user interactions, minimizing cognitive overload and enhancing usability(Garrett, 2011).

Considering the need to evaluate UX and address IA issues early in system design, we propose UXIA, a new set of heuristics based on Garrett's UX elements. These heuristics cover content, IA, navigation, and layout, aiming to provide a framework for assessing both UX and IA during the initial design phases. UXIA was developed to help product teams create a cohesive and well-structured user experience from the outset, ensuring that key design elements are integrated early in the process.

We also conduct a feasability study, attempting to assess UXIA's initial viability. The evaluation revealed several usability issues, such as difficult navigation and inconsistent icons, which led to refinements in the heuristics, including clearer descriptions and the addition of a new heuristic focused on media format, enhancing UXIA's ability to evaluate both UX and IA effectively.

From this study, we aim to develop a more comprehensive and effective heuristics set, capable of guiding the design of system interfaces from the early stages of the project, prioritizing UX and IA.

2 BACKGROUND

2.1 Garrett Framework: The Elements of User Experience

Garrett (2011) proposed a framework of UX elements planes that presents an organizational structure for the web application design process. It aims to divide UX into five distinct and complementary planes, with the goal of providing a comprehensive and holistic understanding of UX, as shown in Figure 1.

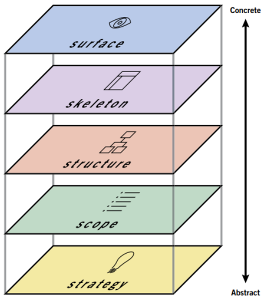

Figure 1: Garrett's planes framework(Garrett, 2011).

Each plane of the framework represents a unique perspective of UX, being used to ensure that no aspect of users' experience when using the product is neglected. The framework's structure is conceived in a bottom-up approach, in which each plane increases concreteness, providing a more detailed and specific view at each stage. Figure 1 illustrates the five planes of the framework. The following are each of the planes in detail:

The first plane is the **Strategy**, which concerns the objectives of the application, both internally and externally. Internally, these objectives are aligned with the product goals and business objectives, while externally, they address the needs of the application's users(Garrett, 2011).

The second plane is the **Scope**, which addresses the application's functional specifications and content requirements. It involves a detailed description of the product features, as well as the media contents that will be shown in the application(Garrett, 2011).

The third plane is the **Structure**, which focuses on interaction design and IA. Interaction design refers to the system's behavior in dealing with user interactions, while IA involves arranging media content and interface elements to facilitate user understanding(Garrett, 2011).

The fourth plane is the **Skeleton**, which is divided into three parts: information design, interface design, and navigation design. Information design deals with the presentation of data to facilitate user understanding, interface design involves the elements that allow users to interact with the application interface, and navigation design refers to the elements that allow users to move through the application through IA(Garrett, 2011).

Finally, the fifth plane is the **Surface**, which stands out for the importance of the user's sensory experience. At this plane, content, functionality, and aesthetics come together to produce the final design of the product, fulfilling the objectives established in the four previous planes.

Garrett's framework provides a thorough approach to UX design, covering all aspects of user experience, from strategy to sensory design. Its bottom-up structure helps create cohesive designs by aligning business goals with user needs, offering a solid foundation in more structured design processes.

2.2 Different Approaches to Usability Heuristics

Masip et. al. (2011) note that Nielsen's heuristics (Nielsen, 1993) are insufficient for evaluating interactive systems. They present two cases where standard heuristics failed. In the first case, the evaluation of Berta, a virtual assistant for the Lleida City Council, focused on dialog and facial expression issues, which were not addressed by traditional heuristics. In the second case, the evaluation of public kiosks (PICs) required heuristics that considered the physical environment and hardware features, which standard heuristics did not cover. These examples demonstrate the need for alternative evaluation approaches for interactive systems.

One of the various approaches to adding the UX perspective to usability inspection is attempted by Choma et al. (2016), in which a set of usability aspects is selected when inspecting a system. Then, a group of typical users is selected, indicating the degree of importance of each aspect. The idea is that, through these steps, a relative usability degree can be generated to identify the usability degree of the evaluated application. Despite the approach adding the UX perspective to usability inspection, the technique used presents results that are influenced by the high degree of subjectivity of the experts.

On the other hand, Bolchini et al. (2009) propose a usability inspection technique that addresses various design dimensions, including content, IA, navigation, and layout. This technique consists of a set of heuristics analogous to traditional usability heuristics, but all related to semiotics, with the aim of identifying problems in interfaces. Although the initial focus of the work is to assist designers and testers in conducting a semiotic inspection on a specific website, it is important to note that the set of heuristics does not explicitly focus on evaluating the UX.

Islam et al. (2020) conduct an experiment to evaluate the creation and application of the SIDE framework, a new set of heuristics designed for the semiotic analysis of web and mobile interfaces. The study compares the effectiveness of this new method with the traditional HE (Nielsen and Molich, 1990), demonstrating that each approach identifies different types of usability issues. While Nielsen's heuristics (Nielsen, 1993) are more effective in detecting structural problems, such as navigation and layout, the proposed heuristics framework prove to be more precise in analyzing the intuitiveness and clarity of visual signs. The results indicate that Nielsen's set of heuristics can be complemented by other frameworks, such as the SIDE framework, to achieve a more comprehensive and detailed evaluation. In this case, the complementarity allowed for a more in-depth examination of the semiotic dimensions of the interface.

Parente Da Costa et al. (2019) conduct a systematic literature review to identify usability heuristics for mobile applications, highlighting gaps such as the lack of heuristics that consider usage context, mobility, and dynamic environments. It also emphasizes the importance of heuristics that address cognitive load by reducing interface complexity, minimizing memory demands, and providing clear feedback to improve efficiency and user experience, especially in multitasking scenarios.

In addition to the previously mentioned studies and approaches, it is important to emphasize the role of IA in system design. Morville and Rosenfeld (2006) highlight that incorporating IA early in the design process offers significant benefits. These include reducing costs related to locating and identifying incorrect information. Furthermore, the authors note that integrating IA enhances the user experience, leading to a more efficient and intuitive application design.

The cited papers propose new heuristics encompassing UX, AI, and other contexts, analyze existing heuristics, and conduct systematic reviews to refine usability evaluation and enhance interface design. However, none of them presents an approach that integrates IA and UX concepts into a single comprehensive and effective heuristic set. The objective of the work presented in this paper is to create a set of heuristics that addresses these identified gaps by integrating IA and UX concepts into a unified framework.

3 DEVELOPMENT OF THE UXIA HEURISTICS

3.1 Concept and Methodology

In this section, we describe the UXIA Heuristics, a heuristics set developed to integrate UX and IA concepts into the system design process. Based on Garrett's UX elements(Garrett, 2011), the UXIA heuristics aim to support usability evaluation by ensuring the inclusion of UX and IA perspectives in the development process. UXIA heuristics should be applied during usability inspections and can be used at any phase of development, as long as prototypes are available for evaluation by usability experts. This flexibility allows the technique to be adapted throughout the entire project lifecycle.

The approach for the use of UXIA opts for a HE as a usability inspection, aiming to provide a simple assessment(Novick, 2007) that can be quickly conducted without user participation, making it easier to implement.

To create this set of new heuristics, we followed the methodology proposed by Rusu et al.(Rusu et al., 2011), which involves initial research through exploratory, descriptive, and correlational steps. This process moves on to describing the heuristics themselves and, finally, validating and refining the created set of heuristics.

3.2 Initial Research

The initial research steps arose from the observation that applications focused on user interaction were not fully covered by evaluations using Nielsen's heuristics(Nielsen, 1993), as seen in related works(Masip et al., 2011). Therefore, it was necessary to develop a set of heuristics that considered the UX perspective when assessing such applications. In this regard, an in-depth study of Garrett's work (Garrett, 2011) was conducted to create UXIA heuristics for each of the planes proposed by Garrett.

3.3 Describing UXIA Heuristics

After the initial research step, the next step(Rusu et al., 2011) involved developing the heuristics themselves. Based on the study of Garrett's work, initially, we developed UXIA comprising 14 heuristics that cover each of the planes of UX elements proposed by the author (Garrett, 2011). Subsequently, the heuristics are presented and organized according to Garrett's planes.

Below, we present the heuristics that have been developed.

Strategy Plane

Garrett (2011) highlights the importance of user segmentation and its impact on the overall user experience of an application. He also points out that users in different roles have distinct needs. With this in mind, we developed H1:

H1: Application for Multiple Types of Users - Attention should be paid to ensure that, according to the objectives, the application is designed for more than just one type of user.

H2, on the other hand, was developed based on Garrett's insights(Garrett, 2011) that suggest that to create a good UX, every decision must be rooted in an understanding of its consequences, closely aligned with the intended goal.

H2: Clear Application Objective - It is necessary to evaluate whether the application's objective is clearly defined and evident within the application, ensuring it aligns with its intended purpose.

Scope Plane

When discussing the scope of an application, Garrett (2011) emphasizes the importance of including essential functionalities that are directly aligned with the proposed objectives. He underscores the need to avoid incorporating unnecessary features that could potentially complicate the product without adding significant value. Based on these considerations, we developed heuristics H3 and H4:

H3: Essential Features - The application must have the essential features to achieve the business objectives.

H4: Inconsistent Features - Evaluate the presence of features that are not part of the application's scope to prevent the loss of the objective.

Based on Garrett's observations(Garrett, 2011), aligning content with required functionalities is more than just creating text or visuals. It's essential to understand how this content will be used to achieve strategic goals and meet user expectations. From these insights, we developed H5:

H5: Cohesive Content with Features - Ensure that the content, texts, photos, and media in general, are related to the features in a cohesive manner.

Structure Plane

Garrett (2011) suggests that a significant aspect of interaction design involves handling user errors, which includes considering how the system behaves when errors occur and how to prevent them from happening in the first place. From this perspective, we developed H6:

H6: Effective Error Management - Applications need to handle errors in a way that allows the user to understand what is going wrong, along with a possible solution, if applicable.

Garrett (2011) underscores the importance of creating navigation schemes that enable users to navigate site content efficiently, ensuring they can easily find the information and functions they seek. With this in mind, we developed H7 and H8 heuristics:

H7: Navigation Control - It should always be possible for the user to navigate wherever possible, avoiding creating screens where the user can only exit using the browser or operating system navigation buttons.

H8: Easy Access to Functions - Functions are the core of an application; therefore, they should be easily accessible to users, enabling them to find them without much difficulty.

Continuing his discussion on architectural schemes, Garrett (2011) emphasizes the importance of ensuring that the number of steps or clicks required to complete a task makes sense to the user, and mainly if each step logically follows the previous one. This underscores the critical importance of a well-thought-out and intuitive structure. Based on these principles, we developed H9:

H9: Organized and Ordered Functionalities - It is necessary to assess whether the application's functionalities present a logical and cohesive flow with the business objectives.

Skeleton Plane

Garrett (2011) emphasizes the critical importance of choosing interface elements that truly enhance user understanding and facilitate interaction with the application. He also highlights the significance of using navigation elements to help users orient themselves and know where they can navigate. Keeping these principles in mind, H10 was developed:

H10: Clear and Structured Navigation - Interface navigation items should be visible and easily accessible to users, allowing them to know where they came from and where they can go.

Revisiting concepts of IA, Garrett (2011) underscores the significance of grouping application information and functionalities based on shared characteristics, ensuring that organizational principles align with both user objectives and the application's goals. From this perspective, H11 is formulated:

H11: Appropriate Organization - The application should present some form of organization, whether alphabetical, temporal, by category, etc., but always in line with the business objectives. With easily accessible menus and without overlapping.

Surface Plane

When discussing the surface plane, Garrett (2011) makes it clear that he is referring to the sensory design plane, specifically more connected to the senses, particularly vision and hearing and also emphasizes that hearing plays a fundamental role in the experience of using an application. From this arises H12:

H12: Necessary Sounds - It is important to assess whether the sounds used in the application are truly necessary and if they align with the rest of the application.

Addressing the perspective of vision, Garrett (2011) emphasizes the importance of applications having adequate contrast to prevent eye strain, while also maintaining internal and external consistency. From this, we developed heuristics H13 and H14:

H13: Color Contrast and Uniformity - The colors of an application need to have a certain level of contrast so that the user knows where to "stop" their eyes instead of seeing everything at once, in addition to uniformity so that the color palette is consistent and does not overwhelm the user.

H14: Proper Icon Usage - The application's icons must make sense of the functionalities and allow users to recognize a feature easily.

Among the proposed UXIA heuristics, some correspond to Nielsen's heuristics (Nielsen, 1993), while others represent novel contributions. In particular, the heuristics addressing the application for multiple types of users (H1), the clarity of the application's objective (H2), the evaluation of essential features (H3), and the cohesion between content and features (H5), as well as guidelines for sound usage (H12), stand out as novel. These new propositions bring a more strategic approach focused on product coherence and user experience, complementing Nielsen's classic heuristics.

The complete description of the initially developed UXIA heuristic set, including positive and negative examples as well as some illustrative images, is available at the following link: https://figshare.com/articles/figure/UXIA/28355546

3.4 Validation of UXIA Heuristics

According to the methodology outlined by Rusu et al. (2011) , the next step in heuristic creation involves validating the developed set of heuristics. In this study, we conducted the initial validation in two steps: first, by searching for real-life examples of each heuristic, and second, through a feasibility study.

The search for examples aimed to verify whether the heuristics could be applied to existing applications. Both positive and negative examples were considered. During this process, we identified the need to combine some heuristics, modify existing ones, and create new heuristics. These changes led to the current set of heuristics, along with the examples provided for each.

This iterative approach resulted in the set of heuristics presented here, each supported by illustrative examples (see section 3.3).

Meanwhile, during the feasibility study, two participants were tasked with performing a series of activities within a specific application, evaluating it in a manner similar to a conventional HE, but using the UXIA heuristics. The following section outlines the details of this inspection process.

3.4.1 Instrumentation and Planning

The methodology for the feasibility study involved selecting the two participants, introducing the key concepts and ideas necessary to understand the use of UXIA heuristics, and presenting the complete set of heuristics. Next, a script of activities was provided, outlining the tasks to be completed within a specific application. Along with this script, materials for recording any defects discovered during the evaluation were also provided, following the guidelines of HE (Novick, 2007). Finally, the participants were asked to participate in an interview to share their experience with the UXIA heuristics, offering feedback and suggestions for improvement.

The instruments used during the study were: (i) Activity script, (ii) HE form, (iii) Feedback interview, (iv) Informed Consent Form, and (v) Training on UX and Garrett's Framework.

The activity script contained a series of tasks designed to guide the participants, acting as inspectors, through activities commonly performed by application users. The goal was for the participants to explore the application thoroughly in search of non-conformities. When a non-conformity was found, the participants filled out the HE form, indicating the defect, the context in which it occurred, and any additional observations.

The feedback interview aimed to gather the participants' impressions of using the UXIA heuristics, including ease of use, challenges encountered, and both positive and negative aspects. The participants also assessed the names and descriptions of the heuristics, the issues they identified, and the relevance of UXIA heuristics for evaluating UX.

The informed consent form was presented and signed by the participants to ensure they were aware of how their data would be used for research purposes. The participants were informed that they could withdraw their data at any time. Since the study was conducted with postgraduate students, the process was simplified, as the participants were already familiar with the academic and research environment. This familiarity facilitated open communication about the details and implications of the study.

3.4.2 Execution

The inspection took place at a university with postgraduate students who had prior knowledge of Usability Inspection and HE, as well as a training on UX and Garrett's Framework. The training was conducted remotely via the Google Meet platform two days before the inspection, which, on the other hand, was carried out in person.

Upon starting the inspection, the participants received the activity script and a computer with access to the application to be inspected, along with the HE form to note down the defects found. The participants were given as much time as necessary to complete all activities and identify defects individually. At the end of the inspection, an interview was conducted to provide feedback on the use of the UXIA heuristics. The script used, as well as the raw data concerning the inspection conducted by the participant during the inspection, are available in: https://figshare.com/articles/figure/FeasibilityStudy/28355519

3.5 Results

After the system inspection, one of the participants, Inspector 1, identified 8 issues within approximately 40 minutes. These included problems such as an overly large banner that made navigating the site difficult, trouble finding essential functions due to inconsistent labels, complex navigation with too many steps or disorderly flow, icons that didn't match their functions, and titles/labels that hindered usability, among other findings.

Inspector 2, on the other hand, identified 10 issues in roughly the same amount of time. These defects included inadequate error handling on the page, overlapping menus, difficulty locating essential features, overly large icons and images that affected navigation, among others.

In the interview, the participants pointed out that UXIA heuristics were interesting, easy to use, and also relevant - *"I found it interesting and very easy to use, the examples and the description of the heuristics helped me a lot to know how to classify [...], [...] and I also thought that yes, it was relevant to evaluate UX."*. But also pointed out that some heuristics were very similar - *"Some are very similar and you need to read carefully to understand that they are different things, so you classify better."*. Participants also suggested that one improvement would be to create a heuristic related to the format of media on pages, as it was a problem encountered - *"[. . .] it would also be* *good perhaps to create a new heuristic to evaluate the size of images and media because sometimes it gets in the way.”*.

After completing the feasibility study, we proceed to the last stage of the heuristic creation process(Rusu et al., 2011), the refinement stage. In this stage, feedback from the previous stage was analyzed, and possible changes were considered if they were within the objectives proposed by UXIA set.

Based on the issues identified by the participants and their findings, it appears, as an initial observation, that UXIA can effectively identify usability problems. Therefore, it demonstrates reasonable feasibility. However, UXIA can be refined to enhance their effectiveness. The highlighted alterations, based not only on the defects identified but also on the insights gathered during the interview, were implemented as follows:

Change in the title or description of the following heuristics:

H7: *User* Navigation control - It should always be possible for the user to navigate wherever possible, avoiding creating screens where the user can only exit using browser or operating system navigation buttons, *while also providing the possibility for users to perform searches in the system, at least on the main screen.*

The inclusion of the term ”user” in the heuristic title was implemented to assist inspectors in understanding its focus on user-specific navigation. Furthermore, incorporating the capability for users to perform searches within the system in the description enhances the integration of IA navigation principles within this heuristic.

H10: Clear and structured navigation *items* - Interface navigation items should be visible and easily accessible to users, allowing them to know where they came from and where they can go.

In this case, the title was adjusted to include ”items” to clarify that this heuristic specifically evaluates navigation items within the interface.

H11: Appropriate Organization - The application should present some form of organization, whether alphabetical, temporal, by category, etc. But always in line with the business objectives *and with labels and titles that are meaningful and help users understand the purpose of the menu or functionality.*

The adjustment in this heuristic serves to consolidate concepts of IA related to organization and labeling within a single heuristic.

And based on the insights gathered from the interview and the inspection, a new heuristic has been developed at the Surface level:

H15: Media and content with appropriate format - The media and content of the application need to have a format that aligns with the functionalities and does not compromise the UX.

Examples related to H15:

- Gov.br[1] displays a very large photo in certain menus that occupies more than half of the screen, which can hinder access to other functions. It is necessary to zoom out the screen to view the image as a clickable menu.
- Netflix [2] demonstrate an example of H15 compliance, as all the media and images on the website are appropriately sized and aligned with the platform’s features as a movie streaming service.

4 FINAL CONSIDERATIONS AND FUTURE WORK

Developing a set of heuristics to evaluate system usability from multiple perspectives, such as UX and AI, is essential.

Therefore, this research proposes a new set of heuristics aimed at providing a comprehensive evaluation of systems, with a focus on UX. The initial validation results demonstrate the feasibility of this UXIA set, showing that it can be successfully applied in such cases and has significant potential to contribute to the software development process. UXIA is designed to be utilized to ensure continuous improvement and user-centric design throughout the entire development lifecycle.

Based on the feedback received, the heuristic set was slightly adjusted, resulting in its second version. These were the first steps of this research. However, it is important to note the limitations of this research. The initial validation process was limited to a small sample size, and the results may not be fully representative of broader contexts. Additionally, the set of heuristics was tested only in specific scenarios, which may affect its generalizability to other types of systems or user groups.

Future work related to UXIA set of heuristics includes conducting a controlled experiment, in which the UXIA heuristics set will be compared with other existing sets, such as Nielsen’s heuristics. The aim is to assess and compare the effectiveness of the proposed technique, with a particular focus on evaluating the efficacy through the average number of defects found by each technique.

Other possible future outcomes include evaluating the set of heuristics in different contexts, potentially

[1]https://www.gov.br/

[2]https://www.netflix.com/

through more qualitative assessments of its use. This could involve an observational study of students using the heuristics, providing insights into their practical application and usability.

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