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Human-AI Interaction Design: Usability Guidelines for AI Systems Interfaces Design

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Human-AI Interaction Design: Usability Guidelines for AI Systems Interfaces Design

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Resumo

As novas tecnologias web que surgiram na última década, simultaneamente com o acesso generalizado a dispositivos e aplicações móveis, resultaram em desafios consideráveis em relação à Interação Humano-Computador (HCI). Ao longo da vida útil de um produto digital, o utilizador tem de se adaptar às atualizações, mudanças na interface e novas funcionalidades. Além disso, dedicar-se às tarefas de personalização e configuração em interfaces genéricas criadas para milhões de pessoas que acedem em diferentes dispositivos, com as mais variadas tecnologias e objetivos.

Por outro lado, as condições dos utilizadores não são estáticas e os sistemas informáticos têm de se ajustar a novos requisitos, preferências e hábitos. Ao mesmo tempo, as tendências do mercado e as expectativas dos utilizadores resultam numa procura constante por novas funções, interfaces e tecnologias. O enorme impacto de tecnologias como a Inteligência Artificial (AI) e novas interfaces, como realidade virtual e aumentada, traz desafios e oportunidades em termos de interação entre humanos e computadores.

Este trabalho analisa a importância do Design de Interação (IxD) no presente e no futuro dos sistemas de Inteligência Artificial. Destacando os autores de referência do Design Centrado no Utilizador, princípios de usabilidade e heurísticas. Promove a exploração da IHC e investiga princípios de design adequados para desenvolver uma Interação Humano-Computador positiva, produtiva e harmoniosa, aprofundando o estudo do estado da arte nesta temática. Esta pesquisa resulta numa tabela que compara e agrega os princípios IxD mais relevantes e origina o desenvolvimento de uma estrutura funcional, consistente e eficiente para projetar sistemas e interfaces de aplicações e plataformas com AI. Esta *framework* visa orientar e dar suporte à experiência do utilizador de sistemas inteligentes, independentemente de sua funcionalidade e interface. Sendo apresentada e exemplificada através do desenvolvimento de um protótipo e validada com um estudo metódico de pesquisa de utilizador.

Palavras-Chave: Human-AI Interaction; User Interface (UI); User Experience (UX); Human-Centered Design; Human-Computer Interaction (HCI)

Abstract

New web-based technologies have emerged in the last decade. Simultaneously, access to mobile devices and applications has become widespread, resulting in considerable challenges regarding Human-Computer Interaction (HCI). Over the lifetime of a digital product, the user must adapt to updates, changes in the interface, and new functions. Furthermore, provide attention to customization and configuration tasks in generic interfaces created for millions of people who access them on different devices.

On the other hand, users' conditions change, and the informatics systems must adjust to new requirements, preferences, and habits. At the same time, current market directions and users' expectations result in a constant search for new functions, interfaces, and technologies. The vast impact of technologies like Artificial Intelligence (AI), and new interfaces, such as virtual and augmented reality, brings challenges and opportunities in terms of interaction between humans and computers.

This work explores the importance of Interaction Design (IxD) in the present and future Artificial Intelligence systems, highlighting the prominent authors of User-Centered Design and usability guidelines, and heuristics. Promoting the exploration of HCI and investigating appropriate design principles for developing a positive, productive, and harmonious Human-Computer Interaction by deepening the state-of-the-art study. This research results in a table that compares and aggregates the most relevant IxD principles and leads to developing a functional, consistent, and efficient framework to design AI-based systems and application interfaces. This framework aims to guide and support the user experience of intelligent systems regardless of their functionality and interface. Being presented, exemplified, and validated through a user research methodic study.

Keywords: Human-AI Interaction; User Interface (UI); User Experience (UX); Human-Centered Design; Human-Computer Interaction (HCI)

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List of Abbreviations

HCI - Human-Computer Interaction

IxD - Interaction Design

AI - Artificial Intelligence

UX - User Experience

UI - User Interface

DSR - Design Science Research

DSRP - Design Science Research Process

IS - Information System

IT - Information Technology

NLP - Natural Language Processing

NPS - Net Promoter Score

1 Introduction

The field of Artificial Intelligence (AI) is vast and can hold several definitions. Based on the evolution over the last decades and the expansion of its characterization, it is usual and accepted to define AI as the art of creating machines that perform functions that require intelligence when performed by people (Kurzweil, 1990). Beyond the scientific and academic contexts, Artificial Intelligence is a phenomenon that is already an intrinsic part of human culture. From the earliest times, it has generated admiration and expectation, but also skepticism, anxiety, and even fear. This fear goes hand in hand with the fascination of human beings of all ages, races, social conditions, and academic backgrounds by intelligent systems[1], and humanoid robots[2].

With the relentless evolution of technology, the way that human beings interact with different computing devices changes at the same rate (Ellwanger, 2013). As humanity, we live in a time where opportunities are immeasurable in this domain, and therefore the design of these systems interfaces faces evolutions and challenges as never before since multiple difficulties, limitations, and innovations continuously arise. In this prolific stage of notorious developments in which we find ourselves, the technical challenges inherent to the accelerated progress in the study of Intelligent Agents are few, and its potential is vast. This Intelligent Agents can receive perceptions of the environment and perform actions in which each agent implements a function that maps sequences of perceptions into actions (Russel & Norvig, 2013) using actuators. An Agent is an autonomous entity and runs in the cycle of perceiving, thinking, and acting. These actions affect the environment where these systems are implemented. With these aspects in mind, it is noticeable that the interaction between humans and computers is a crucial point that can

[1] Technologically advanced machines that perceive and respond to the world around them. Intelligent systems can take many forms, from automated vacuums such as the Roomba to facial recognition programs to Amazon's personalized shopping suggestions (University of Nevada, 2021)

[2] A robot that has mechanisms designed for communication with humans and can generate human-like behaviors by using human-like actuators and vision and audio sensors (Ishiguro et al., 2001).

make the difference between excitement for a new product, like a car that drives itself, or resistance and alarm.

Interaction Design is the design of interactive products that support the way people communicate and interact in their computer work environment (Rogers et al., 2013). Likewise, it is the link required for communication and interaction with the machines around us. The history of interaction design goes back thousands of years, long before the existence of computers. Although this term is also applied to physical products, the massification of computers and informatics systems since the 1970s created the need to study the way people interact with computers. The term Human-Computer Interaction (HCI) emerges as a discipline responsible for the study of the interactions between humans and machines (Mathew et al., 2011).

Human-Computer Interaction consists of designing and implementing interactive computing systems with which users can interact. It includes desktop and embedded systems in different devices (Mathew et al., 2011). This concept is characterized by putting the user first. Having significantly impacted the growth of adjacent areas such as, Human-Centered Design[3] and Human-Centered Computing[4]. These concepts are established as having the human user as their primary focus, so they are called user centered. Witch investigates and outlines consistent principles to define the frameworks for the development of interactive projects in computer systems (Rogers et al., 2013). Usability is referenced in the literature as the basis on which Human-Computer Interaction and other approaches related to Interfaces Design are based (Ellwanger, 2013). It is a shared term that is remarkably pertinent in these contiguous areas and where these topics, as other approaches related to interface design, are working on. Therefore, Usability[5] and the HCI supports all interactions related to products linked to computing. Thus, HCI is not only related to product design, but it also directs the evaluation and

[3] When designers focus on system users' human needs (Skrok & Interaction Design Foundation, 2022).
[4] Combines the human social and cognitive sciences with computer science and engineering for the designing computer systems with a human focus, studying and creating improved methods to design and develop systems that support and improve people's lives (Sebe, 2010).
[5] The study of how human factors interact with different types of products.

optimization process, considering the main phenomena that surround them (Lowdermilk, 2013), (Rogers et al., 2013). In which the User Experience (UX) is fundamentally important, as it is intended to synthesize the entire experience that the user has when interacting with a digital product.

UX Design does not only involve functionalities, but also how captivating and pleasant the experience is, including, in this context, the physical and emotional reactions of users (Soegaard & Dam, 2012). These domains of study have been forged over the last decades, being responsible for how we use the computer, smartphones, and other computer systems nowadays. Its principles are employed consistently across various sectors for design and evaluation purposes. However, the transition and development of intelligent and independent systems introduce new questions and challenges. When considering the distinct and innovative interfaces, such as virtual reality, augmented reality, voice-based interfaces, or even interaction without a physical interface. It becomes valuable to research the leading design guidelines and combine them with Human-AI Design emerging principles and user research studies[6] to attest their usefulness and advantages in terms of Human-AI interaction. Developing a tool that can serve as a framework to support User Experience and User Interaction Design on systems that employ the fundamental concepts of Artificial Intelligence, such as Machine Learning, Deep Learning, or Natural Language Processing (SAS Institute, 2021).

1.1 Contextualization And Definition of The Problem

The scope, functionalities, and ways of using computer systems have changed exponentially. This development, now expanded by Artificial Intelligence and innovative interfaces, continues faster than ever and introduces challenges about how we will interact with highly independent and intelligent systems, full of capabilities and features never seen or manipulated by users. The way of interacting with computers changes because AI explores new paths and assumes new physical forms, such as Robots or environments

[6] User experience research is the practice of studying user interactions to help with the design of people-first products and experiences (usertesting.com, 2020).

related to augmented and virtual reality. In this sense, the design of interfaces and interactions holds a decisive role in correctly understanding and using these systems. Interaction design is the practice of designing interactive digital products, environments, systems, and services (Cooper et al., 2007). In addition to the digital aspect, interaction design is also helpful in creating physical products and exploring how a user can interact with them.

The main domains of IxD are Design, Human-Computer Interaction, Software Development, and Web and Mobile applications. Although this discipline is interested in form, like other fields of Design, its focus is on behavior (Cooper et al., 2007). Interaction Design focuses on predicting and meeting user needs, not limiting itself to the current systems state but imagining how they could be, optimizing the user experience within existing technical or business constraints. While software engineering focuses on design from the technical point of view, and aims to provide systematic, cost-effective, and rigorous processes, techniques, and tools. So that teams of software developers to design, construct, deploy, manage, and maintain complex software systems. The term Interaction Design was coined by Bill Moggridge and Bill Verplank in the 1980s and is based on 5 main dimensions. This concept was introduced in Moggridge's book “Designing Interactions”. Crampton Smith wrote that interaction design is based on four existing design languages, 1D, 2D, 3D, 4D (Moggridge, 2007). Later, a fifth dimension, behavior, was introduced (Silver, 2007).

- **Words** - This dimension defines interactions: words are the elements with which users interact.

- **Visual representations** - Visual representations are the elements of an interface that the user perceives; these may include, but are not limited to "typography, diagrams, icons and other graphics".

- **Physical objects or space** - This dimension defines the objects or space "with which or within which users interact".

- **Time** - The time during which the user interacts with the interface. An example of this includes "content that changes over time, such as sound, video or animation".

- **Behavior** - Behavior defines how users respond to the interface. Users have different reactions to the same interface.

These five dimensions are responsible for how the users perceive a digital product or system and how they relate to it. The evolution has been significant over the last two decades, and its development continues to be a decisive factor in the massification and democratization of information and communication technologies worldwide. However, the fast evolution of digital systems represents a constant challenge, intensified by significant developments in Artificial Intelligence. Which, together with its supporting tools (machine learning, deep learning), is rebuilding our society (Cooper et al., 2007). Robotics, healthcare, covid-19, sustainability, and smart cities are some of the emerging areas where this technology is making significant changes and causing a considerable impact. The idea that in the next ten years, the world will evolve more than in the past 100 years - suggested by Peter Diamandis, author of “The Future Is Faster Than You Think”, is gaining support in different technology areas. Accordingly, it is imaginable that people will depend on AI systems in their daily lives in just ten years to assist them in the most diverse tasks. Therefore, clarity and flawless communication with these systems are increasingly essential.

In recent decades popular culture has portrayed the possibility of an AI revolt against humanity in books and movies. Supposing that intelligent computers could gain total independence and harm humanity. But as our reliance on AI-controlled machines increases, so does the risk that simple malfunctions could lead to serious accidents, or even death. In 2020 a teenager died frozen at a temperature of -50°C after his GPS has taken him to the notorious “Road of Bones” in Russia. Google Maps directions suggested a disabled shortcut in the coldest inhabited region in the world, according to reports (Stewart, 2020). This phenomenon, called Death by GPS, (Lin et al., 2017) is neither recent nor as rare as one might imagine. There are several reasons why people who follow GPS instructions end up losing, getting hurt, or dying. In addition to the lack of communication systems in operation to ask for help, users of this type of navigation

system adventure them self's, in the car, on foot or by bicycle, in remote areas, impassable or dangerous; and are guided by the GPS until their vehicles run out of fuel, mired, or become inoperable. This causes them to stay lost, isolated, hurt, or die due to lack of food, water, or adverse weather conditions. And could be due to an incorrect system operation or outdated maps, which also has led several conductors into flooded places and precipices. Most TESLA's self-driving vehicles have recently been targeted by several controversies, for several deaths associated with the "autopilot" of their cars, and the company is, at this moment, with several processes in the judicial system. Like the case of a 15-year-old boy who was killed in an accident with a TESLA, which allegedly maintained its speed of 111 km/hour until the clash with the vehicle where this young man was following (Bote, 2021). However, not always the system malfunction justifies the accidents, these are often due to failures in communication between the system and the user or an inadequate system configuration by the user. The examples covered include the use of a simple, well-implemented, and harmless technology.

With the exponential evolution of technology and its implementation in areas such as telemedicine, it's predictable that the physical and mental integrity of human beings will be increasingly dependent on AI systems. Humans' emotional health, and well-being, maybe affected as well. The pandemic, we currently live into, due to Covid-19 disease caused by SARS-CoV-2 (Veras et al., 2020) coronavirus infection seems to have accentuated this opportunity for connection, cooperation, and a symbiosis between intelligent men and machines. All over the world, robots were one of the solutions found to accompany and provide psychological and medical support to older adults isolated due to the pandemic (Samuel, 2020). Similar dynamics are just the onset, considering the exponential evolutions in the most diverse sectors AI systems provide.

Machine Learning and Natural Language Processing are main areas within Artificial Intelligence that are experiencing great development. With the evolution of these technologies, the machines can be prepared to fulfil specific tasks based on processing endless amounts of data and recognizing patterns in them. In recent years, advances in the field of AI triggered a series of opportunities and challenges concerning User Interfaces Design. Although this subject is not new, the evolution of Artificial Intelligence and the new uses found for this technology justify additional noteworthy investment in

the topic. Based on this need the Association for Computing Machinery[7] published at CHI Conference on Human Factors in Computing Systems[8] a set of guidelines that guide the interaction between Human and Artificial Intelligence (Amershi et al., 2019). These guidelines were validated through studies and questionnaires made to professionals from the most recognized Artificial Intelligence systems. The developments demonstrated its applicability in interaction cases, highlighting opportunities for further research. Based on these research conclusions, guidelines are a valuable resource for professionals and researchers interested in developing human-AI interaction design principles (Amershi et al., 2019).

When designing Artificial Intelligence systems interfaces, it may become challenging to collect guidelines, principles, and norms for a design that fulfils its function and, simultaneously, the user's expectations. Formal UI/UX design education does not tend to focus mainly on AI systems. Unsatisfactory results in design, functionality, and performance may occur. Designing the interface and interaction of an AI system without the knowledge of best principles and practices can delay the implementation of this type of technology, cause some mistrust and not ensure a productive relationship as intended. In the stage we are going through, it is relevant to improve this task by compiling the Interaction Design guidelines of AI systems. Providing a framework and examples that can guide professionals and beginners in developing interfaces for communication with web platforms, applications, cars, robots, and other intelligent systems.

1.2 Motivation

The main motivation for the development of this research is the opportunity to explore the important and exciting topic of UI and IxD in-depth. Discovering, understanding, and learning while contributing to this meaningful subject.

[7] ACM is the largest academic and scientific computer science organization - https://www.acm.org/

[8] The Academic ACM Conference Series on Human Factors in Systems Computing is generally considered to be the most prestigious in the field of human-computer interaction and an of the highest-ranked relationships in basic science

Nowadays, the daily activity of the human being is experienced through interfaces, which makes this matter increasingly important. It is virtually no longer possible to subsist in today's world and carry out tasks without the daily use of computer systems. These systems, when developed by the world's tech giants, tend to be highly functional and user focused. But this comes at a cost, such a dependence on these systems makes it very difficult to change or stop using them. The big tech companies, despite dominating a large part of the users screen time, are not the only ones that an ordinary citizen needs to navigate the demands of professional and personal life. There are several products and services from the of public entities and small and medium-sized companies that do not have access to budget, technologies, highly experienced professionals, and design processes who also need to communicate digitally. It was also with these limitations in mind that this research was carried out. The way main IxD guidelines where aggregated, explained, and exemplified is simple to understand and replicate in computer systems with or without AI - depending on current needs. Believing that the current demand and expectations will encourage the implementation of AI also by public entities and SMEs, this work can help to understand this subject and start out the development of Interfaces for AI systems, where the means may be limited.

At the same time, AI is more than an emerging technology. Is already present and becoming increasingly popular across the different areas. The possibility of making a bridge with the fascinating world of Thinking Machines (Dormehl, 2016) in a practical, organized, and replicable way is something considered stimulating and valuable. The reference works in the UI and Usability matters are not exclusive, and most of the time focused on AI systems. Considering that UI designers have a background in design, it is the purpose of this research to discuss AI with a language adapted to designers. Making this information accessible to everyone. This way the world of AI is closer to the world of Design. This will bring advantages to AI programmers and designers. Something that will certainly be reflected in the quality of the AI systems themselves, their interfaces and mainly in a better experience for users.

1.3 Description of the Investigation Objectives

For this work development a sequence of goals was put together. Considering the main purpose to produce a final product with quality in terms of research, artifact creation and documentation.

Starting by contextualizing and concretely defining the problem to be solved and which methodology that would be more efficient in its resolution. Concluding that the Design Research Science methodology is the most suitable for the type of research intended, is time to define the main points to be covered and the objectives of this work.

Then, study the state-of-the-art on the relevant subjects and explore reference works in terms of guidelines and usability heuristics. Searching emerging works in the field of interaction design focused on AI systems. Compare and confront these works with the standard norms and current design processes, to obtain a comprehensive and complete view of the current state of the art in the topics to which it's intended to add value.

Such a vision will allow working with all this information to extract the most consistent and relevant principles and create something that is useful and replicable in the development of interfaces of AI systems. With a level of abstraction that can be adapted to the most diverse sectors and interfaces.

With this information, create a comparative table between the works, aggregating the guidelines of the main works in a single source where it is possible to verify the existing and non-existing correspondences between them. Followed by the development a set of guidelines, which serves as a focus for the development of an artifact that ensures an intuitive, harmonious, and safe interaction between humans and intelligent systems.

Design an interactive prototype of a demonstrative AI system that can be tested by normal users and design professionals. Validating the usefulness and functionality of this prototype through the development of a user study. Exploring the prototype and acquiring insights with a set of professionals in the area through a focus group.

Lastly, register and document all progress and information obtained, as well as the conclusions acquired from this process. Sharing this work, its conclusions, and the practical result with the interested community and overall public.

1.3.1 Detailed Objectives

Based on the objectives of this research work, presented above, the following specific objectives were established.

- Introduce the topic and contextualize the problem. Conduct an extensive literature review on the main topics, namely Artificial Intelligence and Interaction Design.

- Based on the state of the art compare and compile the reference authors' works specific guidelines. Complementing and adding value to each individual work, through the development of a guidelines framework that aggregates them. Considering ISO norms and the fundamental methodologies used in interface and interaction design for more than three decades.

- Develop an interactive artifact in a prototyping tool. This artifact is a demo of the desktop version of a platform that uses AI to make life easier for its users. This platform, created based on the guidelines suggested in the framework introduced in the previous chapter, can be seen in detail in chapter 5 of this work.

- Demonstrate the work with the interactive presentation of the created artifact, provided by Figma, as well as a video, in a user research study as well as a focus group.

- Create a questionnaire for this purpose and enable its completion by common users and professionals in the field of design. Complement the results and conclusions with a focus group of professionals.

- For the communication of this research work, adding together to this dissertation, a paper was written and published at the 2022 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), and indexed to Scopus - presented in attachment F of this work.

- The elaboration and publication of a second scientific article, with the validation results, proportionated by the research the user research study is an objective for future work.

The methodology is explained in detail in Chapter 2.

1.4 Document Structure

This document is composed of seven main chapters. These chapters are distributed as follows:

Introduction - In the first chapter an introduction to the work is made and the contextualization of the topic and the problem is presented. Motivation for this research, the research object, and the objectives to which this work proposes are described, as well as the document structure.

Methodological Approach - This chapter describes the methodology followed throughout this research work. Since this work is the result of a Design Science Research process, this methodology is justified.

State Of the Art - Introducing the state of the art of the topics covered by this work. Describing Artificial Intelligence and its main technologies; Machine Learning, Deep Learning and Natural Language Processing, with the focus on Interface Design and Interaction Design and its role in AI systems. The IxD and Usability guidelines of the reference works analyzed in this research are presented.

Guidelines Analysis, Aggregation and Comparative - In this chapter, a framework of fundamental guidelines focused on the development of interfaces of AI systems is developed. This work aggregates the guidelines obtained in the state of the art. A similarity matrix between the studies and the suggested framework is also created, as the respective conclusions are drawn.

Framework and Prototype Development - This chapter serves to describe the guidelines present in the compilation of guidelines, created as a result of the research. A set of guidelines is selected and exemplified through a prototype of an AI platform.

Discussion of Results - This chapter explains the validation of the framework and the prototype developed, as the results of the user research study carried out are presented.

Conclusions and Future Work - The conclusions are drawn, and future work stated.

2 Methodological Approach

For a research work be recognized as reliable and appropriate work, the author(s) must confirm both in the academic field, as for community that the results have been rigorously produced. Furthermore, they must be available to discussion and confirmation (Silva, 2019). For this to be achievable, it is essential that a research work is developed according to a meticulous and recognized scientific methodology. Based on the proposed objectives and considering the solution that this research work aims to find, the methodology that best corresponds to the intended purpose is Design Science Research (DSR).

Design Science produces and evaluates IT artifacts, aimed to solve identified organizational problems (Hevner et al. 2004). The artifact should be subject to validation to ensure its utility for the specified problem (Silva, 2019) and it must either solve a problem that has not yet been solved or provide a more effective solution (Hevner et al. 2004). The core of Design-Science Research is achieving knowledge and understanding of a problem domain by construction and application of a designed artifact (Silva, 2019). Generating knowledge by the research and creating solutions in the form of artifacts, to impact the problems observed.

(Peffers et al., 2007) design and demonstrate a process for carrying out Design Science Research in IS, demonstrating the use of the process to conduct research. The process includes six steps: problem identification and motivation, objectives for a solution, design and development, evaluation, and communication (Peffers et al., 2007). Figure 1 demonstrates the Design Science Research Process (DSRP) model.

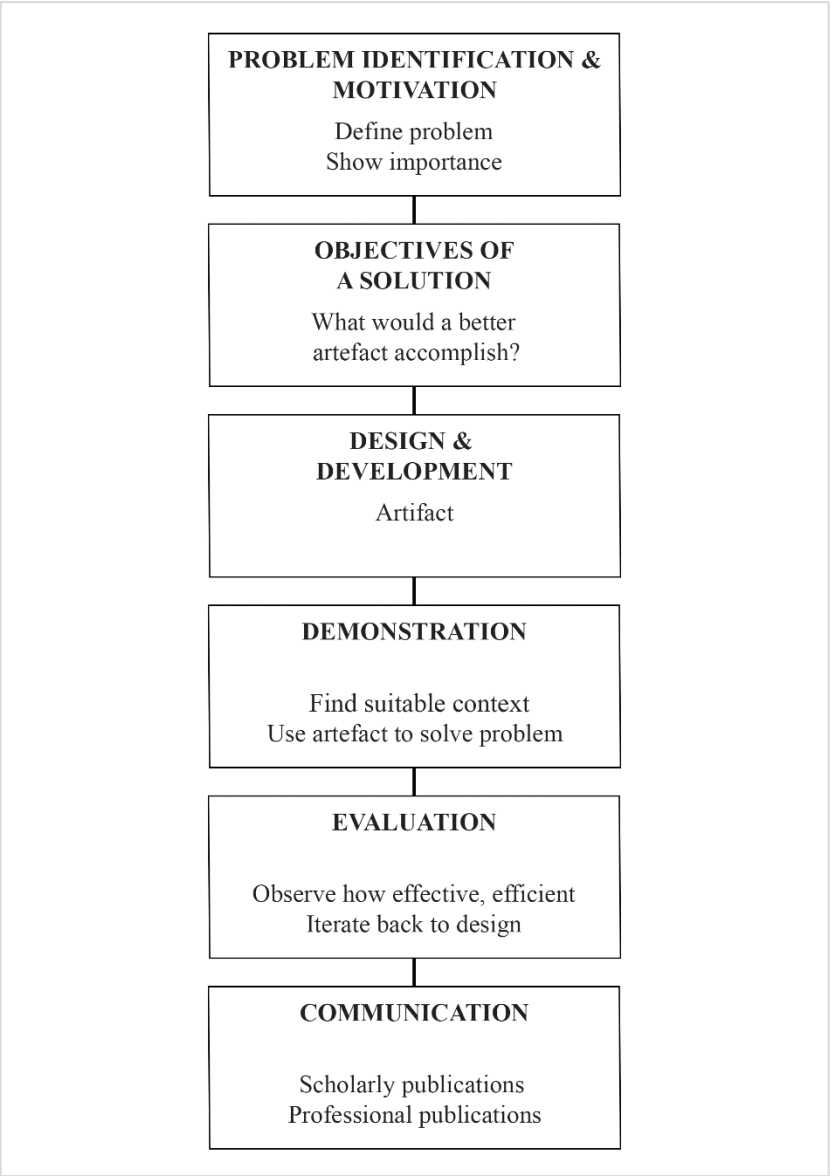

Figure 1 - Design Science Research Process (DSRP) model (Peffers et al., 2007)

The outcome of design-science research in IS is a purposeful IT artifact that solves significant organizational problems. Enabling is implementation and use in applicable fields. The resultant IT artifacts expand the limitations of human problem solving and organizational capabilities, by providing intellectual and computational tools (Hevner et al. 2004). Table 1 shows the DSRP framework aligned with the topics of this research work and the development of the respective artifact.

Table 1 - Addressing used methodology to DSRP (Peffers et al., 2007)

(Peffers et al., 2007) DSRP	Methodology Chapters
Problem Identification	1 - Introduction 1.1 - Contextualization and Definition of The Problem 1.2 - Motivation 1.3 - Description of the Investigation Objectives 3 - State of the Art
Define the Objectives of a Solution	4 - Guidelines Analysis, Aggregation and Comparative
Design and Development	5 - Framework and Prototype Development
Demonstration	6 - User Research Questionnaire
Evaluation	6 - Discussion of Results
Communication	Thesis Report and Paper Publication

To support the research work with objectives of the DSR and generate knowledge that other professionals can use to develop solutions for their field problems (Hevner et al. 2004), prominent authors in the area of interest, and their main studies were researched in depth. Analysis that resulted in the compilation and aggregation of main IxD guidelines. This aggregation was then systematized and produced a matrix that assigns a similarity value to each principle. Enabling the selection of the most consistent guidelines, that are exemplified with an interactive prototype and validated by design professionals and everyday users. For a comprehensive understanding of the application of the methodology in this research, the main steps are explained in detail below.

Problem Identification

Determine the research problem and explain the value of a solution, due to the knowledge of the state of the problem and the importance of its solution (Peffers et al., 2007). Based on an extensive examination of the most relevant bibliography for the research work that is proposed to develop, i.e., the “Interaction Design Heuristics” (Jakob Nielsen and Robert L. Mack, 1994), the “Golden Rules of Design” (Shneiderman et al., 2016), “The Design of The Future Things” (Donald A. Norman, 2010) and further related works. With particular focus and development on the “Guidelines for Human-AI Interaction” developed by several authors in the Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (Amershi, 2019). Along with the ISO 9241-

210:2010 standards and the leading designers, that the designed the IS world as we know it, works.

Objectives of a solution

The objectives should be inferred rationally from the problem specification. Resources required for this include knowledge of the state of problems and current solutions and their efficacy (Peffers et al., 2007). For that the research works analysed in the previous objective are compiled and compared, aggregating the guidelines in a framework of good practices for designing interfaces of AI systems.

Design and development

An interface of an Artificial Intelligence system was developed. This UI design was created applying the guidelines matrix elaborated and consists of a functional interactive prototype designed in Figma prototyping tool. Supported by (Hevner et al. 2004) DSR framework objectives:

"Create the artifactual solution. Such artifacts are potentially, with each defined broadly, constructs, models, methods, or instantiations."

Demonstration

In this step we must demonstrate the efficacy of the artifact to solve the problem (Peffers et al., 2007). A functional interactive link for the prototype is shared. A presentation video to demonstrate the guidelines' practical application, is presented.

Evaluation

Explore, test, and validate a set of guidelines developed through results obtained in the previous point by conducting user research. The compiled guidelines were tested, and questionnaires were made with users to perceive the practical application and experience of using an interface that employs the framework developed. So it can be observed and measured how well the artifact supports a solution to the problem (Peffers et al., 2007). Complementing research through a focus group with design and digital communication professionals.

Communication

Communicate the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences, such as practicing professionals, when appropriate (Peffers et al., 2007). Outlining all progress in the project report delivered in this thesis. The communication is also present in the publication and presentation of a paper designated: “Interaction Design for AI Systems: An oriented state-of-the-art” in the 2022 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA). A second scientific article is also being developed with the conclusions of this work.

3 State of the Art

In addition to the interface design usually done by humans - the focus of this work, current developments demonstrate that UI/UX design can be also done by artificial intelligence systems successfully. In the book Design of the Future (Norman, 2010), the author distinguishes between the rules of design for human designers and the rules of design developed by machines to improve their interactions with people. This book, of a notable author in this domain, serves as a reference for several succeeding analyses and studies. These are presented below, where the Design rules for human designers of intelligent machines and Design rules developed by machines to improve their interactions with people are demonstrated.

Design rules for human designers of intelligent machines (Norman, 2010)

- Give natural, abundant, and complex signals
- Be predictable
- Provide a good conceptual model
- Make the result understandable
- Provide continuous attention without being intrusive
- Explore natural mappings

Design rules developed by machines to improve their interactions with people (Norman, 2010)

- Simplify things
- Give people a conceptual model
- Give reasons
- Let people think they are in control
- Always confirm
- Never label human behavior as an error (rule added by the human interviewer)

These principles are transversal in other significant advances in this field. They serve, in this work, as a starting point for the analysis of communication between man and

machines through their interfaces, focusing on attributes such as functionality, safety, and engaging user experience. One reference in this domain is the work of a computer scientist with a Ph.D. in human-machine interaction – Jakob Nielsen. "The Jakob Nielsen heuristics" (Nielsen & Mack, 1994) are standard usability heuristics for user interface design examination. Nielsen developed the heuristics together with Rolf Molich in 1990, and the final set of heuristics was released in 1994. The decades of the existence of this work only established its applicability, considering the remarkable fact that they are as current now as when they were established. This usability inspection method identifies usability problems in user interface design by examining the interface and its compliance with determined usability guides (Nielsen, 1995). Principles that are explained in this work.

It is usual to associate design with the aesthetic part of a product or brand. However, this isn't always the case. Being a reductive and mistaken view of this area. Design at its core is created with a goal that combines aesthetics with functionality and user experience. So, design goes hand in hand with development and must be thought of at all stages of designing and developing a project. A poorly designed interface will result in a poor user experience, so it is necessary to consider the design before, during, and after the development of a project. Thinking about UI design is thinking in designing an interface that does not convey a feeling of insecurity to the user, that clearly defines the results of their actions, and ensures that they perform all tasks simply and efficiently. The purpose of the ten heuristics created by Jakob Nielsen is to help design a good interface and provide a great user experience. Understanding the relevance of an interface and some of the points that must be considered throughout the design cycle is crucial. Then we can conclude that these points alone can determine whether the user experience will be pleasant or not. Based on the heuristics, it is possible to understand that it is not about making a system with better presentation, but about making the interaction experience between a person and a machine as natural and smooth as possible.

With the same goal in mind, Ben Shneiderman, computer scientist and professor of computer science at the Human-Computer Interaction Laboratory at the University of Maryland has studied interface design for the past 30 years and compiled the Eight Golden Rules (Shneiderman et al., 2016) for the interaction design that will be also analyzed in this study. When approaching intelligent systems, it is required to pay even

more attention to this topic. Since the configuration, personalization and communication can be more complex on the human part. Considering the areas where artificial intelligence is gaining ground and becoming essential, the results can be more damaging in case of some miscommunication or error.

3.1 Artificial Intelligence

Artificial Intelligence (AI) is the field of computer science that allows computers to learn from their experiences, and adapt to new data to perform a task, such as a human being (SAS Institute, 2021). The field with the most developments in this phase, and in which most of the current examples stand out, is related to Machine Learning and Natural Language Processing (Liddy, 2001). With the expansion of these technologies, machines can be prepared to fulfil specific tasks based on the processing of endless amounts of data, recognizing patterns in them. The evolution of AI has been a constant since 1950 when the first work with neural networks started, which generated enthusiasm and the first artifacts of machines capable of thinking and learning (SAS Institute, 2021). Initially focused on playing checkers or chess against humans, it was a period marked by important advancements, such as the development of Perceptron, one of the first artificial neural networks with pattern recognition based on a two-tiered computer learning network by Frank Rosenblatt in 1957. At the time described by New York Times as the "embryo of an electronic computer expected to walk, speak, see, write, reproduce and be aware of its existence" (Gil, 2016). This description is over 60 years old provides an insight into the tremendous expectation this technology had already created at the time. Table 2 shows the main evolutions of AI over the last decades.

Table 2 - Evolution of AI (based on Sebe, 2010)

Period	Technology	Result
1950 - 1970	Neural networks	Initial work with neural networks generates enthusiasm.
1980 - 2010	Machine learning	Machine learning starts to become popular.
Currently	Deep learning	Deep learning causes the exponential development of AI.

Along with the initial enthusiasm, the first criticisms arose in the 60s and 70s, going so far as to affirm that "computers are still so crude and primitive machines that using them to replicate the human mind would be equivalent to climbing a tree wielding a stick to fish and say that this way we could touch the moon" (Teixeira, 2019). Criticism would

serve, however, to demarcate the need for a better understanding and understanding of our mental processes and concepts used to describe them. It was in this period that the researchers realized that many of the tasks they proposed to perform using AI encountered great difficulties. We can think about a translation system, where the ambiguous character of several terms of our language encounters great technical difficulties since for the human being, based on the context, the same words have very different meanings (Teixeira, 2019).

The classification of Artificial Intelligence models is based on the form and the objective with which the system works, this classification that initially evidenced independent classes, today conjectures that the systems combine resources between them (Gallegos et al., 2014)

Even today, it is not easy to define Artificial Intelligence by itself, but we can define these as the main lines of thought (GOMES, 2010), illustrated in figure 2 and detailed below.

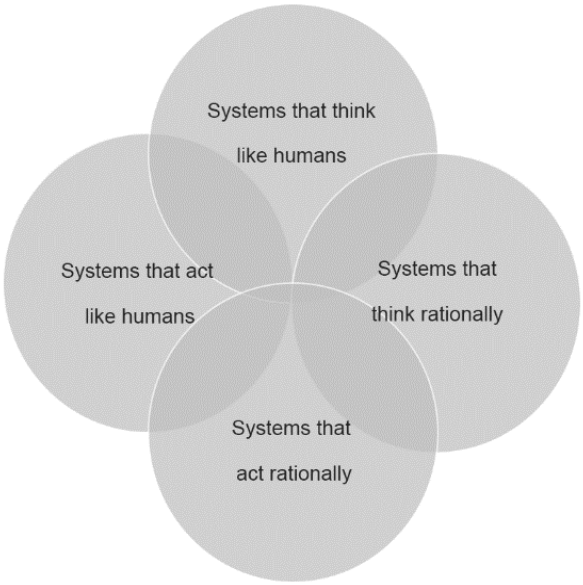

Figure 2 - Evolution of AI (Sebe, 2010)

- **Systems that think like humans**

Thinking humanly is a cognitive modelling approach. There are two ways of determining how humans think through introspection or psychological experiments. For example, the General Problem Solver (Newell & A. Simon, 1961), was not developed to correctly solve problems. It was developed to mimic humans solving the same problems. This is in distinction to other systems witch the main goal is obtaining the correct answers (Russell & Norvig, 2020).

- **Systems that act like human**

When AI programs must interact with people, acting like a human is a crucial aspect. For example, when a natural language processing system has a dialogue with a user, it must behave according to expected conventions of human interaction to be understood. The Turing Test, which Alan Turing[9] proposed, was designed to provide an acceptable operational definition of intelligence. Turing defined intelligent behavior as the ability to achieve human-level performance in all cognitive tasks, sufficient to deceive an interrogator (Russell & Norvig, 2020).

- **Systems that think rationally**

The so-called logicism tradition within artificial intelligence is the basis of decision-making in Artificial Intelligence. This approach faces tremendous challenges because, as humans, not all right decisions are made based purely on logic but several other factors. Agents included in this group try to simulate humans' rational, logical thinking so that machines can understand, think and act (Russell & Norvig, 2020).

- **Systems that act rationally**

Right action is not always rational or logical, there are often situations in which there is not something demonstrably correct to be done, but something still must be done.

[9] Alan Mathison Turing was a mathematician and computer scientist who was extremely influential in the development of computer science. Turing Recognized within the Scientific Community as the Father of Theoretical Computer Science and Artificial Intelligence

Analyzing the following example: "removing one's hand from a hot stove is a reflex action that is more successful than a slower action taken after careful deliberation" (Russell & Norvig, 2020) may suggest that more than logical decisions, these agents need good decisions in a wide variety of situations as well as, to be able to communicate in natural language, which can allow navigating an increasingly complex society.

In summary, one can understand the purpose of AI with the expectation that a computer can solve a problem autonomously and at the same time AI automates repetitive learning and discovery from data.

3.1.1 Machine Learning

This is where Machine Learning comes in, which is a subset of AI that works on the possibility of a machine concluding patterns and data as a human being would. The great evolution in Machine Learning is that machines do not need to be taught, they can learn from examples given by humans. Of course, it is much simpler for humans to give examples than to write endless lines of code. When the algorithm gains sufficient experience, it can replicate its conclusions in new data sets. This is called the Machine Learning Life Cycle (SAS Institute, 2021).

This cycle can be defined as “asking a question, getting the data, training the algorithm, testing the algorithm, getting feedback, using feedback” to improve the algorithm and in this way improve your results and performance. This method behind machine learning simply requires granular data, large volumes of data, and extremely diverse data to find patterns and learn (Gil, 2016). The most popular methods of Machine Learning are (SAS Institute, 2021):

- **Supervised learning** - A learning technique that uses labelled data.
- **Semi-supervised learning** - A learning that occurs based on partially labelled datasets.
- **Unsupervised learning systems** - Are the ones that can perform without the presence of data labels.
- **Deep Reinforcement Learning** - A learning technique for use in unknown environments (Alom, 2018).

Machine learning automates the construction of analytical models using neural network methods, statistics, operations research, and physics to find the conclusions

behind the data, without having to be specifically programmed. A neural network is a type of Machine Learning composed of interconnected units (such as neurons), which process information when responding to external inputs, relaying them between the units themselves. The process requires multiple passages in the data to find connections and extract meanings from undefined data. As shown in figure 3, the machine learning life cycle consists of 7 steps, detailed below.

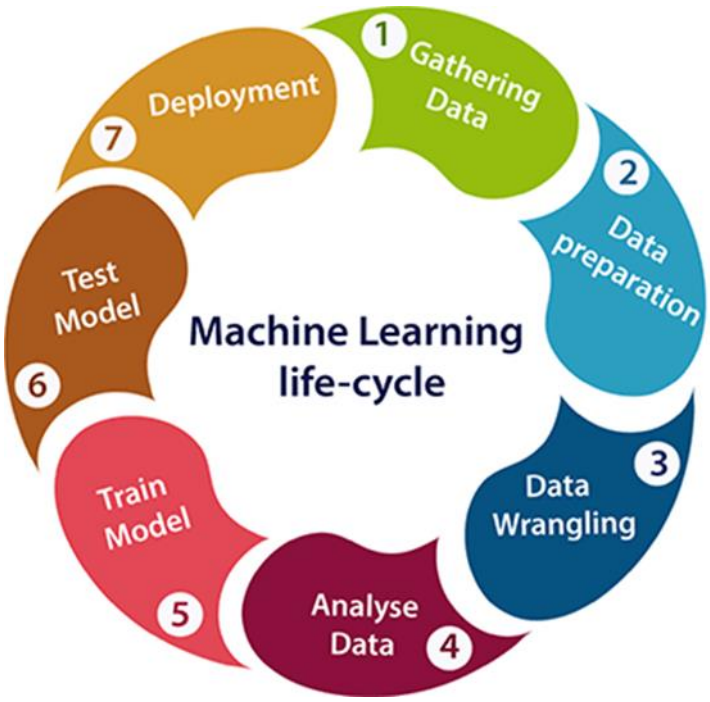

Figure 3 - AI Lifecycle (Mathew et al., 2011)

1. Data gathering

Data can be collected from diverse sources. The objective of this phase is to identify the distinct data sources. Data gathering is a significant step of the life cycle because the quality and quantity of the data collected will be directly responsible for the efficiency of the output. The main steps of this phase are:

- Identify various data sources
- Collect data
- Integrate the data obtained from different sources

- The result will be a coherent dataset used in the subsequent phases.

2. Data preparation

This phase aims to prepare data for machine learning training by placing all data together and randomizing its ordering. The outcomes are fulfilled based on data exploration and data pre-processing.

3. Data wrangling

In this phase, the raw data is converted into a useable format. Making the collected data appropriate for various downstream purposes such as analysis. Data cleaning is required to address the quality issues like missing values, duplicate data, invalid data, and noise. These problems negatively impact the quality of the outcome, so it is required to detect and remove them.

4. Data analysis

Data analysis is the procedure of finding a pattern and extracting useful information from data. It begins with determining the problem type and selecting machine learning techniques such as classification, regression, cluster analysis, and association to build and evaluate the model using prepared data.

5. Train model

This phase aims to improve machine learning model performance for a better outcome. This is essential to understanding the various patterns, rules, and features. In this step the training model runs the input data through the algorithm and correlates the processed output against the sample output.

6. Test model

In this phase, the model's accuracy is tested by providing a test dataset to determine the model's accuracy rate.

Deployment

The final stage of the machine learning life cycle is deployment. In this stage, the model is deployed in the real-world system.

3.1.2 Deep Learning and Natural Language Processing

The use of large neural networks with many layers of processing units, taking advantage of advances in computational power and improved training techniques to learn complex patterns in large amounts of data is called Deep Learning (Arnold et al., 2011). Deep learning architectures demonstrate their high potential in several functions "requiring a high number of labeled samples to be captured by shallow architectures" (Arnold et al., 2011). One of its main functions is Natural Language Processing (NLP). Natural language processing is the ability that computers may have to analyze, understand, and generate human language, including speech itself. In natural language processing, a very interesting approach - "A unified architecture for natural language processing: Deep learning and neural networks with multitasking learning" (Collobert & Weston, 2008), gives proof that deep architectures can perform multitasking learning, giving results of the last generation in difficult tasks, such as semantic function labeling (Arnold et al., 2011).

The next stage of NLP is the interaction of natural language, which allows human beings to communicate with computers using everyday language to perform tasks. However, natural languages contain inherent ambiguities, and writing systems usually amplify and generate new ambiguities, so most of the challenges have to do with resolving these ambiguities (J. Damerau & Indurkhya, 2010). The expression Human-like language processing reveals that NLP is considered a discipline within Artificial Intelligence (AI). And while the full lineage of NLP depends on several other disciplines, since NLP strives for human-like performance, it is appropriate to consider it an AI discipline (Liddy, 2001). Bearing in mind the objective of relating to these intelligent machines, it is essential that the machines know how to interpret human language and can interact with humans in the most natural way possible. This should always happen in the relationship with humans and especially at times and in the imputing methods that require instructions and human interaction. We understand through Nielsen and Molich's 10 Usability Heuristics for User Interface Design (Nielsen & Mack, 1994) that any system must imitate and replicate the real world and speak the user's language. Use words, phrases, and concepts familiar to the user, rather than internal jargon (Nielsen & Mack, 1994) or complex graphical

representations that do not represent this function in the real world, an example of good practice is the Save function in the MS text editor Word, which is represented by a floppy disk icon instead of a graphical representation of a coil with magnetic impulses so that the molecules can move on the disk and thus record the data (Pozzebom, 2012). In the book Design of the Future Things (Norman, 2010), the author suggests that a new relationship be established between human beings and computers, like what man already has with animals. This is a good example between two species with totally different characteristics that complement and relate cooperatively. With technology, it should be no different. If in the past it was controlled by man, with simple on and off buttons, the technology has become more powerful and complex, with its logic, and the human being is currently less able to predict its actions. For designers of this type of system, it is a huge challenge to create adequate ways to provide a harmonious interaction between people and intelligent systems (Nielsen & Mack, 1994).

3.2 Interaction Design in AI systems

The advances made in recent years in the domain of Artificial Intelligence have triggered a series of opportunities and challenges in terms of user interface design. Based on this need, the Association for Computing Machinery created and published a set of Guidelines for the interaction between Human and Artificial Intelligence at the previously mentioned CHI - Conference on Human Factors in Computing Systems. The developed, tested, and validated collection of guidelines can be a resource for professionals working in designing applications and other systems that use AI technologies, as well as for researchers interested in developing AI human-AI interaction design principles (Amershi et al., 2019). Table 3 shows the group of principles to be analysed and the purposes related to each point.

Table 3 - IxD guidelines for AI systems (based on Amershi et al., 2019)

Id	Guidelines	Objetives
1	Clarify what the system can do	Helping the user understand what the AI system can do
2	Clarify with what quality the system can do it	Helping the user to understand the system's margin of error

3	Timing of services must take context into account	Adapt system actions and interruptions according to user needs
4	The information shown must be contextually interesting	Show information relevant to the user's current activity/task
5	Considering the context and social norms	Adapt the user experience to the user's social and cultural context
6	Mitigate social prejudices	Ensure that language and behaviors do not reinforce stereotypes
7	Promote efficient invoke	Make it simple to invoke or request services when desired
8	Promote efficient dismissal	Make it simple to dismiss services when desired
9	Promote efficient correction	Make it simple to fix or recover in case the system is not correct
10	Inform in case of doubt or ambiguity in the options	Helping the user understand what the AI system can do
11	Make it clear why the system took a certain action/option	Let the user know what the system did and why
12	Remember recent interactions	Keep a history of interactions and allow the user to reference it
13	Learning from user behavior	Customize the experience by learning from user actions
14	Update and change carefully	Limit updates and disruptive system changes
15	Promote feedback	Encourage regular user feedback through interaction with the system
16	Convey the consequences of user actions	Inform how user actions will impact the system in the future
17	Provide full control	Allow the user to control what the system monitors and how it behaves
18	Notify users about changes.	Keep the user informed about updates and new capabilities

The joint coordination of human activities and autonomous machines needs to be created, that these are natural, smooth, and pleasant tasks (Norman, 2010). Interaction design is a fundamental key to achieving a new level of satisfaction in the human-machine relationship, as a system that simulates physical objects or characters (and being able to perceive human actions and intentions) will make people interact with this system, appropriating strategies that they use in their day-to-day (Sebe et al., 2004). According to

these principles, the designer should focus on passing all needed information and doing it clearly on an initial stage, while emphasizing the context and considering the user's social and cultural norms, as well as mitigating potential biases during the interaction. Simplicity in use and invocation, dismissal, and correction is also part of the designer's commitments to a good interaction design in artificial intelligence systems (Amershi et al., 2019). By applying these principles, we can ensure that the user is correctly informed about system characteristics when initiating the use and that the systems do not interrupt or confuse the users with unwanted, unnecessary information or something that is not interesting at a particular moment. Making the use of the system enjoyable by supporting and easily invoke of the system or its' functions in case of need and a simple dismissal or correction in case of error. Furthermore, considering the social-cultural norms of the users and user's environment. If some Artificial Intelligence systems are employed more explicitly, others run in the background and it is essential that in all of them any more unpredictable, disruptive, offensive, discriminatory, confusing, and even dangerous behavior is reduced (Sebe et al., 2004).

A good example of some of these principles is seen in the "Spotify" music streaming application, where the system regularly makes a playlist and sends a notification to the user stating "I made a playlist based on the songs you listened to (what I did and based on what). I think you will like it (margin of error implied.) Furthermore, we observe human and natural language as the system interacts with the user during the entire use of the application. The second section of principles highlights the communication in case of ambiguity, suggesting control and information once. The user's past interactions and options are also aspects that the designer should not neglect. An excellent example of several of these guidelines is the "Google Maps" app which, on the one hand, memorizes the places where users often go (learn by use and record the user's options history) and on the other hand it shows to the users a contextually important message with great ease of dismissal (usually one click) but also very easy to invoke if needed (usually 2 to 3 clicks.) This message appears in timing that makes sense, for example when approaching a toll road. In case of ambiguity and if the system chooses us immediately and in a very noticeable way it informs the user who made that choice and the reason why he made it.

Learning through user behavior, promoting feedback in both directions, being cautious about any updates/changes to the system, as well as, providing full control and

monitoring by the user are strongly exposed points in the principles of interaction design. This important subject is also denoted by Nielsen (Nielsen & Mack, 1994) and is related to the control and freedom of users being fundamental in the interaction with any system because users do actions by mistake and in these cases, it is essential to have a clear "emergency exit" signalized to give up an unintended or undesired action. As happens in physical spaces where there is a quick, clear, and well-marked emergency exit. When considering a system capable of learning and taking decisions and actions on its own, it would be valuable to go even further, conceiving the concept of a reset button that provides users a total sense of control and the possibility to at any time the user feels that an error may have been made, by the human or the system, to shut down the system and quickly hard reset all data, information, and learning attained. This may work to mitigate the concern and/or doubts that can exist and may increase with the growth of capabilities of these kinds of systems. This functionality already exists in other types of systems that can cause accidental hazards to humans, such as industrial machines, can be essential and act as a guarantee that in the worst-case scenario that machine could be turned off and all its learning erased. Allowing it to be restarted clean, inserted other inputs, or even reprogrammed to avoid the previous situations. Computer systems must be designed in a way that they are predictable, that is, they work in a way that does not cause unpleasant surprises to users and make the result understandable. The human being must understand the computer working process and establish a form of communication with it. And always let people think they are in control, even if they are not, sometimes, and never labelling human behavior, often unpredictable, as an error (Norman, 2010).

These guidelines interconnect with other relevant works in the area. It is not surprising to see that most of the principles and/or its objectives remain consistent in Shneiderman's The Eight Golden Rules of Interface Design, as can be understanded in the table 4 presented below.

Table 4 - Eight Golden Rules (based in Shneiderman et al., 2016)

ID	Golden Rule
1	Maintain consistency
2	Allow users to use shortcuts

3	Provide informative feedback
4	Create dialogs that indicate the end of an action
5	Prevent errors and offer simple error handling
6	Allow easy reversal of actions
7	Keep the user feeling in control
8	Reduce short-term memory load

Analysing this Golden Rules with the sets of essential interaction guidelines studied and defined by the reference works with the design principles for artificial intelligence systems, the interconnection between them is evident. To better understand its relationship with the most elementary interaction design heuristics and especially its functionality in an environment of real use and impact for the human being, the fundamental and previously presented Interaction Design Guidelines will be detailed and exemplified. Subsequently, they will be related through a table with the design heuristics of AI systems and the Eight Golden Rules of Design.

Any design, even if it follows the principles established by the industry and the guidelines previously presented, must be subject to a heuristic evaluation to ensure its usability. As already mentioned throughout the work, one of the usability inspections considered standard was developed by Jakob Nielsen and Robert L. Mack- 10 Usability Heuristics for User Interface Design (Nielsen & Mack, 1994). This usability inspection method is presented and explained below.

Usability Heuristic Number 1: Visibility of system status

Figure 4 - Usability Heuristic #1 (Nielsen, 2020)

Design should continuously keep users informed of what is occurring through proper feedback within a reasonable time. When users know the system's state in real-time, they understand the result of their previous interactions and determine the next steps. Predictable interactions build trust in the product and brand.

Usability Heuristic Number 2: Match between system and the real world

Figure 5 - Usability Heuristic #2 (Nielsen, 2020)

Design must speak the users' vocabulary, for this to be possible, designer must use familiar words, terms, and concepts rather than technical jargon. Following real-world conventions, making information appear in a natural and logical order. When a design's controls follow real-world conventions and match the desired results – natural mappings, it is easier for users to learn and remember how the interface works. This is crucial to constructing an intuitive experience.

Usability Heuristic Number 3: User control and freedom

Figure 6 - Usability Heuristic #3 (Nielsen, 2020)

Users need a clearly marked *emergency exit* to stop unwanted action without having to go through a prolonged process. When it's easy for people to undo an action, it promotes a sense of freedom and trust. Outputs allow users to remain in control of the system and avoid getting stuck and frustrated.

Usability Heuristic Number 4: Consistency and standards

Figure 7 - Usability Heuristic #4 (Nielsen, 2020)

Designers must follow platform and industry conventions. Jakob's Law states that people spend most of their time using websites other than yours. Users' experiences with these other products define their expectations. Failure to maintain consistency can increase users' cognitive load, forcing them to learn something new.

Usability Heuristic Number 5: Error prevention

Figure 8 - Usability Heuristic #5 (Nielsen, 2020)

Helpful error messages are necessary, but the goal should be to prevent problems from occurring. Do not disseminate space and conditions for errors to occur and showing users a confirmation option before committing to a specific action is an essential assignment that must be carefully thought out and tested.

Usability Heuristic Number 6: Recognition rather than recall

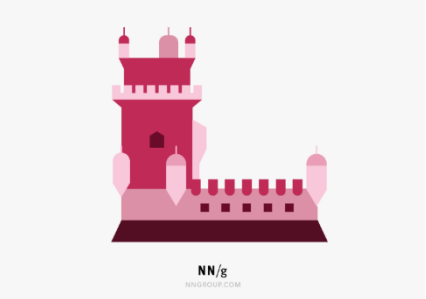

Figure 9 - Usability Heuristic #6 (Nielsen, 2020)

Minimize user memory load by making elements, actions, and options visible. Info needed to use the design (e.g. menu items) should be visible or easily retrievable when needed. Interfaces that promote recognition reduce the amount of cognitive effort required of users.

Usability Heuristic Number 7: Flexibility and efficiency of use

Figure 10 - Usability Heuristic #7 (Nielsen, 2020)

Flexible processes can be carried out in different ways, so people can choose whichever method works best for them. The design should operate for inexperienced and experienced users, it should be enabled to customize frequent actions.

Usability Heuristic Number 8: Aesthetic and minimalist design

Figure 11 - Usability Heuristic #8 (Nielsen, 2020)

Interfaces should not contain irrelevant or infrequently needed information. Each extra unit of information in an interface competes with the relevant units of information and decreases their relative visibility. The visual elements of the interface should support the user's main goals.

Usability Heuristic Number 9: Help users recognize, diagnose, and recover from errors

Figure 12 - Usability Heuristic #9 (Nielsen, 2020)

Error messages should be expressed in straightforward language (no error codes) and accurately indicate the problem and constructively suggest a solution. These kinds of messages should also be presented with visual aspects that help users to recognize them.

Usability Heuristic Number 10: Help and documentation

Figure 13 - Usability Heuristic #10 (Nielsen, 2020)

It's crucial to provide documentation to help users understand how to complete their tasks. Help and documentation content should be easy to search, be concise and list the concrete steps that need to be carried out to complete user's task.

When investigating design heuristics, it becomes noticeable that virtually all digital products and services we know settle to these guides. That does not happen by chance:

- These standards guarantee good usability, which is essential for a product to reach the point of being adopted by the market.
- These studies began to have enormous advances in the 80s and are responsible for the very way in which the user already expects a particular system to behave.

It is impressive to verify that the principles being studied for designing interfaces in artificial intelligence systems are interconnected with the standard guidelines of the computer systems design sector. Table 5 demonstrates how the central studies relate to what are currently the main principles of Usability and Interaction Design.

4 Guidelines Analysis, Aggregation and Comparative

Based on the study of leading authors and scientists, and the descriptions of the design principles and heuristics presented in their works, a table that combines and aggregates the works in a framework of abstract design principles was developed. These abstract principles were compiled and selected based on an intensive examination of the authors' work and the fundamental methodologies used in interface and interaction design for more than three decades. The importance of these terms is found across the studies and books that gave rise to the previously presented guidelines: “Design do Futuro” (Norman, 2010), “Usability Inspection Methods” (Nielsen & Mack, 1994), “Designing the User Interface: Strategies for Effective Human-Computer Interaction” (Shneiderman et al., 2016). As well as, in the books: “Technology affordance”s (Gaver, 1991), “The psychology of everyday things” (Norman, 1988), “100 things every designer needs to know about people” (Weinschenk, 2011), “The human factor: Revolutionizing the way people live with technology” (Vicente, 2013) and “Pleasure with products: Beyond usability” (Green & Jordan, 2002), who contributed significantly to developing this framework that extracts these principles from their studies and compiles them into a set of good practices, abstract enough to adapt to the most diverse interfaces and, in this work, focused effectively on systems with AI. These principles are within the scope of the ISO 9241-210:2010 norms. Although they are not explicitly delineated for AI systems, they are inherently considered in elaborating any interface and interaction design process. Table 5 shows how the studies associate with a framework of fundamental abstract principles of usability and interaction design and compares the main works in this area and confirms which guidelines are matched and which are not among the several works, using a green Check icon for correspondence and a red X icon where there is no correspondence. The representation is a yellow check icon with a dash when the match is partial or incomplete.

Table 5 - Aggregation of the main studies in a framework of fundamental AI Design principles

AI Design Principles	Amershi et al., 2019	Norman, 2010	Shneiderman et al., 2016	Nielsen & Mack, 1994
1 - Affordance	✗	✓ Guideline 1	✓ Guideline 2	✓ Heuristic 1
2 - Discoverability	✓ Guideline 1	✓ Guideline 6	✓ Guideline 2	✓ Heuristic 2
3 – Reliability & Predictability	✓ Guideline 2	✓ Guideline 2,4	✓ Guideline 8	✓ Heuristic 6
4 - Feedback	✓ Guideline 3,4,10,11,16	✓ Guideline 4,5	✓ Guideline 3,4	✓ Heuristic 1
5 – Internal & External Consistency	✗	✗	✓ Guideline 1	✓ Heuristic 4
6 - Personalization & Shortcuts	✗	✗	✓ Guideline 7	✓ Heuristic 7

7 - Social and Cultural Context	Guideline 5,6			
8- Ease of use (access, dismissal)	Guideline 7,8			Heuristic 3,8
9 - Error prevention and correction	Guideline 9	Guideline 1	Guideline 5,6	Heuristic 5.9
10 - Interactions history	Guideline 12		Guideline 8	Heuristic 6
11 - Learning based on user interactions	Guideline 13			
12 - Avoid major disruptive changes	Guideline 14	Guideline 2		
13 - Promote prompt feedback	Guideline 15			

14 - Customize AI behavior	Guideline 17		Guideline 7	
15 - Ease of forgetting			Guideline 7	
16 – Help and Documentation	Guideline 18	Guideline 3		Heuristic 10

Understanding the purpose behind each usability guideline and heuristic is essential to associate them with this set of fundamental IxD and usability principles. There is a connection in some guidelines that may seem more complex at first glance because user-centered design focuses on the user and not the system itself. Therefore, it is usual that in systems with different capabilities, the corresponding guidelines can be displayed differently though with the same objective and result for the user of this system. Hence its utility in addition to gathering and interconnecting the central studies in the field of interaction design and user experience, exploring the purposes behind each of the principles and binding them with a set of fundamental guidelines for designing AI systems interfaces. To create the best potential interface that ensures a productive, safe, and pleasant interaction with intelligent and independent systems.

4.1 Guidelines Similarity Score

To systematize and find a degree of similarity between the analyzed works, scores were assigned according to the total or partial existence and the absence of correlation between each of the guidelines. The score was distributed as follows and assigned in table 6 to each research work:

- The guideline exists and fully correspond: 2 points
- The guideline is partially addressed: 1 point
- The guideline has no correspondence: 0 points

Table 6 - Matrix with the degree of similarity between studies

AI Design Principles	Amershi et al., 2019	Norman, 2010	Shneiderman et al., 2016	Nielsen & Mack, 1994
1	0	2	2	2
2	2	1	2	2
3	2	1	1	1
4	2	1	2	1
5	0	0	2	2
6	0	0	1	1
7	2	0	0	0

8	2	0	0	2
9	2	1	2	2
10	2	0	1	1
11	2	0	0	0
12	2	2	0	0
13	2	0	0	0
14	2	0	2	0
15	0	0	1	0
16	2	2	0	2
Average	1.5	0.6	1	1

Based on this matrix (table 6), the degree of similarity was calculated by calculating the sum of the entire score divided by the number of guidelines, thus calculating the average of the results. It is observable that the work of Amershi et al., 2019 has a higher similarity, followed by Nielsen & Mack, 1994 and Shneiderman et al., 2016, ending with the slightest similarity of Norman, 2010 design principles.

4.2 Conclusions of the Guidelines Aggregation

Comparing the guidelines to obtain an essential and consistent user experience and interaction design principles framework, it is unexpected that the suggested principle Affordance is not present in Amershi et al., 2019, and is in correspondence with the other works analysed. Affordance is the quality of an object that allows the individual to identify its functionality without the need for previous explanation, which occurs intuitively or based on previous experiences. For example, a doorknob or the icons of a computer or website. The greater the prolificacy of an object, the better the identification of its use.

Suggested Principle 2 - Discoverability, is transversal to all studies, although partially observable in the work of Norman, 2010. This term is particularly important because it represents the degree of ease that a user has in accessing and using all the functionalities of a system the first time, he encounters it. Discoverability is one major component of

learnability, a measure of how easily someone can find, access, and make use of the components and features of a new system. Learnability, in turn, is a crucial element of usability.

Principle 3 points out the importance of the system being designed in a Reliable and Predictable way. This principle is suggested in the work Amershi et al., 2019 and partially referred to in the remaining studies. In the sense that some of its benefits are pointed out, such as being predictable, making the results understandable, reducing the user's effort and memory load, and recognizing instead of remembering. It is difficult to conceive of a world where an intelligent, independent system is not highly reliable and predictable. Animals that are not predictable are considered wild by humans, for example. Even little pets like canines must have a massive degree of predictability, otherwise, they would hardly cohabit with humans in harmony. Hence, it is essential to define these concepts as a fundamental principle.

Principle 4 refers to the Feedback provided by the system in an overall manner. This is addressed completely in the work Amershi et al., 2019 and Shneiderman et al., 2016 as these are guidelines intended for use in AI systems. And partially in the remaining works. Communicating with the system and obtaining real-time feedback, based on time and context, and informing the user of the consequences and results of all actions can be considered fundamental in an AI system.

The internal and external Consistency shown in principle 5, already addressed in detail throughout the work, is one of the main usability heuristics that must be preserved in AI systems. Despite its importance, it is not specifically reflected in the works Amershi et al., 2019 and Norman, 2010. As well as principle 6 - Personalization & Shortcuts, being this only partially corresponded in the other studies analysed - Shneiderman et al., 2016 and Nielsen & Mack, 1994.

Matching Social Norms & Context, as well as, mitigating social biases is a vital principle contemplated Guideline 6. Despite its relevance demonstrated in the work Amershi et al., 2019 is not covered in the other works addressed. Ease of Use mentioned in Guideline 7 refers in this case specifically in accessing or ignoring activities and functions is also found in the work Amershi et al., 2019 and in the heuristics of Nielsen & Mack, 1994.

Principle 9 - Error prevention and correction are universal guidelines across all these works. As it is essential in any type of computer system. The concept 10 - Interactions history, on the other hand, is not concretely observable in Norman, 2010, having some of its benefits demonstrated in Shneiderman et al., 2016, Nielsen & Mack, 1994, hence materializes as a partial correspondence.

Principle 11 - Learning based on user interactions, is merely enshrined in the work Amershi et al., 2019. This is mandatory in an AI system. As well as principle 12 which is Avoiding major disruptive changes, with the difference that can be considered partially inherent to the characteristic of being predictable in the work of Norman, 2010.

Principle 13 - Promote prompt feedback is different from the Feedback principle as this feedback goes from the user to the system. This must be natural, incremental, and always after or very close to the actions to which it relates. When it comes to Customize AI behavior. principle 14, is suggested that the user would be and feels always in control and is present in both studies that focus on AI systems. Not being precisely noted in the others.

The Ease of forgetting mentioned in principle 15 is not included in the studies, appearing only partially reflected in Guideline 7 - Keep users in control of the work of Shneiderman et al., 2016. However, it is not specific. This task is still quite difficult on current platforms that somehow consider user preferences and habits to be their main advantage and driving force. It is intended to test if for the user the importance of this principle increases with the increase of capacities and information that the AI system has about the user. Being this considered a fundamental principle as well. Principle 16 - help and documentation is specifically mentioned in all works except Shneiderman et al., 2016.

It is concluded that each of the authors individually does not cover all the aspects necessary to guarantee the best results. These works should serve as a basis and a complement, but they are not sufficient by themselves to ensure all the principles that the aggregation in a framework presents. Also, because, as can be understood, part of the most prolific works and principles are not specific to AI interfaces.

In this sense, its aggregation in a single table allows UI, and IxD designers to follow a unique and understandable path in the development of AI systems interface that ensures optimal usability to users.

5 Framework and Prototype Development

The goal of this framework is to design AI products with the potential to accomplish the goals of the user, in an enjoyable, efficient, and safe way. For this, the Guidelines with the highest scores, in table were selected. However, it should be noted that all guidelines are important. The work developed aims to mainly exemplify and validate the following suggested interaction design principles for AI systems:

- Affordance
- Discoverability
- Reliability & Predictability
- Feedback
- Internal & External Consistency
- Ease of forgetting
- Help and Documentation

An interactive prototype was developed to demonstrate the application of these guidelines. The examples presented below are part of the AI Vitamin platform – an intelligent food supplement platform that can be tested online through the following link: https://bit.ly/prototipo-vitamina-ai

An example video of its use was also created, and can be viewed here: https://youtu.be/-ZKAkBm6oN0

5.1 Guidelines Description and Prototype Examples

- **Affordance**

Affordance is the quality or property of an object that defines its possible uses or clarifies how it can or should be used. For example, when we see a chair, it is pretty evident that it is used to sit on (Lafee, 1993). According (Gibson, 1986) it is a resource that the environment offers to an animal that the animal must possess the capabilities to perceive and use it. If the object is an AI system and the animal the human being, it is an essential attribute that this system must have to ensure acceptable usability.

Example: We can use this property through a slider that the user can instinctively slide and select the option they want and naturally and logically check the selected option.

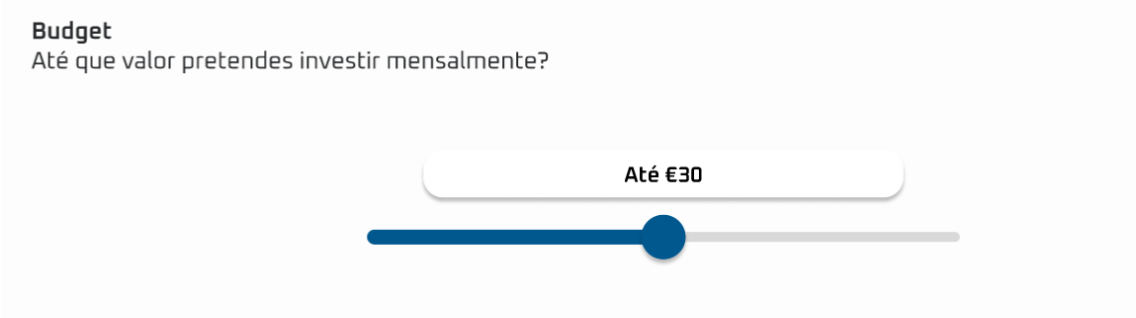

Figure 14 - Example Affordance Guideline

This objective is also visible in buttons, checkboxes, X-shaped icons to close messages, among others.

- **Discoverability**

The degree of ease with which users can discover all the elements and features of a system when they first experience it is directly proportional to its discoverability. An AI system should be quickly learned with no effort from new users that can interact with it.

Example: Discoverability depends on many factors. It is likely that applying the main guidelines in the design of an interface will achieve this desired effect. We can highlight the importance of the "Hero" section, where the good organization of the information, a well-crafted copywrite, and the existence of a primary CTA with the option that the platform wants the user to execute (and that probably took the user to the website) highlighted, as well as a secondary option will have a major impact on this goal.

Figure 15 - Example Discoverability Guideline

In the footer, it is likely that the user will look for the help menu and contacts. Another relevant issue is to maintain the flow of movements in the footer by not allowing a page to simply end up in the footer without any continuity option.

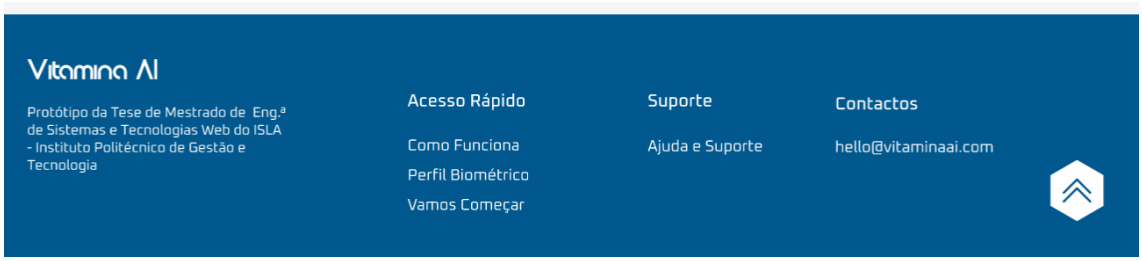

Figure 16 - Example 2 Discoverability Guideline

- **Reliability & Predictability**

When evaluating an independent and intelligent system, its full compression is paramount. An AI system must be reliable and predictable to ensure its implementation and use by users.

Example: In the examples presented user can successfully foresee the result of an interaction and all factors of the interaction design set proper anticipations about what will happen. Even before the user clicks on something, which means it his predictable.

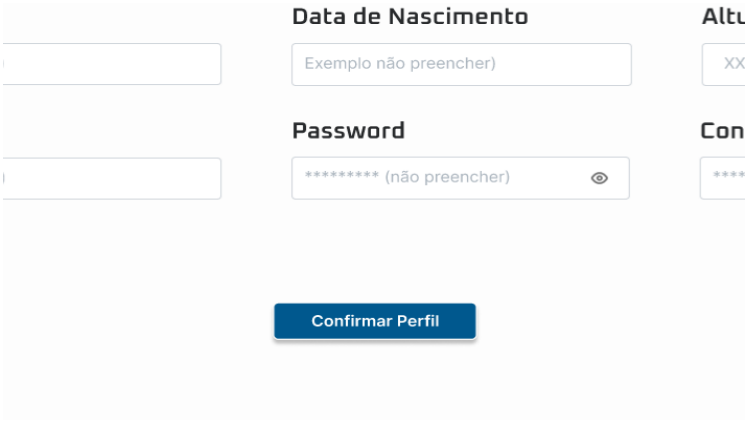

Figure 17 - Example Reliability & Predictability Guideline

Clear and timely information helps the user to know exactly what is happening and avoid the tension of the unknown. In this example, a moving image gives the perception of creating the biometric profile, which helps with the predictability of the system.

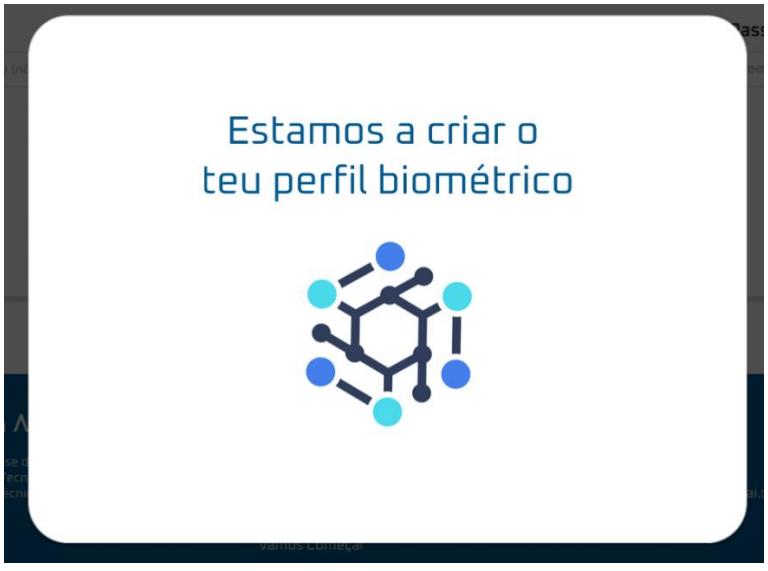

Figure 18 - Example 2 Reliability & Predictability Guideline

Copywrite is essential for a system to be predictable. Natural language is one of the most important aspects, as well as the clarity of texts and information present throughout the platform.

Figure 19 - Example 3 Reliability & Predictability Guideline

For the system to be reliable, it is essential that it be specified, not only what it does, but the degree of error with which it does it. Something that can be explicit or implicit in the messages presented to the user.

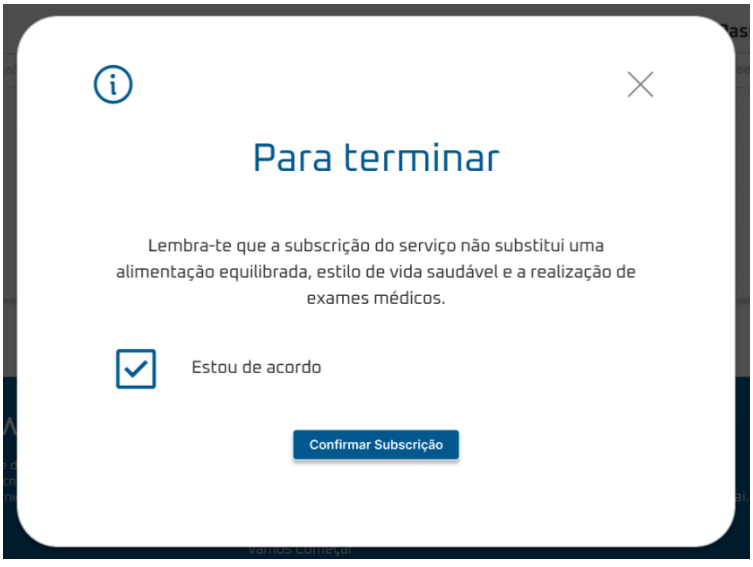

Figure 20 - Example 4 Reliability & Predictability Guideline

- **Feedback**

For proper communication to exist, it must be done in both directions. Hence the feedback in all moments of the interaction is essential for acceptable usability.

Example: In the interactions shown in the examples, the feedback is complete and simple to understand. In addition to explaining to the user what is happening and the relevant issues for the point he is in, it provides options in the interaction itself that take the user to where he wants to go directly.

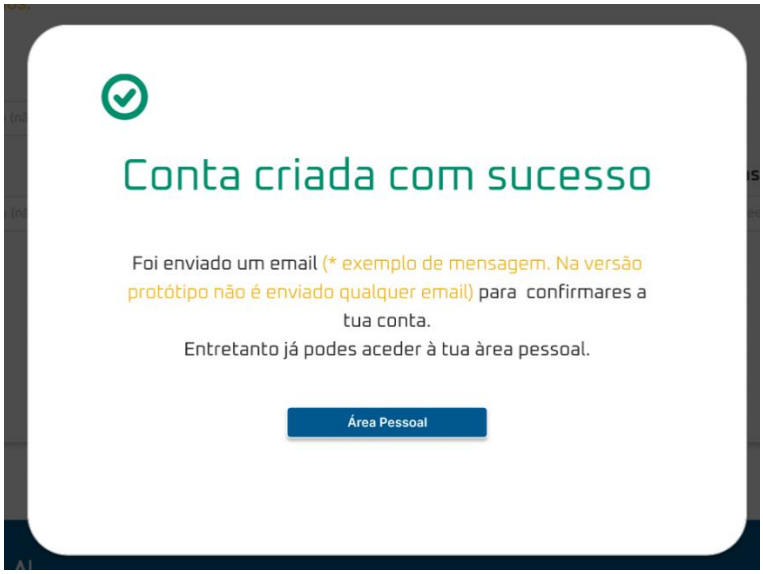

Figure 21 - Example Feedback Guideline

Confirmation messages are also critical. Critical and irreversible actions must have, in addition to text and visual confirmation, ways of easily not confirming and even continuing to use the platform - thus avoiding any action that may not be ideal for the system, as is the case with delete data or close an account.

Figure 22 - Example 2 Feedback Guideline

- **Internal & External Consistency**

Following the most basic interface design principles, internal consistency (within the system itself) and external consistency (in line with expectations and with the industry's standards to which it belongs) should also be a vital concern in AI systems.

Example: Internal consistency is achieved using fonts, colours and illustrations throughout all pages. Contributing with the design and presentation of the information for internal consistency. The external consistency, although challenging considering that it is an innovative platform that does not exist and is being designed for the future, was created through futuristic AI 3D illustrations, along with easily recognizable illustrations in this area, such as a doctor / nutritionist and a pills box.

Figure 23 - Example Internal & External Consistency Guideline

It is also important to humanize the platforms through vectors or photographs of human beings. Creating interactions that are empathetic and easily recognizable.

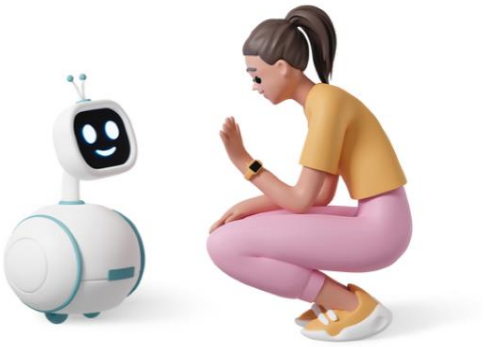

Figure 24 - Example 2 Internal & External Consistency Guideline

People may trust AI more when associated with a professional they already have respect and admiration for. In this sense it is also easier to understand what an AI system does with a representation of a human being that is recognized as reliable for that action.

Figure 25 - Example 3 Internal & External Consistency Guideline

- **Ease of forgetting**

The complexity and dynamism with which we live our lives online are such that the patterns may not remain consistent over the years and often months. It is crucial to force commonly used applications to forget about the learning process and start learning again,

aiming for better or simple results for the current needs. In the case of more advanced AI systems, a quick reset/stop should be considered, allowing the system to be restarted with factory settings and even work temporarily in safe mode (without AI).

Example: It is possible to verify the possibility of erasing the data in a prominent part of the platform, without having to take several steps and searches to find the functionality. This increases the degree of control and perceived security and effectively allows for a more dynamic relationship between the human and the AI platform.

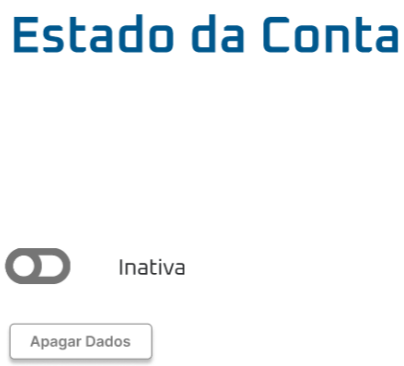

Figure 26 - Example Ease of forgetting Guideline

- **Help and Documentation**

As much as the systems are well designed, they must always have helpful, valuable, and efficient documentation. If, on the one hand, we have the tasks of personalization and advanced customization of users, on the other hand, interoperability will be important in this type of system, as well as the possibility of integrating more functions, so the documentation for "programmers" should also be a reality to consider.

Example:

In the platform's help page it's perceptible a search bar to facilitate the search for specific terms, but also task-oriented help menus and the most used / searched topics by users. All with a simple and clean design that makes this task as simple and pleasant as possible.

Figure 27 - Example Help and Documentation Guideline

The examples presented are part of the prototype of a developed AI system interface – in its Desktop version. Its concept, business, products are merely illustrative. Likewise, the profile results visible in the personal area are for demonstration purposes only – being the same for all users and without any nutritional or medical validation. However, the practical use seeks to match that of a digital product ready for production, with practical actions and satisfactory results in terms of user experience. For this, a user research study was carried out, which is presented in the next section.

6 Discussion of Results

In order to evaluate the performance and know the opinion of potential users of the prototype and design professionals a user questionnaire was carried out. This user research technique aims to validate the usefulness of the work developed. It can be analyzed in its full extension as attachment of this work. The purpose of the questionnaire is to test the platform User Experience on its desktop version. The presented platform is an integral part of this work, being created as a prototype according to the investigation carried out throughout this work. It consists in an AI system, whose interface is a website that automatically suggests, orders, and sends food supplements and vitamins based on the user's diet and habits. It's called Vitamin AI and the concept, business, products are merely illustrative. Likewise, the profile results visible in the personal area are for demonstration purposes only – being the same for all users and without any nutritional or medical validation. To obtain the necessary information, the platform was presented to the users, and they were asked to carry out some tasks, followed by the completion of the questionnaire. The preparation of this questionnaire was divided into 3 main parts:

- **General user data:** In this first part of the questionnaire, questions were asked to understand the demographics of users. Users were also divided into 2 groups, these are: common users and design professionals.

- **Platform usage data:** In the 2nd part of the questionnaire, the link to the application was provided. Users were asked to perform 5 tasks on the platform. The suggested tasks were the following: Access the page and navigate through the homepage and its menus, create a profile, access the personal area, delete the biometric profile, exit the personal area. In this 2nd part the questions focused on the accomplishment of these tasks.
- **User experience data:** Finally, in the 3rd phase, a general assessment was requested, through questions that allow describing the user experience as a whole and the main characteristics of the platform.

After completing the development of the users questionnaire, it was tested and optimized. Once ready it was shared on the author's and ISLA-IPGT's social networks. In addition to sharing on social media, the author encouraged the participation of his

personal and professional contacts through an individual request. It was also sent to private groups and UI/UX communities in Portugal and Brazil.

The questionnaire had the participation of 41 users between 18 and 51 years of age, of which 53.7% are common users (non-designers) and 46.3% are professionals in the field of interfaces and user experience design.

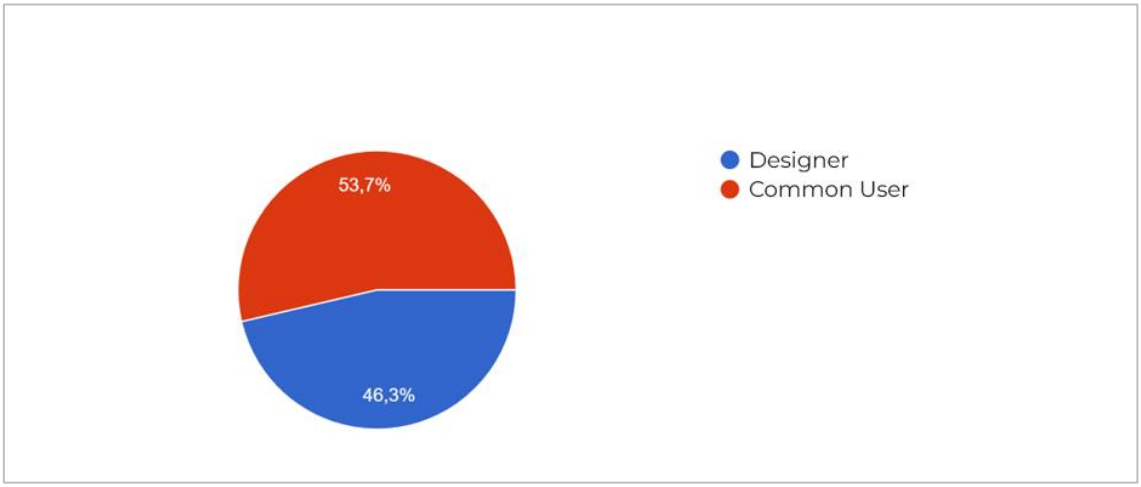

Figure 28 - Questionnaire Results: Users Type

These users cover the various levels of education, with the majority (61%) having a degree, however users with the 12th year or less also responded, as well as holders of a doctorate degree. These users are Portuguese's and non-Portuguese's and reside in several districts of Portugal, as well as, outside Portugal. All demographics attached.

The results are satisfactory and align with the objectives, as all tasks were performed without any difficulty by more than 95% of users. The tasks performed as well as the respective results are presented below.

After performing task 1 (navigating the homepage) did you understand the objectives of the platform?

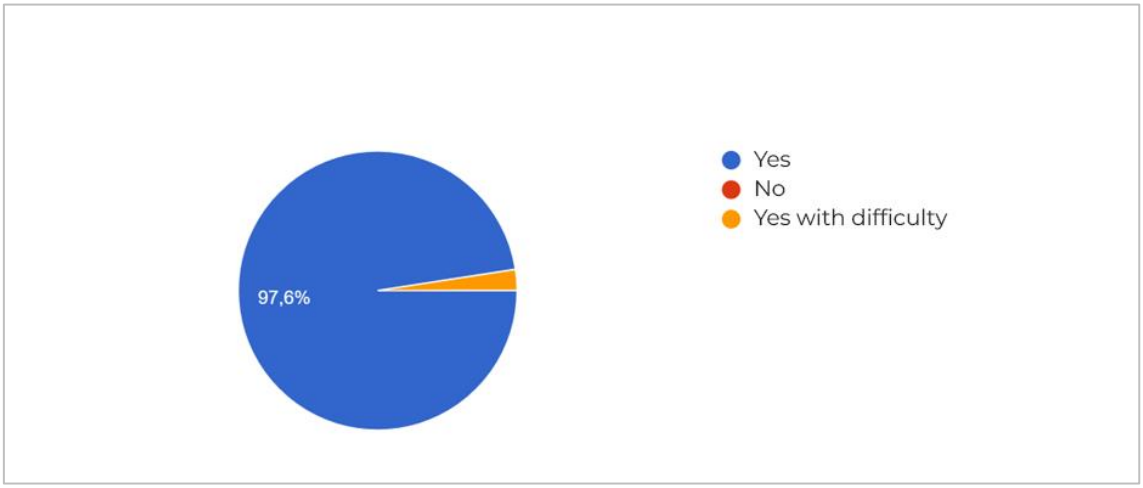

Figure 29 - Task 1

Were you able to complete task 2 (create a biometric profile)?

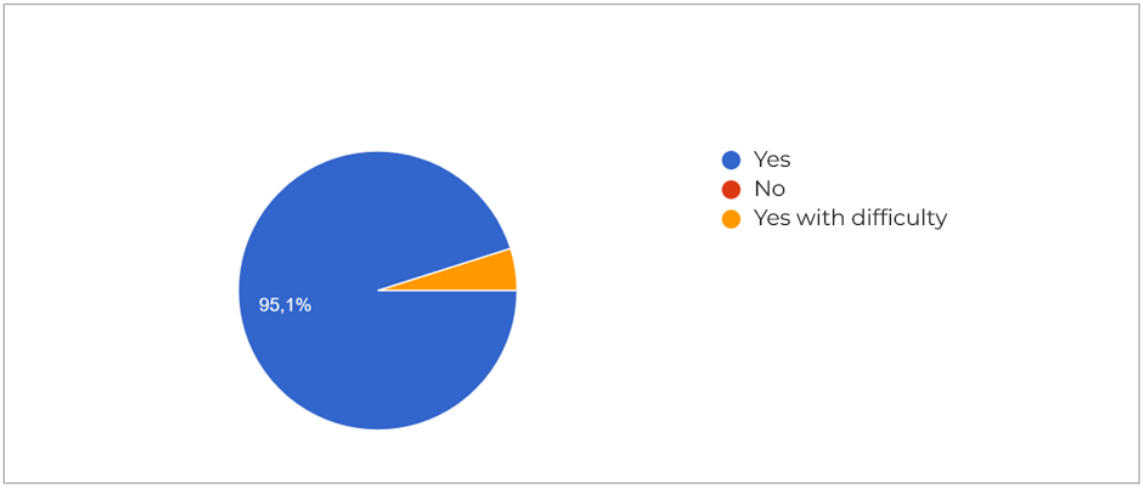

Figure 30 - Task 2

Were you able to complete task 3 (access the Personal Area)?

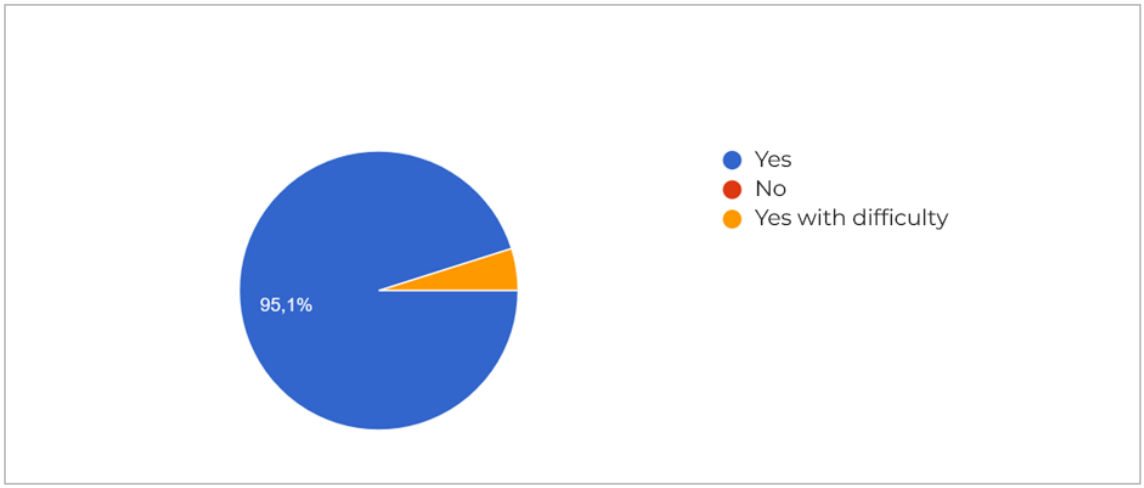

Figure 31 - Task 3

Were you able to complete task 4 (erase your data / biometric profile)?

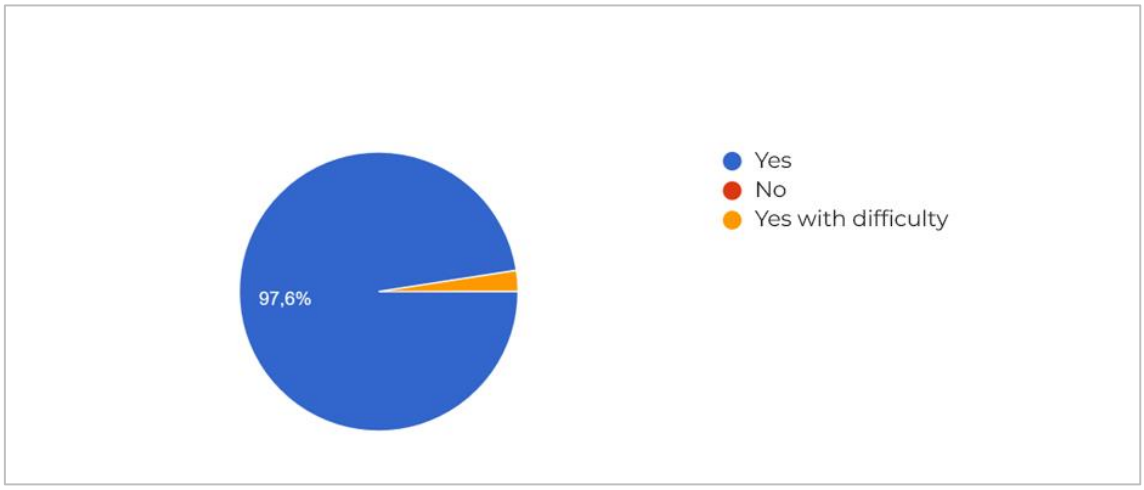

Figure 32 - Task 4

Were you able to complete task 5 (return to the homepage from the Personal Area)?

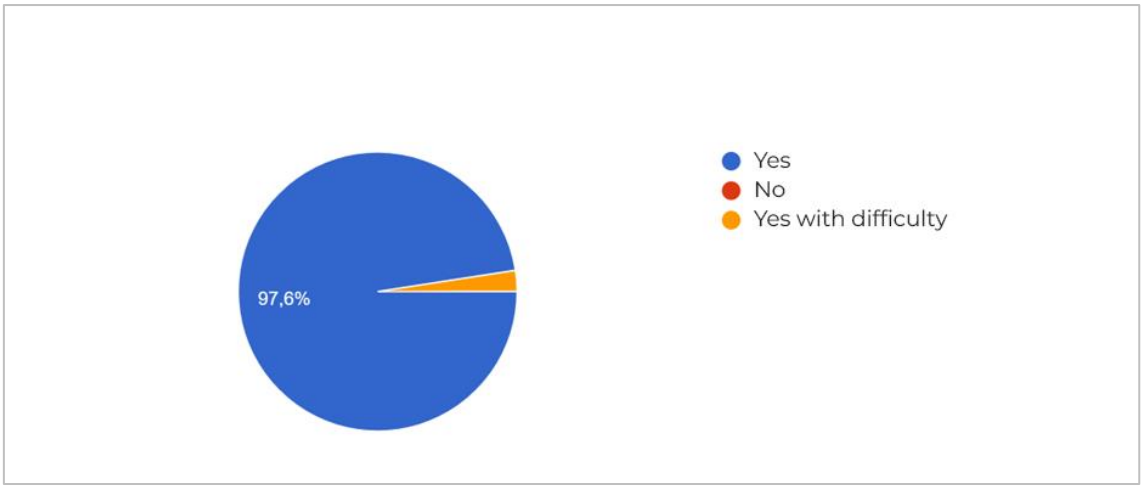

Figure 33 - Task 5

To support the questionnaire, a video was created that shows the performance of tasks on the platform, however 90.2% of users indicate they did not need to see. When users were asked to mark in a collection of options (positive and negative) all the characteristics that they associated with their experience of using the platform, the most selected were the following:

- Safe - 73.2%
- Pleasant – 63.4%
- Intuitive - 70.7%
- Functional - 58.5%
- Simple - 70.7%
- Reliable - 48.8%

With a residual record of selected negative adjectives, as shown by the results obtained in figure 34.

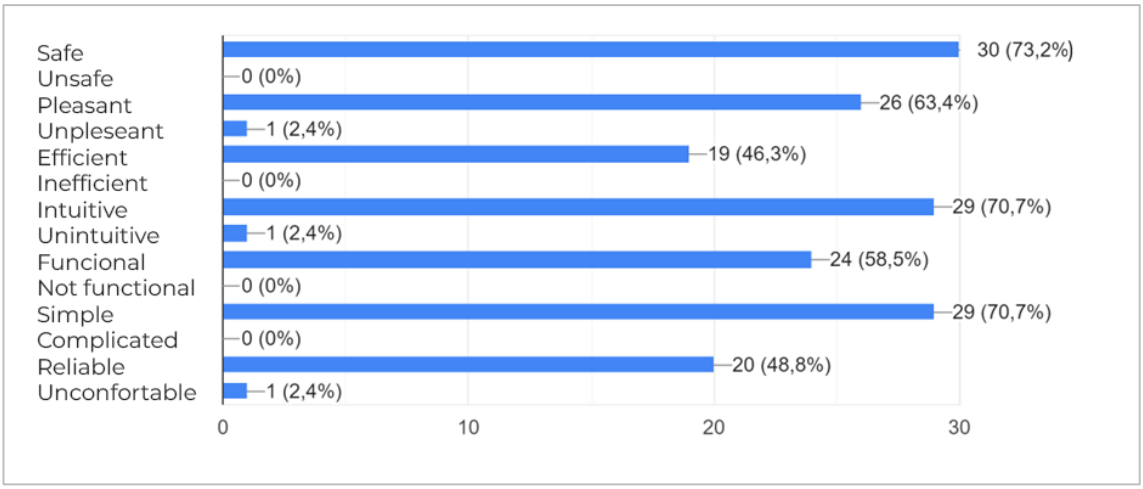

Figure 34 - Characteristics that users associate with their experience using the platform

These picks are fundamental when adopting a computer system of any type, and their reliability and security will be increasingly relevant when we talk about systems with AI. Therefore, the fact that they were selected by this group validates exactly the points addressed throughout this work. Since most users are interested in using platforms of this kind in the future, as shown in the figure 35.

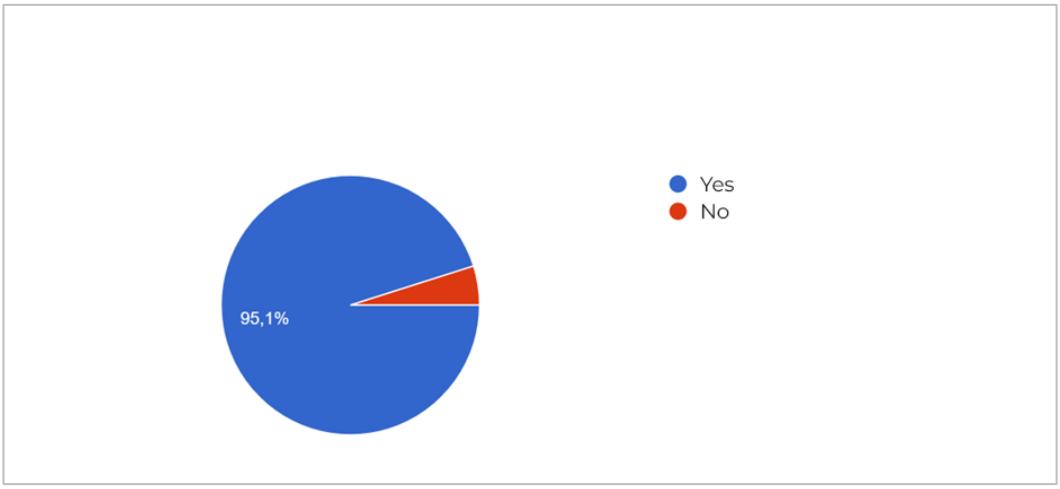

Figure 35 - User considering using similar AI platforms

At the end of using the platform and completing the questionnaire, a generic comment was requested from users. Table 7 summarizes the positive and negative impressions.

Table 7 - Generic comments made by users

User Comment	Conclusions
I really liked the fact that the action buttons are explanatory, which makes it easier to understand, and it is very easy to navigate the site	These comments demonstrate that the application of the guidelines is useful and appreciated by the user. It should be noted that users without being aware of the concrete application of guidelines show in this comment the relevance of the result obtained by them. Referring specifically to guidelines 2, 3, 4 of the developed framework.
The platform is very intuitive, and it was very simple to navigate and perform the tasks.	
I think it will be very useful in the near future. I know of a project that could benefit from a similar AI platform	The more generic comments tend to confirm the results obtained in the UX topics of the questionnaire. Users show interest and enthusiasm in this type of platform, so they will, based on these comments and the answers to these questions, recommend and use them in the future. Bearing in mind that these correspond to users expectations and ensure a UI/UX that safeguards their interests, in this case with the application of all the guidelines proposed.
I found the prototype very interesting; I loved the project!	
Extremely interesting. That can be patented and used	
I think that in the health area I consider the use of AI associated with a medical recommendation initially, but for other purposes I think it is a great solution.	These comments tend to confirm the importance of guideline 3. This type of interfaces must be reliable, which may require constant optimization based on the results of UX Research. Users tend to try to protect themselves when using this type of systems, something that is analyzed in the development of the framework and which, in the case of our example, may have improvements based on these opinions.
Perhaps I would think of a slightly simpler type of chart for the area of Eating Habits. And in the register, if relevant, it would include a question about any pre-existing disease or if you use any medication.	
There was no option to view the menu when in sections at the bottom of the page	
Very functional. I missed illustrations of real people too.	Internal and External Consistency is a very important factor in interface design. The fact that the prototype is based on an innovative system makes it more challenging to obtain the external consistency present in guideline 4. According to the comments, an improvement of the interface will be considered to obtain better results in this topic.
The design is not very attractive for a health tech.	
The feeling was that it was in futuristic films, where the population lives in colonies and needs to stay healthy through synthetic foods.	

Although the platform was intuitive, it was not so easy for a layperson.	All users have different experiences and different backgrounds. In this sense, it can be difficult to obtain a result that pleases everyone. What this research work allows is to reduce to a minimum the users who cannot easily navigate an interface. This user does not seem to have achieved what will require an analysis to understand the reasons and be able to improve the design accordingly if there is an opportunity to do so.

Despite the possibilities for improvement, in general, the feedback was positive and very motivating. Bearing in mind that the prototype promoted a simple, pleasant, and reliable use and, therefore, fulfilled its objectives.

6.1 Net Promoter Score

The Net Promoter Score, commonly known as NPS, is an indicator of loyalty and satisfaction developed by Fred Reichheld in 2003 (Lee, 2018). It is a very simple way to calculate the degree of satisfaction with a product or service, without the need to create long and complex questionnaires or complex consumer surveys. This indicator measures, through just one question, the level of customer loyalty and satisfaction with the company, service or product and is used by organizations around the world. For Reichheld the other indicators are complex and, in that way, practically useless, whereas the NPS consists of one question only, that is simple and gives the organizations timely data (Reichheld, 2011) . In addition to its recognized importance in the marketing of products and services not being new, its usefulness for digital products is increasingly being explored. Its relevance in IT services is studied in the article and can be verified in the Proceedings of the 2018 ACM SIGUCCS Annual Conference (Lee, 2018).

To obtain the NPS, a question must be asked to customers or users. This unique question is: “On a scale of 0 to 10, how likely are you to recommend this product/service to a family member or friend”? Aggregating the answers into 3 groups (Lee, 2018):

- **Dectrators: 0-6**
- **Passives: 7-8**
- **Promoters: 9-10**

After a behavioral analysis of several customers, in different segments, companies, and profiles, it is concluded that customers who rate 9 and 10 effectively recommend the

product, and customers below 6, do not recommend it guaranteed and in many cases even share the negative experience to other people. Customers 7 and 8 are uncertain customers, who, not being dissatisfied, have not yet reached a high degree of satisfaction – which makes them promote this product or service. Figure 36 explains an NPS study structure.

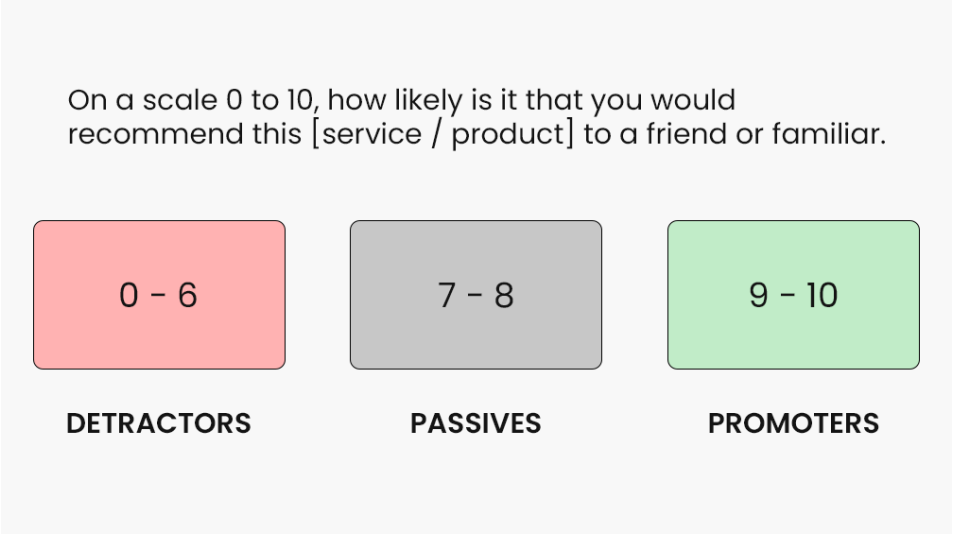

Figure 36 - NPS Study Demonstration

To calculate the NPS, we consider the Percentage of Promoters minus (-) the Percentage of Detractors, as shown in figure 37.

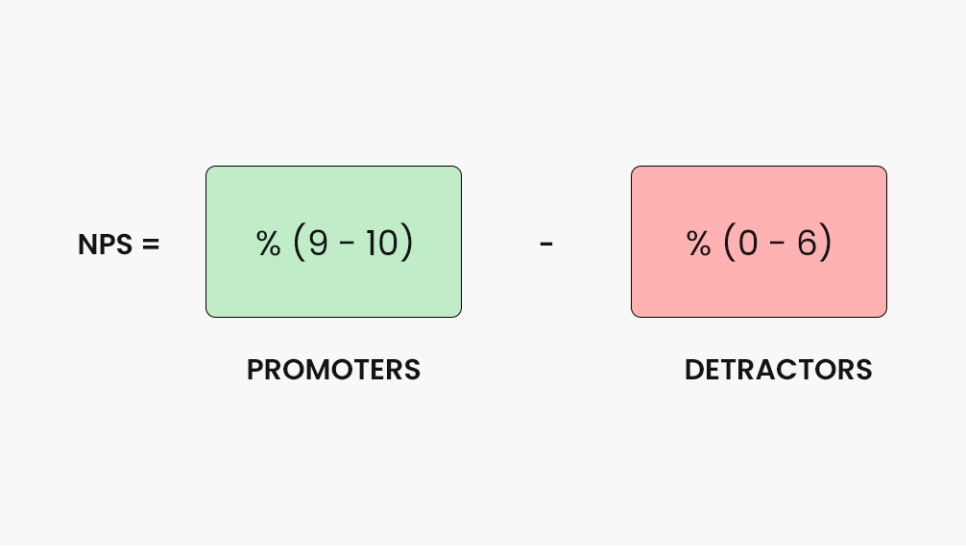

Figure 37 - NPS Calculation

This calculation will give a result between 100 and -100 and can by itself provide a sense of what the opinion of consumers or users of our product or service is. This idea can be even more accurate when compared with competing companies or with the sector values in which we operate. According to the study with more than 10,000 companies (Grigore, 2022), an NPS score below 0 is a sign that the product / service needs to be reviewed. Already from 0 to 30 is good but can still improve. More than 30 is great as it is a clear sign that the company/brand has many more satisfied customers than dissatisfied ones. When a customer loves a brand, they tend to refer it to everyone, and that is likely with a result above 70. The higher your NPS is, the more likely it is that your user referrals will convert into new customers or users. Figure 38 illustrates what is a good NPS score.

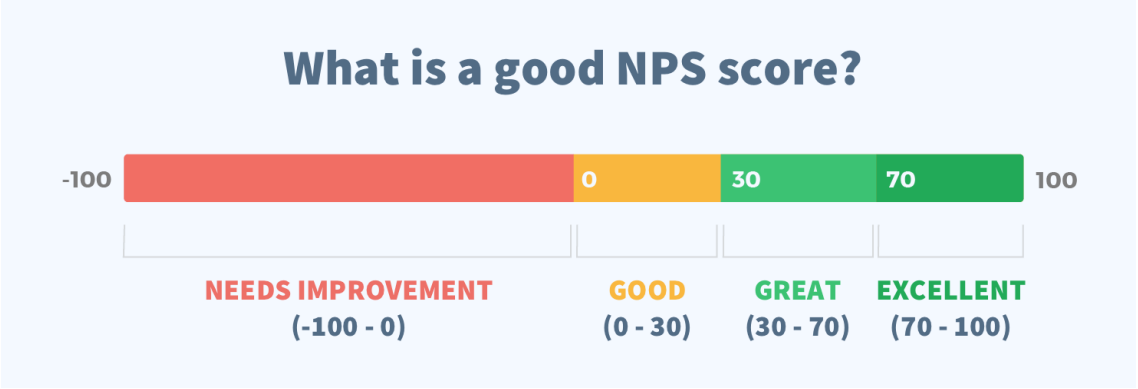

Figure 38 - What is a Good NPS Score (Grigore, 2022)

In the questionnaire made to users, this question was asked to provide data to obtain a Net Promoter Score. The results are shown in table 8.

Table 8 - Questionary NPS question results

Question: Would you recommend this platform to your friends, colleagues, or family if you knew it would be useful for their goals?	**Number of users that select this option**	**Percentage of users that select this option**
1	0	0
2	0	0
3	0	0
4	1	2.4

5	0	0
6	4	9.8
7	8	19.5
8	7	17.1
9	10	24.4
10	11	26.8

These results produced the NPS score of the prototype presented, whose value was 39(%) from now on indicated as 39. Based in (Grigore, 2022) , the result of 39 is good and indicates that users are satisfied and would recommend this digital product to their friends, colleagues, and family. This value is notoriously high when compared to the benchmark for the internet software & services industry – whose average value is 4 (Grigore, 2022).

6.2 Focus Group Feedback

The prototype was also analyzed by a focus group composed of 1 UI designer, 1 UX designer, 1 UX research professional, and 1 communication and digital marketing manager, with the following demographics:

Age Group:

From 19 to 29: 2 | From 30 to 40: 2

Place of Residence:

Porto: 1 | Leiria: 1 | Brasil: 2

Education:

Graduation: 3 | Up to 12th grade: 1

The group, through the discussion and completion of the questionnaire, documented their observations and enabled some improvements both in the design of the website and in the questionnaire itself.

The opinion was consensual when exemplifying the guidelines and the overall conclusions were as follows:

The platform is intuitive and simple to use. The principles analyzed in the guidelines examples are verified and make the platform functional, safe, and reliable. The architecture/structure and dynamics of the platform could be easily adaptable to other AI-powered websites from the most diverse sectors. Some improvements were put into consideration but overall, the user experience is satisfactory.

The following improvements were suggested by the focus group:

- Set an option in the question “Place of Residence” for Portuguese users outside Portugal and foreign users.
- Optimize the questionnaire description/explanation field.
- Change the Call to Action (CTA) of the button located on the top menu of the homepage from “Let's Get Started” to “Create Profile”
- Change the colors of alerts/explanations on the platform to yellow (they were gray)
- Place a CTA button on the personal area page (deleted data) to return to the Homepage and change the location of the “Create new biometric profile” button.
- Put the fixed navbar on top (sticky navbar)
- In the create profile section, put objective cards as the first question.

7 Conclusions and Future Work

This work contributes with the opportunity to understand Artificial Intelligence and its impact on human beings in the scientific, and academic areas, from users and designers point of view. AI models are described, as well as the implication of Machine Learning, Deep Learning, and its association with Natural Language Processing in an accessible and understandable way to non-programmers and/or specialists in Artificial Intelligence and its technologies. As it recognizes the great challenge for humanity, of being able to communicate with computers like communicating with people. With that in mind, it explores and compiles the main interaction design guidelines and heuristics, adjusting them to Artificial Intelligence interfaces. Developing an abstract framework of fundamental Human-AI guidelines, as a basis for the design of wireframes and prototypes of interfaces for AI systems. And, with the use of the studied principles, obtain an exceptional user experience in a simple, practical, and safe way. Most of all: a pleasurable interaction for the computer and the human. With this goal in mind, the best ways to achieve it and the contribution to the enrichment of this topic don't end with the delivery of this work.

As future work, design graphical presentations of the guidelines, both individually and for the framework, for sharing on forums, websites, and social networks. Promote community gatherings and webinars for AI, UI and IxD professionals and enthusiasts. As well as the development of a second scientific article with the conclusions of this dissertation, aimed to be published in the near future.

Currently, nothing can be done without succeed managing the limitations of time and focus. And particularly, a health complication in a decisive phase of this project. Language limitations were also felt, writing in a non-native technical language, and in a formal way is challenging. Fortunately, Artificial Intelligence is here to help, for what I relied on an AI tool myself to enhance the writing of this document. These limitations were overcome by determination and consistency. And with the help of everyone already mentioned in the Acknowledgements section.

AI systems may think they know what is best for us, however, their intelligence is limited. This limitation is necessary: a computer cannot have sufficient knowledge of all the factors that go into a human decision-making process. But that does not mean that

we should not open our arms and minds to the support of intelligent machines. But machines begin to take more and more control of everything, they need to be inserted into society, and they surely need to improve and humanize the way they communicate and interact, as well as recognize their limitations. Only then will they be absolutely valuable (Donald A. Norman, 2010). This is the mission that is in the hands of developers and designers of Artificial Intelligence systems. And whose success could shape the way we relate to smart computers for decades to come.

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design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed

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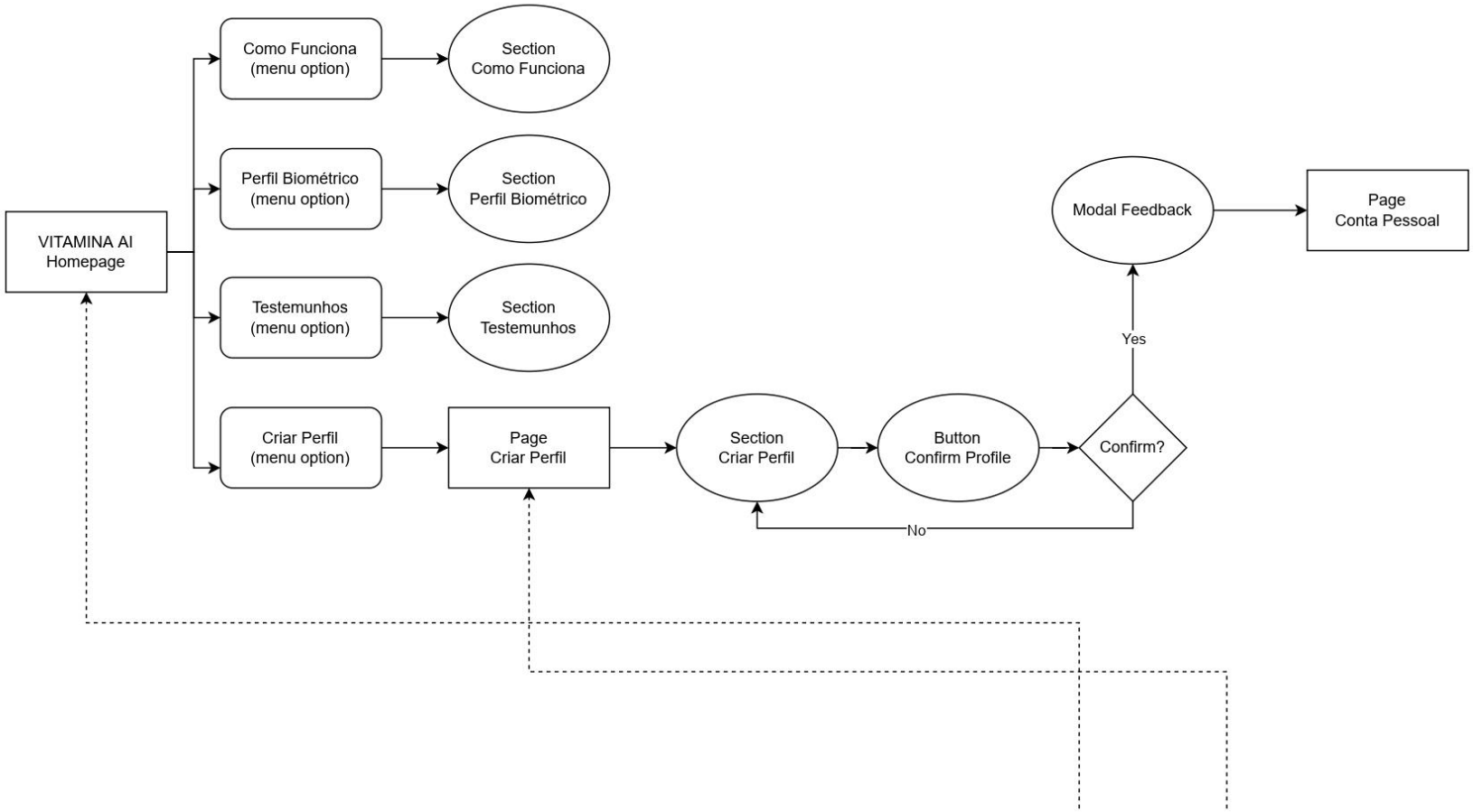
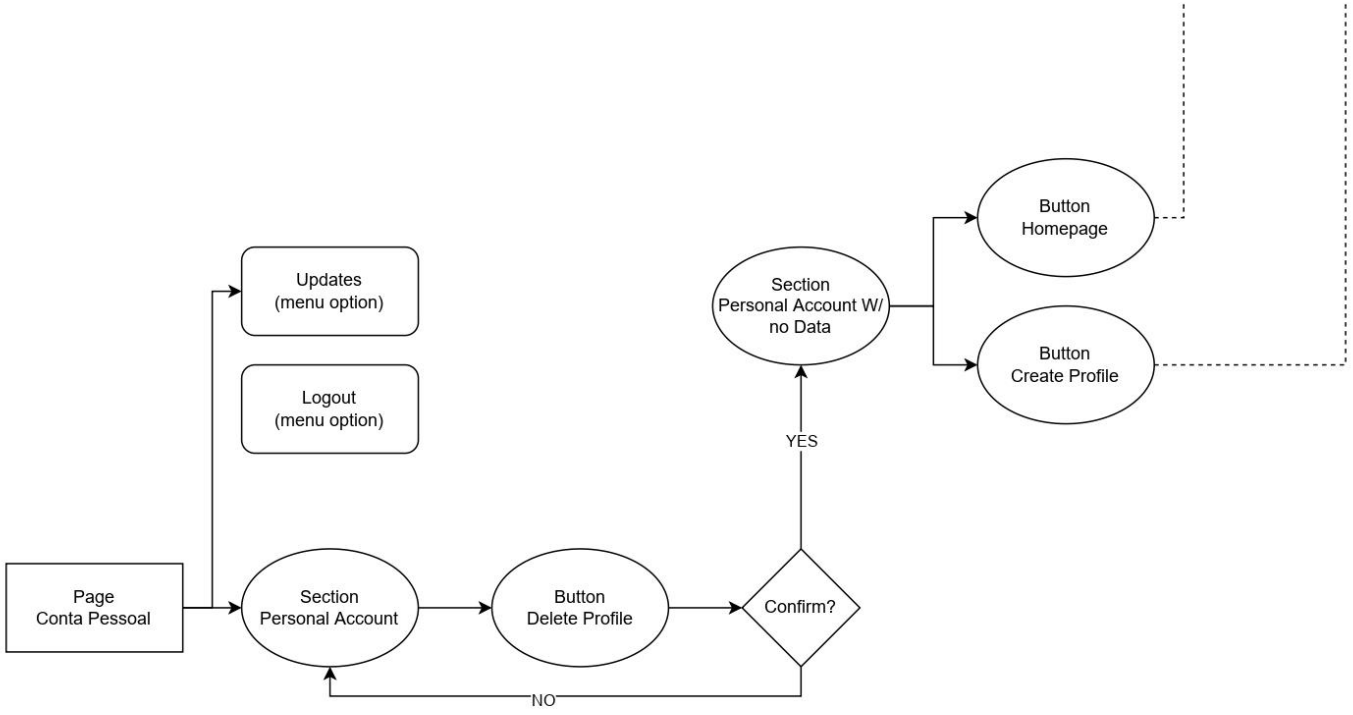
ATTACHEMENT A: Prototype Diagram




Page
Conta Pessoal
Updates
(menu option)
Logout
(menu option)
Section
Personal Account
Button
Delete Profile
Confirm?
NO
YES
Section
Personal Account W/
no Data
Button
Homepage
Button
Create Profile

ATTACHEMENT B: Prototype

Bearing in mind a better visualization of the prototype, a repository was created to store it. This repository is available at the following link: https://drive.google.com/drive/folders/1lXAk7PmxBvC8jO-C2697nEawIREkq-1p?usp=sharing

The artefact of this dissertation can also be accessed online, in its interactive version, at the following link: https://bit.ly/prototipo-vitamina-ai

ATTACHEMENT C: User Research Questionnaire

Estudo da Experiência de Utilizador

No âmbito da dissertação *Design de Interação em Sistemas de Inteligência Artificial* foi desenvolvido um protótipo de um sistema de Inteligência Artificial na sua versão desktop.

O objetivo deste questionário é testar a Experiência de Utilização do Website. O foco deve ser a realização das tarefas sugeridas. O conceito, negócio, produtos são meramente ilustrativos. De igual forma, os resultados do perfil são apenas demonstrativos – sendo iguais para todos os users e sem qualquer validação nutricional ou médica.

Caso te encontres no telemóvel, aguarda por teres acesso ao computador pois este design não é mobile nem responsivo - é uma versão DESKTOP / computador.

A duração prevista deste questionário é de 5 minutos e as respostas (anónimas) recolhidas permitem validar a utilidade do trabalho desenvolvido pelo aluno do 2º ano do Mestrado de Engenharia de Tecnologias e Sistemas Web do ISLA-Gaia.

afmcosta@gmail.com (não partilhado) Mudar de conta

*Obrigatório

Caso tenhas dificuldade em realizar alguma tarefa, podes ver o vídeo de exemplificação da utilização da plataforma e realização das tarefas sugeridas - se assim o pretenderes (visualização facultativa).

DADOS GERAIS DO UTILIZADOR

Por favor, descreve o teu perfil de utilizador e os dados demográficos mais relevantes para o estudo.

Tipo de Utilizador *

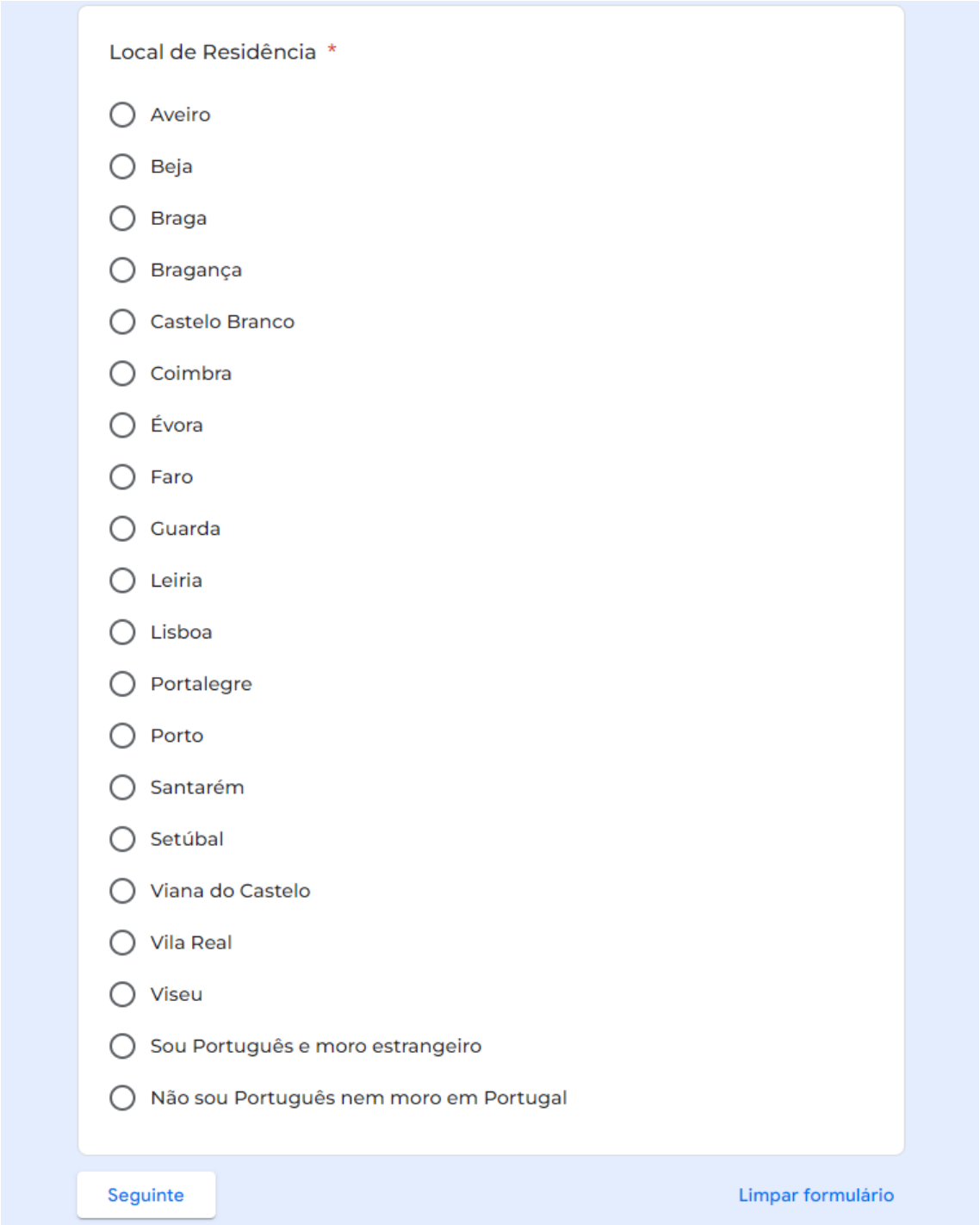
- ◯ Designer
- ◯ Utilizador Comum

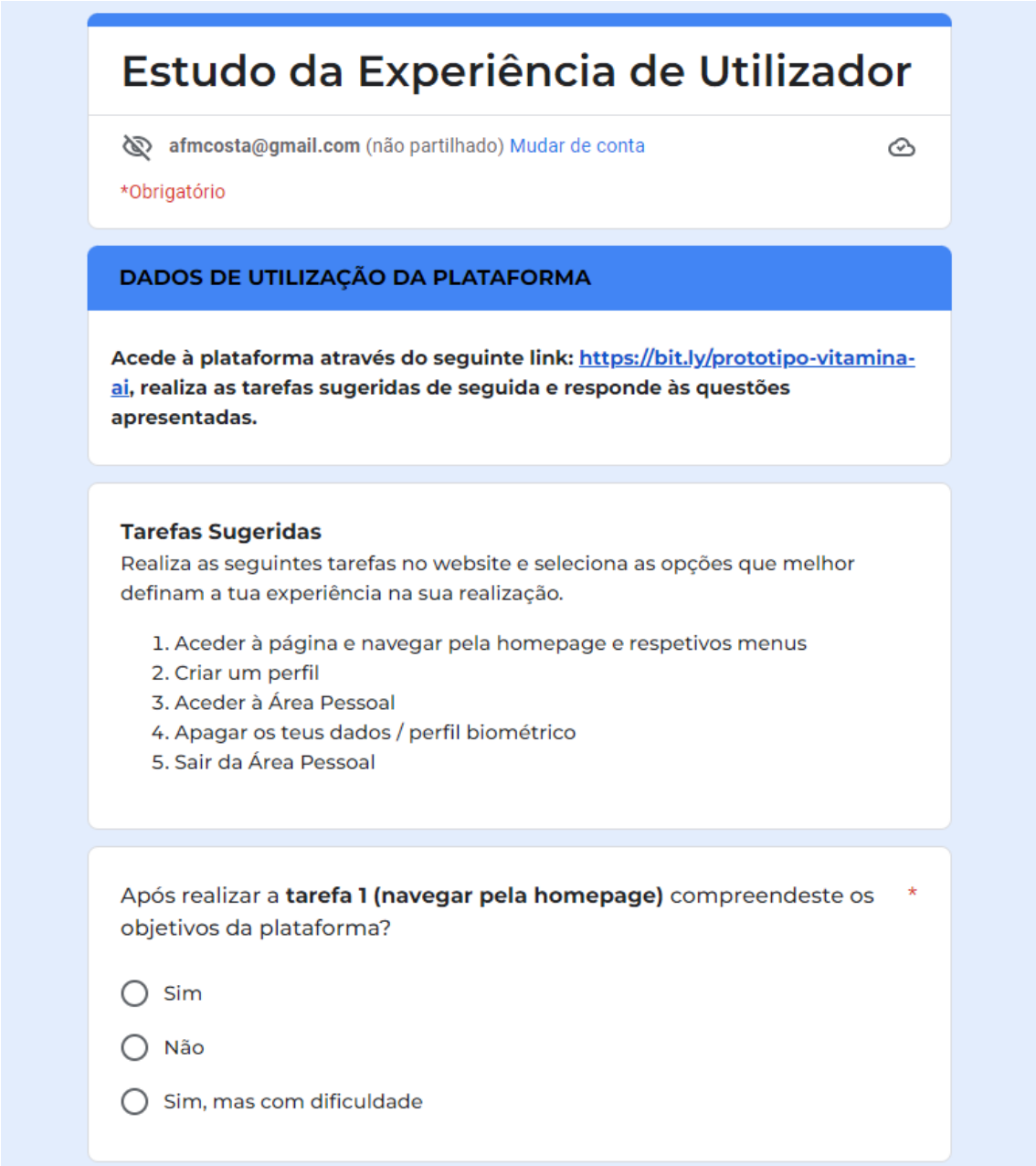
Faixa Etária *

- ◯ Menos de 18
- ◯ Entre 19 e 29
- ◯ Entre 30 e 40
- ◯ Entre 41 e 51
- ◯ Entre 52 e 62
- ◯ Mais de 62

Escolaridade *

- ◯ Até ao 12° ano
- ◯ Licenciatura
- ◯ Mestrado
- ◯ Doutoramento


Local de Residência *
Aveiro
Beja
Braga
Bragança
Castelo Branco
Coimbra
Évora
Faro
Guarda
Leiria
Lisboa
Portalegre
Porto
Santarém
Setúbal
Viana do Castelo
Vila Real
Viseu
Sou Português e moro estrangeiro
Não sou Português nem moro em Portugal
Seguinte
Limpar formulário



Estudo da Experiência de Utilizador

afmcosta@gmail.com (não partilhado) Mudar de conta

*Obrigatório

DADOS DE UTILIZAÇÃO DA PLATAFORMA

Acede à plataforma através do seguinte link: https://bit.ly/prototipo-vitamina-ai, realiza as tarefas sugeridas de seguida e responde às questões apresentadas.

Tarefas Sugeridas

Realiza as seguintes tarefas no website e seleciona as opções que melhor definam a tua experiência na sua realização.

1. Aceder à página e navegar pela homepage e respetivos menus
2. Criar um perfil
3. Aceder à Área Pessoal
4. Apagar os teus dados / perfil biométrico
5. Sair da Área Pessoal

Após realizar a **tarefa 1 (navegar pela homepage)** compreendeste os objetivos da plataforma? *

- ◯ Sim
- ◯ Não
- ◯ Sim, mas com dificuldade

Caso não tenhas conseguido realizar a tarefa 1 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário.

A sua resposta

Conseguiste realizar a **tarefa 2 (criar um perfil biométrico)**? *

- ◯ Sim
- ◯ Não
- ◯ Sim, mas com dificuldade

Caso não tenhas conseguido realizar a tarefa 2 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário.

A sua resposta

Conseguiste realizar a **tarefa 3 (aceder à Área Pessoal)**? *

- ◯ Sim
- ◯ Não
- ◯ Sim, mas com dificuldade

Caso não tenhas conseguido realizar a tarefa 3 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário.

A sua resposta

Conseguiste realizar a **tarefa 4 (apagar os teus dados / perfil biométrico)**? *

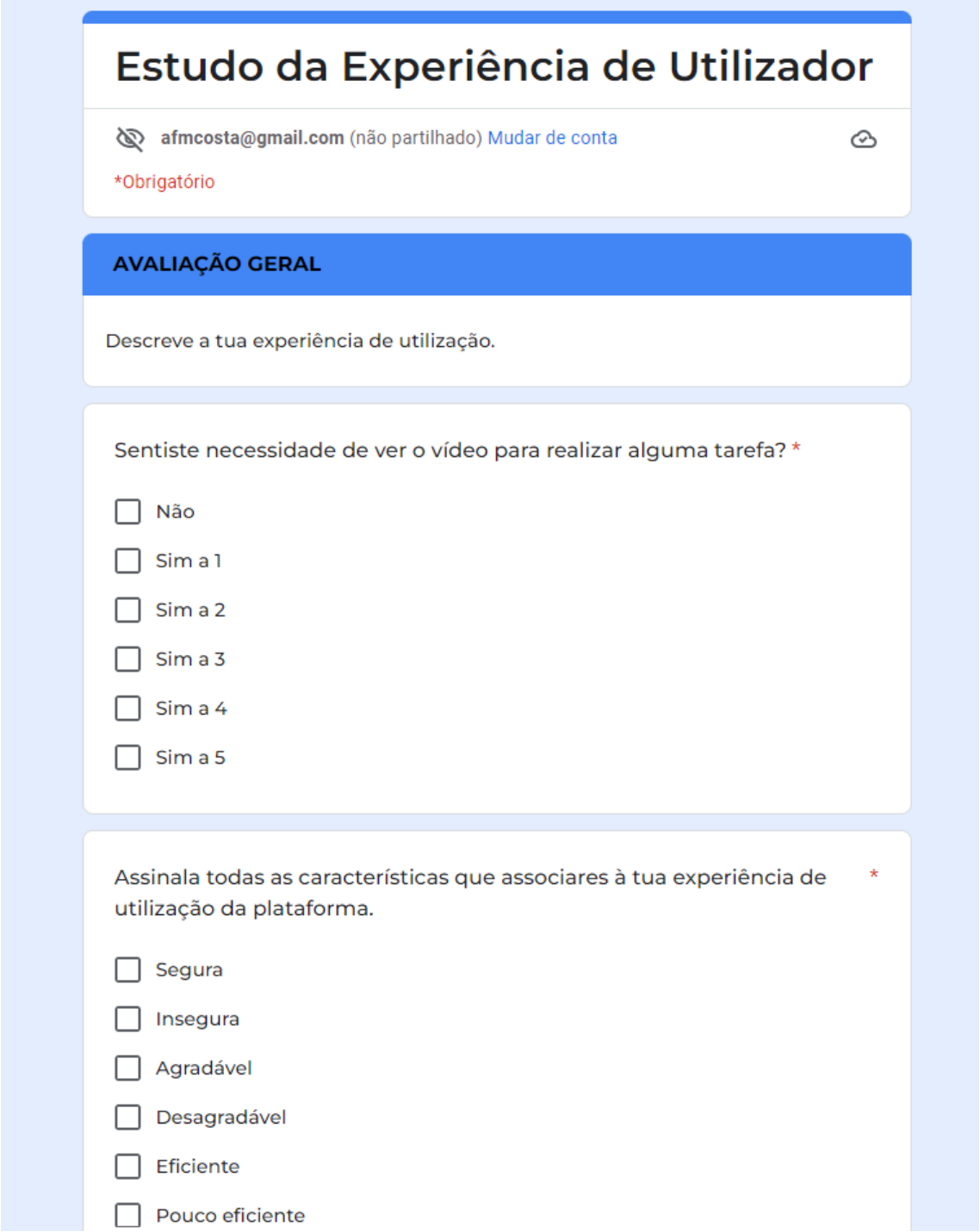
- ◯ Sim
- ◯ Não
- ◯ Sim, mas com dificuldade

Caso não tenhas conseguido realizar a tarefa 4 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário.

A sua resposta

Conseguiste realizar a **tarefa 5 (voltar à homepage a partir da Área Pessoal)**? *

- ◯ Sim
- ◯ Não
- ◯ Sim, mas com dificuldade



Estudo da Experiência de Utilizador

afmcosta@gmail.com (não partilhado) Mudar de conta

*Obrigatório

AVALIAÇÃO GERAL

Descreve a tua experiência de utilização.

Sentiste necessidade de ver o vídeo para realizar alguma tarefa? *

- [ ] Não
- [ ] Sim a 1
- [ ] Sim a 2
- [ ] Sim a 3
- [ ] Sim a 4
- [ ] Sim a 5

Assinala todas as características que associares à tua experiência de utilização da plataforma. *

- [ ] Segura
- [ ] Insegura
- [ ] Agradável
- [ ] Desagradável
- [ ] Eficiente
- [ ] Pouco eficiente

- [ ] Intuitiva
- [ ] Pouco Intuitiva
- [ ] Funcional
- [ ] Pouco funcional
- [ ] Simples
- [ ] Complicada
- [ ] Confiável
- [ ] Outra: _____

No futuro consideras utilizar uma plataforma com AI que te auxilie a atingir os teus objetivos (mesmo que diferentes destes) *

- ○ Sim
- ○ Não

Recomendarias esta plataforma aos teus amigos, colegas ou familiares, caso soubesses que seria útil para os objetivos deles? *

0 1 2 3 4 5 6 7 8 9 10

Discordo Totalmente ○○○○○○○○○○○ Concordo Totalmente

Gostarias de fazer alguma observação ou deixar algum comentário?

A sua resposta

Anterior | Enviar | Limpar formulário

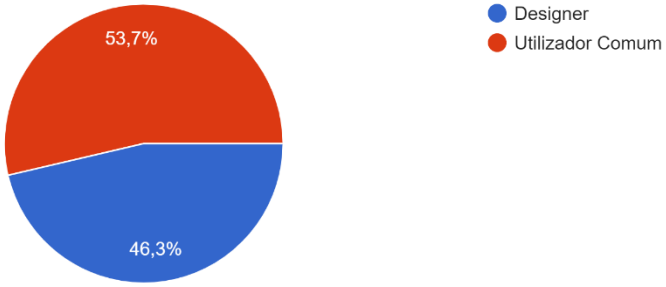
ATTACHEMENT D: User Research Questionnaire Results

Considering a clearer understanding of the user research questionnaire results, a Google spreadsheet was created. This spreadsheet was stored in a drive and it's online at the following link:
https://docs.google.com/spreadsheets/d/14A0mWYHj3rmYB7bS98GnTFYtDNhU-iFxgJOmeHdJxBQ/edit?usp=sharing

ATTACHEMENT E: Questionnaire Results Presentation

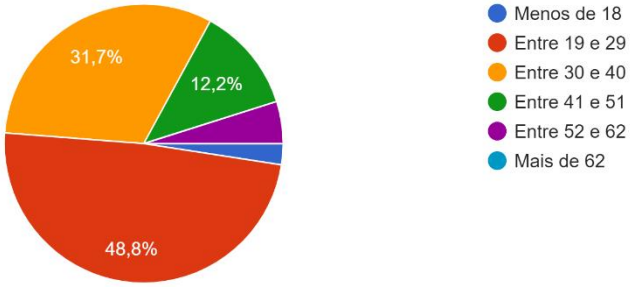
Tipo de Utilizador

41 respostas



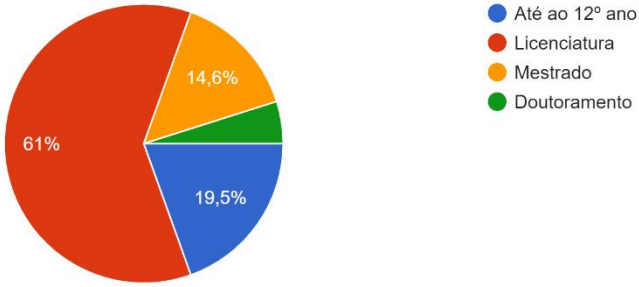
Faixa Etária

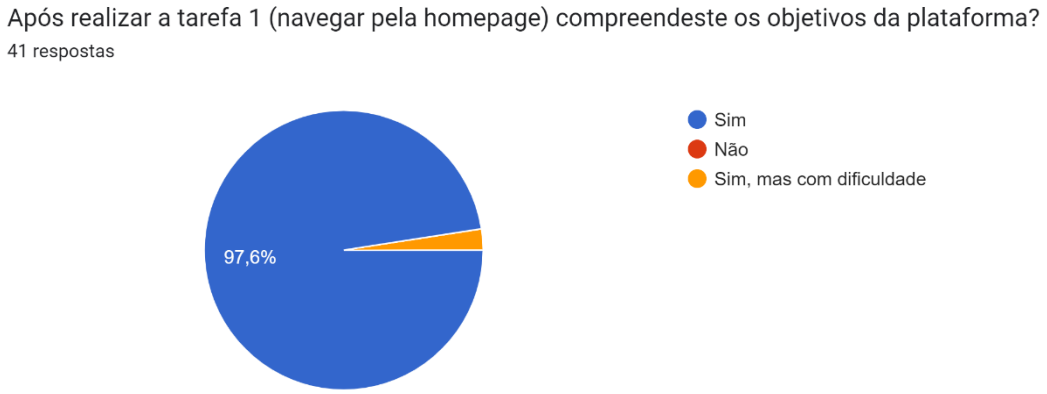
41 respostas



Escolaridade

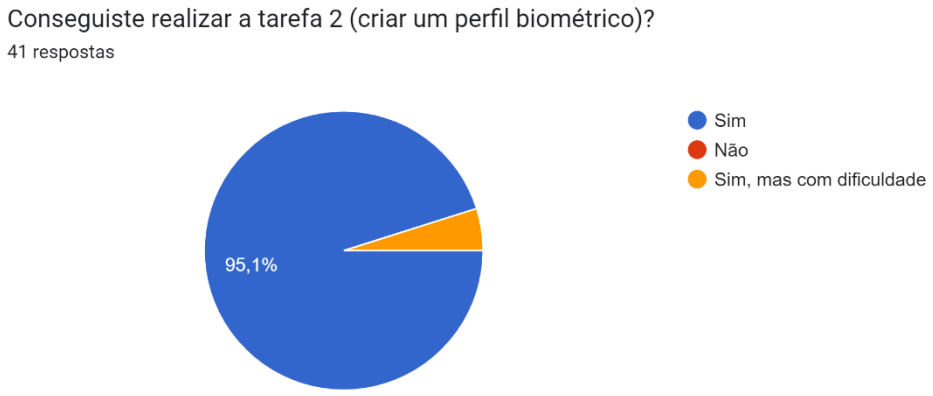
41 respostas





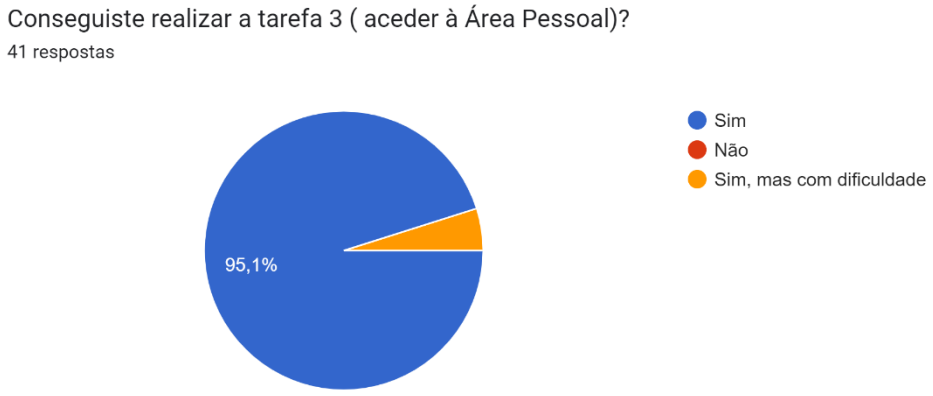
Caso não tenhas conseguido realizar a tarefa 1 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário. 3 respostas

I. Não havia opção de ver o menu quando estava em secções em baixo na página
II. Consegui sim, mas compreendi melhor ao rolar a barra para baixo e ler o botão para realizar a tarefa.
III. Sem problemas



Caso não tenhas conseguido realizar a tarefa 2 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário. 3 respostas

I. A barra não é muito responsiva
II. Sem Problema
III. Alguns campos de preenchimento (os 2 primeiros) poderiam ser de selecionar a opção, e não arrastar até chegar à opção correta



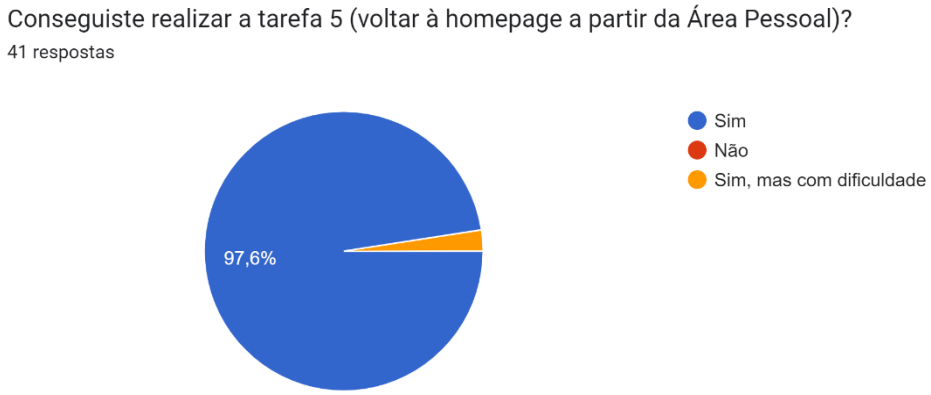
Caso não tenhas conseguido realizar a tarefa 3 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário. 3 respostas

I. Ao criar um perfil, acedemos automaticamente à área pessoal

II. Não tive dificuldade, porém me incomodou os gráficos e informações estarem divididos em quadrantes de diferentes formas e com uma cor forte, me senti perdida o que verificar primeiro.
III. Apesar de intuitiva a plataforma não foi tão fácil para uma leiga

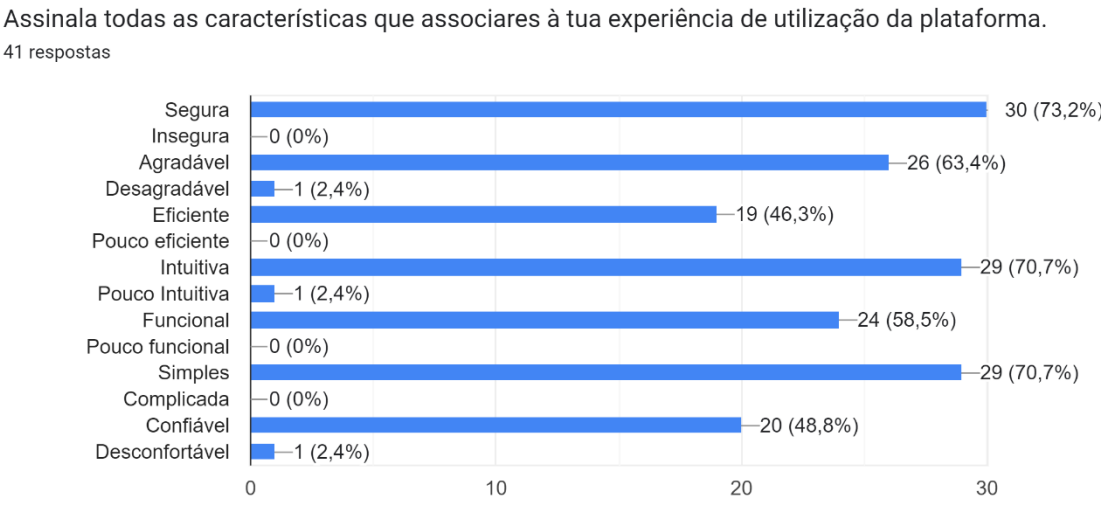
Caso não tenhas conseguido realizar a tarefa 4 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário. 1 resposta

I. Sem problema



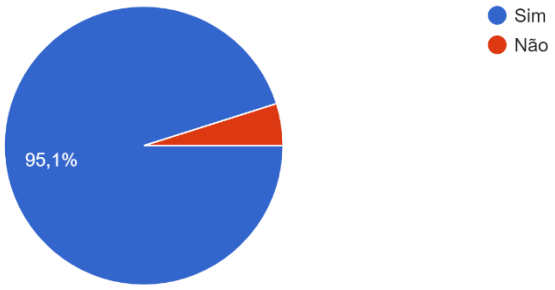
Caso não tenhas conseguido realizar a tarefa 5 indica de forma sucinta o motivo / dificuldade e vê no vídeo como o podes fazer para continuares este questionário. 3 respostas

II. ao clicar no botão de voltar para homepage, ele volta para a criação de perfil em vez da homepage em si.
III. Página deveria conter menu e não apenas logo para voltar à homepage
IV. Sem Problema



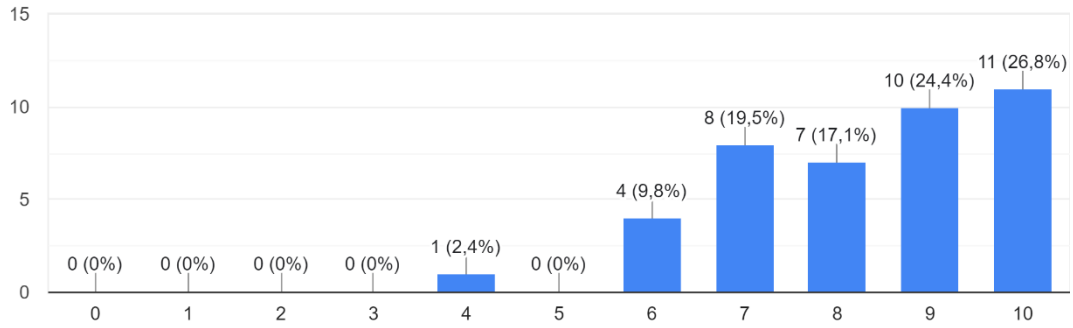
No futuro consideras utilizar uma plataforma com AI que te auxilie a atingir os teus objetivos (mesmo que diferentes destes)

41 respostas



Recomendarias esta plataforma aos teus amigos, colegas ou familiares, caso soubesses que seria útil para os objetivos deles?

41 respostas



Gostarias de fazer alguma observação ou deixar algum comentário? 10 respostas

1) A plataforma está muito intuitiva e foi muito simples navegar e realizar as tarefas.
2) A navegação foi muito simples e intuitiva, não tive dificuldade de encontrar nada que as tarefas pediam, exceto pela página de suporte.
3) Considero que será muito útil num futuro próximo. Conheço um projecto que poderá beneficiar de uma plataforma IA similar.
4) Gostei muito do fato dos botões de ação serem explicativos, o que facilita o entendimento, e é bem tranquilo a navegação pelo site.
5) Gostei bastante do projeto! Talvez pensaria num tipo de gráfico um pouco mais simples para a área de Hábitos Alimentares. E no cadastro incluiria, se for relevante, uma pergunta sobre alguma doença preexistente ou se faz uso de algum medicamento.
6) Muito funcional. Senti falta de ilustrações de pessoa reais também.

7) O design não é muito atrativo para uma Health Tech
8) Eu achei o protótipo bem interessante, adorei o projeto!
9) Acho que na área de saúde considero a utilização de AI associado a uma recomendação médica inicialmente, mas para outros fins acho uma ótima resolução.
10) Extremamente interessante. Que possa ser patenteada e utilizada.

ATTACHEMENT F: Paper Interaction Design for AI Systems: An oriented state-of-the-art

The paper “Interaction Design for AI Systems: An oriented state-of-the-art” was published and indexed by IEEE to Scopus and is available for consultation in the following link: https://ieeexplore.ieee.org/abstract/document/9800084