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UI/UX Optimization for a Quality Control Tool

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Master in Computer Science and Business Management

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TECNOLOGIAS
E ARQUITETURA

Department of Information Science and Technology

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This journey has taught me that with the right people by your side, nothing is impossible. So, to everyone who has been a part of this project, I give my deepest and most sincere thank you.

Resumo

No contexto do aumento das preocupações com a segurança alimentar, os sistemas relacionados à sua gestão eficaz tornaram-se indispensáveis para monitorizar os riscos em tempo real, garantir a conformidade regulamentar e manter os padrões de higiene.

Este estudo apresenta o desenvolvimento de um protótipo para um sistema de gestão de segurança alimentar intuitivo e de fácil utilização, com o objetivo de permitir que os *stakeholders* da indústria acedam a informações precisas sobre práticas de higiene e limpeza, assim como de conformidade regulamentar.

A integração do UI/UX, com ênfase na melhoria da usabilidade, na redução da complexidade e na capacidade de os utilizadores conseguirem gerir facilmente as suas tarefas, foi fundamental para a conceção deste sistema.

Para tal, foi utilizada uma abordagem DSR que combina avaliações de usabilidade, inquéritos de satisfação e entrevistas que resultam na avaliação do artefacto. Cada iteração incorpora o feedback de profissionais do setor, garantindo que a solução é continuamente aperfeiçoada para satisfazer as exigências do mundo real.

Por último, o estudo visa tornar a gestão da segurança alimentar mais acessível, impactante e eficiente para os utilizadores, tal como mostrar o papel crítico do UI/UX, demonstrando como uma interface bem concebida pode simplificar os processos e contribuir para a melhoria contínua dos sistemas de segurança alimentar. A investigação não só destaca a importância da boa conceção de UI/UX para melhorar a usabilidade, como também sublinha a necessidade de melhorias contínuas dos sistemas de modo a acompanhar a evolução das normas da indústria e as expectativas dos utilizadores.

Palavras-chave: Sistema de gestão de segurança alimentar; HACCP; Interface do utilizador; Experiência do utilizador, Aplicação

Abstract

In the context of the increase of global concerns over food safety, effective management systems have become indispensable for monitoring real-time hazards, ensuring regulatory compliance, and upholding hygiene standards. While these systems must meet stringent technical requirements, their success heavily relies on user experience and user satisfaction.

This study presents the development of a prototype for an intuitive and user-friendly food safety management system aimed at empowering stakeholders within the food industry to access accurate and comprehensive information about hygiene practices and regulatory compliance.

The integration of UI/UX concepts, with an emphasis on enhancing usability, reducing complexity, and empowering users to easily manage their food safety duties, is fundamental to the design of this system.

To achieve this, a Design Science Research (DSR) approach was used and combines assessments of usability, satisfaction surveys, user studies and iterative interviews that result in the evaluation of the artifact. Each iteration incorporates feedback from industry professionals, ensuring that the solution is continuously refined to meet real-world demands.

Ultimately, the study aims to make food safety management more accessible, impactful, and efficient for the users such as show the critical role of UI/UX by demonstrating how a well-designed interface can streamline safety management processes and contribute to the ongoing improvement of food safety systems. The research not only highlights the importance of UI/UX design in improving usability but also underscores the need for continuous system enhancements to keep pace with evolving industry standards and user expectations.

Keywords: Food safety management system; HACCP; User interface; User experience; Application

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List of Acronyms

AI	-	Artificial Intelligence
DSR	-	Design Science Research
HACCP	-	Hazard Analysis and Critical Control Points
ML	-	Machine learning
UI	-	User Interface
UX	-	User experience
SLR	-	Systematic Literature Review

CHAPTER 1
Introduction

1.1 Context

Mobile phones are the most easily accessible devices used by the current population, and because applications and new technological tools are constantly at our fingertips, this calls for improved and more interactive interfaces that effectively link the physical world to the virtual [27]

Therefore, the realm of User Experience (UX) and User Interface (UI) design has undergone a profound transformation and evolution, emerging as a prominent trend in the dynamic tech landscape. Due to this, companies are actively enhancing the UI/UX of their products, aiming to foster increased customer engagement and outshine their competitors [28].

The evolution of quality control in the food safety industry has also been shaped by technological advances, but also by historical incidents, regulatory developments and the increasing global awareness of the critical role food safety plays in public health [29].

The implementation of systems like the Hazard Analysis and Critical Control Points (HACCP) system, in the 1960's, brought a revolutionary structured approach to identify and control potential hazards in food production, further enhancing food safety practices and hygiene control [30], [31]. Likewise, technological advancements and the recent pandemic have required significant adjustments in food safety, particularly in quality control because of the growing concerns regarding this topic [16]. These adjustments include the implementation of more sensitive detection technologies, the adoption of advanced data analysis tools, improvement in communication through online platforms, and considering sustainable and ethical practices in the application of new technologies [32].

As a result, the traditional methods of quality control are evolving, making way for digital solutions that promise not only efficiency but also enhanced accuracy and transparency [29]. At the heart of this technological transition, lies the implementation of UI/UX in applications or web services, which, when optimized, can facilitate real-time data collection and automation and a better analyses of quality control [33], [21]. Moreover, it aids decision-making by capturing, storing, and analyzing input information that facilitates the generation of reports [8], [34].

On the other hand, implementing UI/UX in quality control in food safety is challenging due to the industry's complex data, processes and food chain that is very fragment in nature and because of that it might be a barrier to the adoption of new technologies [33], [35]. Therefore, it is extremely important to know the best approaches of UI/UX to use in this scenario.

1.2 Motivation

Food safety control holds a crucial significance in our day-to-day existence, particularly with the expansion of global food companies. To address challenges related to food safety, numerous advanced technologies have been devised for monitoring the various stages of the food industry (production, processing, transportation, storage, and retail). The technologies gathering the most attention include artificial intelligence (AI), big data, and blockchain because they find extensive applications across various research domains [37].

One of those applications is UI/UX, since AI opens up new opportunities for creating interfaces that are more intuitive and user-friendly. These interfaces will improve the user experience and focus on addressing users needs and, with constant enhancements, make them simple but appealing instead of complex, so that users are persuaded to use it [14]. Tasks such as color adjustments, image and background resizing and detecting design patterns can be managed by AI, therefore helping enterprises in obtaining the initial draft of quality assessment [38].

That being the case and taking into account that food safety is a growing topic, it becomes very important to assess the value of incorporating appropriate UI/UX practices and methodologies in the design of quality control tools.

1.3 Objectives

The goal of this research is to identify and explore UI/UX guidelines that can evolve with user needs and tastes, market dynamics, and technological advancements, consequently providing a foundation for the quality control tools regarding food safety continuous improvement and long-term usability. Thus, the research questions to be explored in this investigation are the following:

- RQ1 - What are the specific requirements of UI/UX food safety professionals need in their quality control processes?
- RQ2 - What approaches of UI/UX can contribute to the optimization of quality control for food safety professionals?

CHAPTER 2

State of the art

A Systematic Literature Review (SLR) was conducted in order to address the inconsistencies and gaps that currently exist in the early phases of research regarding UI/UX and food safety.

This approach aimed to analyze quality control practices in alignment with food safety and hygiene, focusing on UX and UI best practices and methodologies.

An SLR provides a methodological framework designed to identify, evaluate, and synthesize all relevant evidence available on specific research questions in a rigorous and structured manner.

Given that the SLR uses the principles set by the author Barbara A. Kitchenham, the three phases performed in the literature review are outlined in Figure 1 [40].

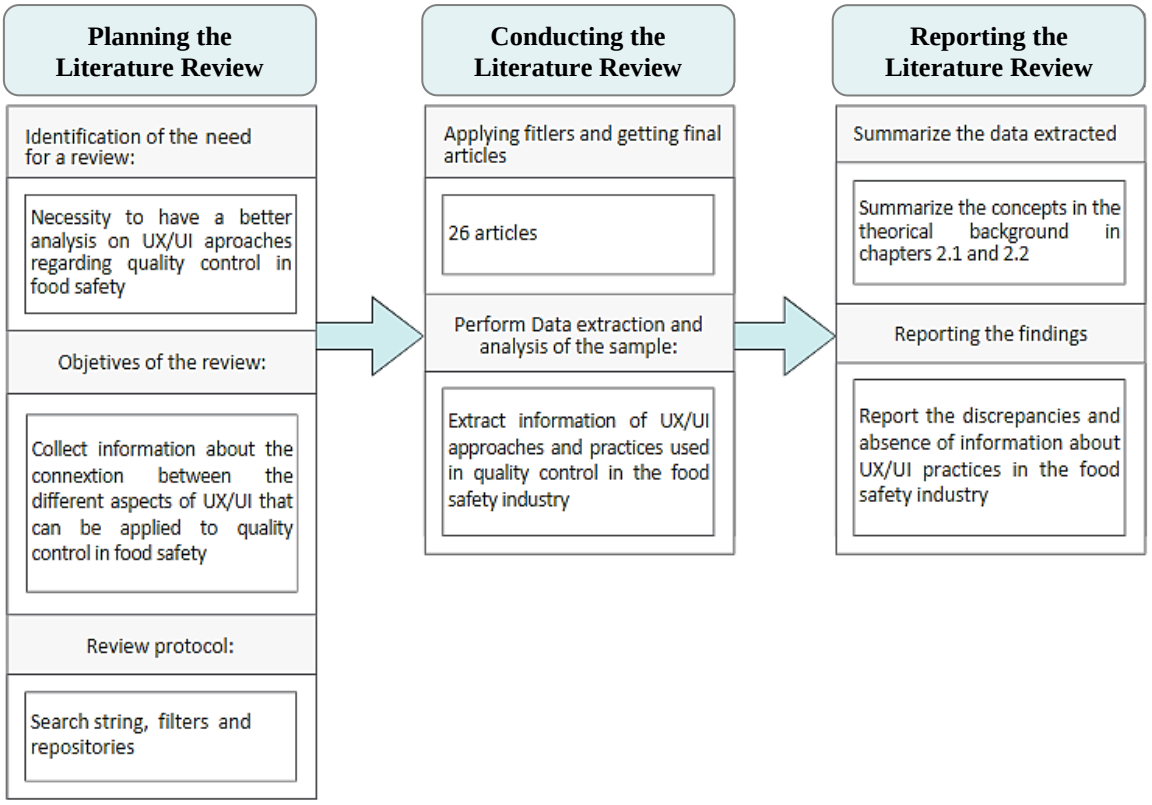

Figure 1- Representation of the SLR phases

Accordingly, the review protocol begins with identifying the keywords appropriately derived from the formulated research questions, therefore, a set of keywords was used to construct the search string, as it shows in the Table 1.

Table 1 - Keywords and respective search string

Keywords	Quality control; Food safety; Hygiene; UX; User experience; UI; e User interface
Search String	(“Quality control” OR “Food safety” OR “Hygiene” AND ((“UX” OR “User experience) OR “UI OR “User interface”))

In pursuit of additional insights into the topics mentioned above, a selection of five online repositories was used. The selected repositories were:

- ACM Digital Library (https://dl.acm.org/)
- Emerald (https://www.emerald.com/insight/)
- IEEE Xplore Digital Library (https://ieeexplore.ieee.org/Xplore/home.jsp)
- Web of Science (https://www.webofscience.com/wos/woscc/basic-search)
- Scopus (https://www.scopus.com/home.uri)

At first, no filters were used other than the designated keywords (Full Text) but subsequently, six different inclusive and exclusive criteria were applied (Table 2). The results of this filtration are documented in Table 3.

Table 2 - Inclusive and exclusive criteria

Inclusive Criteria	Exclusive Criteria
• Abstract • Journals and Conferences • From 2013-2023 • Articles in English • No duplicates • Only articles relevant to the study	• Not in Abstract • Not a Journal or Conference • Before 2013 • Articles not in English • Duplicates • Irrelevant articles to the study

Table 3 - Filtration process

Database	**Filters**						
	Full Text	Abstract	Journals/ Conferences	2013-2023	English	No duplicates	Manual
Scopus	13 418	444	407	250	212	212	13
IEE – Xplorer Digital Library	4992	34	34	16	16	16	6
ACM	1626	15	11	8	8	8	2
Esmerald	1109	76	70	45	45	45	1
Web of Science	537	297	226	162	162	103	4
Total	21 682	866	748	469	469	384	**26**

In the first filter, the decision was to apply the designated keywords exclusively to abstracts. The result of this was a significant depletion in the number of articles.

Moving to the second filter, only articles/journals or papers of conferences were considered. Concerning the third filter, the time frame, a filter was applied to focus on the articles from the last decade, therefore spanning from 2013 to 2023. The fourth filter was applied to retain only English papers. The fifth filter involved the removal of duplicates and the final filter excluded the results that after a brief analysis didn't match the purpose of the research and that couldn't be physically accessed. This process revealed that the UI and UX acronyms have different interpretations in the medicine and technological worlds and that explains the notable reduction that took place in this filter.

Therefore, the outcomes of the filtration process culminated in 26 articles and the flowchart corresponding to the filtration is shown in Figure 2.

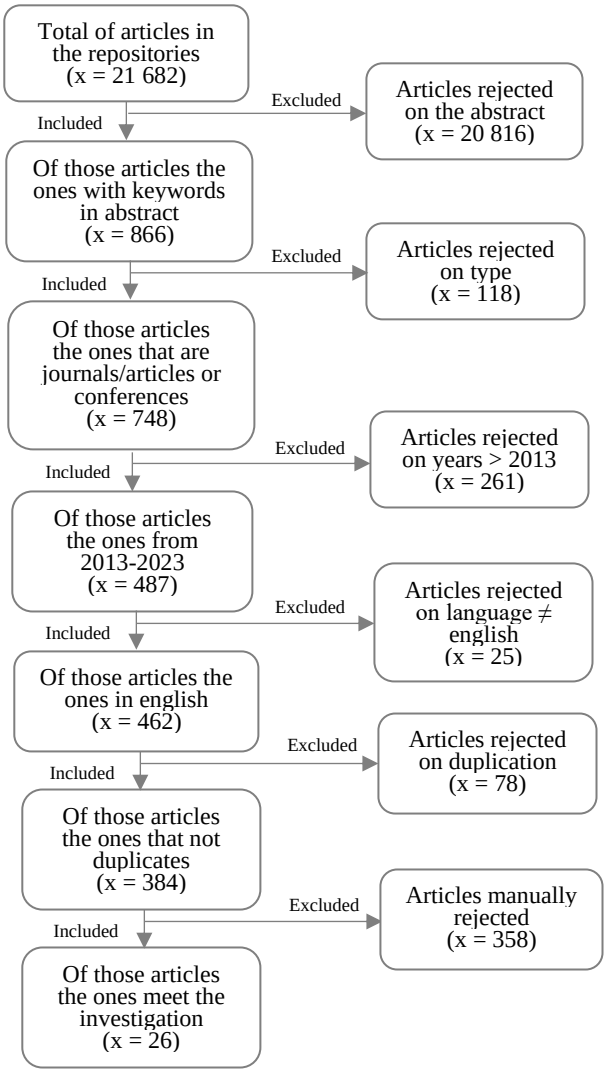

Figure 2 – Filtration procedure flowchart

Following the filtration process, an analysis of the studies was carried out.

As illustrated in Figure 3, within the 26 articles, journals/articles constitute the majority, considering that 17 journals were selected, in contrast to conference papers, which are only 9.

To demonstrate that divergence over the years, the Figure 4 was created. As it shows, the collection doesn't compile articles from the years 2014 and 2016. Although, the other articles show a noticeable trend among them, considering that since 2020, the number of articles has been increasing, being the year 2022 the one that stands out with the highest number. Regarding 2023, the articles collected compile only half of the year, which means that if this year follows the same patterns as 2022, the number of articles will increase once again demonstrating the increasing interest around the topic.

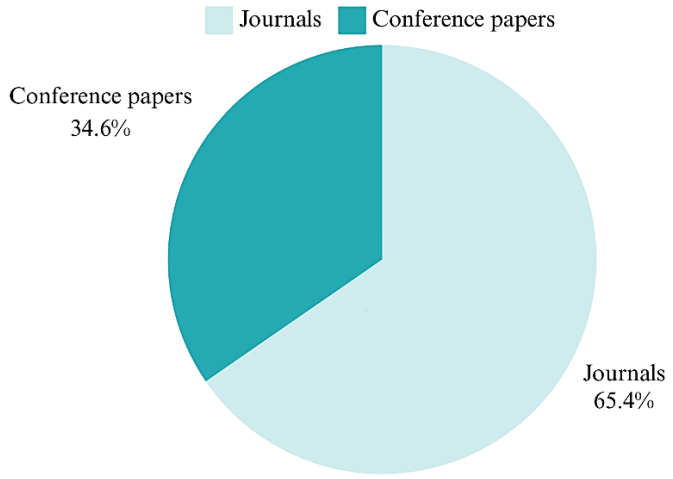

Figure 3 - Distribution of journals/articles and conference papers

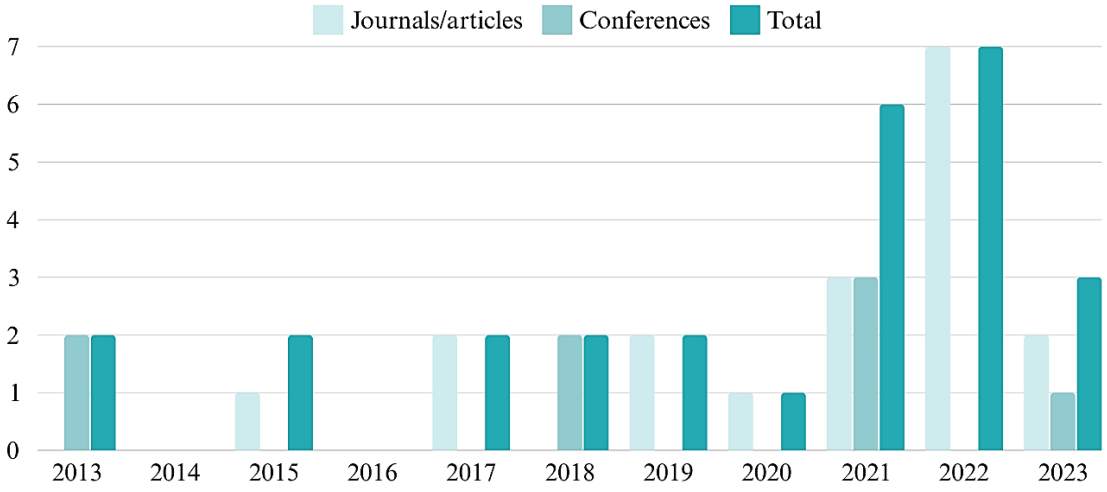

Figure 4 - Distribution of articles/journals and conferences through the past ten years

2.1. Theoretical Background

The essential terms and ideas for this dissertation are introduced in this part. The framework for the creation of the artifact is provided by the literature addressed below, which is a summary of the 26 articles previously stated.

2.1.1 Impact of food safety and hygiene

Nowadays, food safety assessment is important in identifying hazards, including behaviors that could contaminate prepared food, the cook, or kitchen surfaces/items [3].

The Covid-19 pandemic has had a significant impact in shifting people's behavior towards that assessment of food safety because of the increase in concerns about cleanliness and environment, particularly in the context of food hygiene. Hygiene perception played a critical role in how consumers view the hygiene standards of foodservice providers and continues to be a crucial factor [16].

Therefore, addressing food safety risks is a significant concern for stakeholders. While diverse process monitoring mechanisms are in place, many more can be modified to be effectively managed and made more hygienic through the implementation of certain systems [18], [19].

As a result, companies in the food industry are adopting innovative systems to enhance production and sanitization processes, reduce stress for employees and minimize human errors [8]. However, the rapid growth in food production and distribution has led to an increased probability of food safety incidents which makes it a lot harder for these systems to succeed [10].

2.1.2 Quality control

Quality control is a rigorous process designed to ensure the reliability of data by proactively identifying and preventing errors at every stage of a process. It involves managing various factors, including personnel and equipment, to minimize the impact of errors on test results for example. Therefore, the overarching goal is to maintain accuracy by detecting errors and addressing missing data [12],[17]. This is only possible by continuously gathering information relevant to the good functioning of the process [1].

To improve quality control and make the processes described above easier, digital tools and automation can be used to implement real-time, online and intelligent engineering data, facilitating sharing, analysis, and informed decision-making [4]. In addition, development of applications can help quality control to solve communication problems and notify the user if the process parameters are being fulfilled, ensuring adherence to standard indicators and preventing defects [5], [6]. For example, in

maintenance, organizations are seeking to transition the process of giving the worker procedures to follow in paper format and instead start using digital platforms [2].

In recent years, quality control systems have also become increasingly important regarding food safety issues because improper quality control can lead to low productivity in food safety processes [9].

The UI/UX also plays a crucial role in quality control because it can provide users with interactive plots and some features that can be designed to enable users to evaluate the quality of data effectively [24].

2.1.3 User interface

The User Interface (UI) is a system or device display that facilitates the interaction between the user and the system. It includes different elements like buttons, menus, icons and when focusing on appearance, feel, access to tools/services, and supporting communication, aims to enhance the interaction between the user and the system, making it easier, faster, and more efficient [11]. After realizing the success of the UI when well implemented, companies develop user interfaces which assist users in projects, tasks, information collection, message notification, and on-site record [4], [5]. In order to develop it effectively, requirements are conducted to analyze primary target groups and if necessary, gather a list of requirements for the implementation of industry-specific user interfaces [20].

In the digital enhanced world we live today, UI is a pivotal element in human-computer system interactions. Designing an effective and suitable user interface enhances user's ability to navigate systems and boosts the overall performance [14]. The main benefits of a human-computer interface include the clear and comprehensive presentation of information on the screen, accessible control options, a user-friendly interface, and effective interaction for the operators. This results in continuous control over the automated technological processes [13].

In the context of quality control, organizations develop a user-friendly interface to aid operators in executing and overseeing tasks. UI facilitates the storage of quality control values and issuance of commands to automated systems, contributing to enhanced product quality and efficiently access, organize, process and conduct quality control [6], [17].

In conclusion, according to Splitz, a well-designed user interface contributes to increased acceptance by users, while an inappropriate design can have a significant negative impact [14]. Hence, the user interface component must effectively lead users through all application/website workflows. It should also present information clearly, adapt to individual user preferences, and adopt the familiar look and feel of applications users are accustomed to [26].

2.1.4 User experience

The User Experience (UX) includes the feelings, thoughts, and overall experience that users undergo when interacting with a product, service, or system. There are two different perspectives within the realm of UX: the first one aims to emphasize user-focused interactions, design, and usability and the second sees UX as a contemporary research movement dedicated to understanding user needs and enhancing overall user experiences [11].

Nevertheless, when addressing the technological world, the aim of the design follows two principles of UX that are the essence: ease and intuitive to use and minimal learning time requirement [3], [5]. Normally, to analyze that user experience, questionnaires are designed to get general feedback from users and then make improvements before the launch of the app [15]. These surveys provide insight in things like the psychological state of users when certain elements of color and font are used and how these elements can be leveraged to enhance the user experience [7].

On the other hand, there are some common issues (errors or dislikes) highlighted by users regarding their user experiences have to do with these aspects:

- Layout: Participants have difficulties locating significant elements on the page.
- Terminology: Participants struggle with understanding terms used in content or instructions.
- Data Entry: Issues with filling in information.
- Comprehensiveness: Lack of effective instructions on the page on how to use the content [10].

In light of this, understanding user experience can lead to enhanced services and refined marketing strategies, capitalizing on existing willingness to pay, and gaining acceptance from governments. Furthermore, finding prospective markets for inclusive solutions is an essential component in guaranteeing the creation of more efficient products [22].

2.2 Related work

After the revision of the articles and addressing the principal concepts mention in them, two concept tables were made to obtain a better understanding about certain aspects of the related work.

As one can see in Table 4, only seven of the articles mention UI or UX in the food safety area, which confirms the lack of research in the area.

These articles collectively shed light on various facets of user experience, design interfaces and challenges associated with food safety management systems.

One of the studies was on developing an interface for gesture control in kitchen settings and revealed that innovative interfaces in this area can offer benefits in hygiene, time management, and immediate control and if it is taken into account the integration of visual design principles, mention in other studies, there will be also possible the enhancement of the user experience [11], [18].

Another perspective delves into real-time testing methodologies for food safety awareness, introducing an innovative tool that assesses awareness through dynamic simulations, uncovering patterns in risk identification and other exploration focuses on user experience within learning modules, employing evaluations and assessment questionnaires to analyze efficiency, effectiveness and errors [3], [10].

Additionally, another approach focuses on the development of a user interface that provides information on corrective actions and guidelines based on research studies, addressing challenges in complex ready-to-eat food production like the ones mention above. The tool aims to offer decision support by ensuring compliance with food safety, nutrition, cost, and quality criteria set by legislation, customers, or internal standards [25].

To finalize the analysis of all the articles, a co-design approach takes center stage in the creation of a website interface showing the importance of collaboration with community members, stakeholders, and UX design experts, which results in a prototype tailored to meet the unique needs of the users.[23]

Even though these studies showcase that the use of UI/UX in applications has a tremendous positive impact, existing food safety apps still have some limitations, revealing issues such as information silos, inadequate context-based user experience and insufficient usability evaluations and research, emphasizing the importance of emerging software design approaches and focusing on context-based design principles for effective interface development [10].

Table 4 - Areas using UI/UX in the articles

ARTICLES	AREAS THAT USE UI OR UX												
	Food and hygiene related areas					Other areas mentioning aspects of quality control							
	Food safety	Food packing	Livestock management	Sanitation	Dairy	Medical field	Maintenance	Information security	Construction	Welding	Multimedia	Cars	Weather
[1]						•							
[2]							•						
[3]	•												
[4]									•				
[5]									•				
[6]										•			
[7]								•					
[8]		•											
[9]			•										
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[21]												•	
[22]				•									
[23]	•												
[24]						•							
[25]	•												
[26]						•							

The seven articles that clearly address food safety also address a variety of critical UI/UX elements, from clear information visualization and usability to more aesthetic aspects like attractiveness and engagement which can be seen in Table 5.

Articles [3], [10] and [18], show a strong focus on interface attractiveness and minimal learning time, indicating a priority on user engagement but without compromising the simplicity. Articles [10] and [11] emphasize visual design and layout pointing the importance of the structure and organization of interface elements. On the other hand, articles [19] and [23] highlight the importance of a clear and accessible interface, emphasizing the critical nature of making interfaces not only easy to use but also accessible to a diverse range of users.

Together, these articles suggest a comprehensive approach to UI/UX design, where functionality, aesthetics, and user engagement should harmoniously integrate.

Table 5 - Aspects of UI/UX mentioned in the articles

ARTICLES	ASPECTS OF UI/UX MENTIONED IN THE ARTICLES								
	Layout	Interafce usability and accessibility	Minimal learning time	Attractiveness and engagement	Graphic and image elements	Color and font analysis	Clear visualization of information	How to catch user's attention	User friendly/intuitive
[3]	•	•	•	•					
[10]	•	•	•		•				
[11]		•			•	•	•		
[18]		•	•	•					
[19]		•				•	•		
[23]					•	•	•	•	•
[25]				•	•	•			•

CHAPTER 3

Research Methodology

Design Science Research (DSR), was the chosen research methodology for this dissertation.

DSR aims to enhance knowledge and organizational capabilities through the creation of innovative artifacts. These artifacts are designed to solve real-world problems and improve the environments in which they are applied, by addressing specific challenges and contributing to the advancement of both theory and practice [42].

This methodology involves 6 phases which include problem identification, definition of research goals, development, demonstration and evaluation and lastly, the conclusion of the artifact. The process stated is shown in Figure 5.

Therefore, a comprehensive evaluation of existing quality control tools is essential to provide a UI/UX methodology for the development of this new food safety application. Subsequently, a design methodology was established and expert interviews took place, along with the development and testing of the proposed solution.

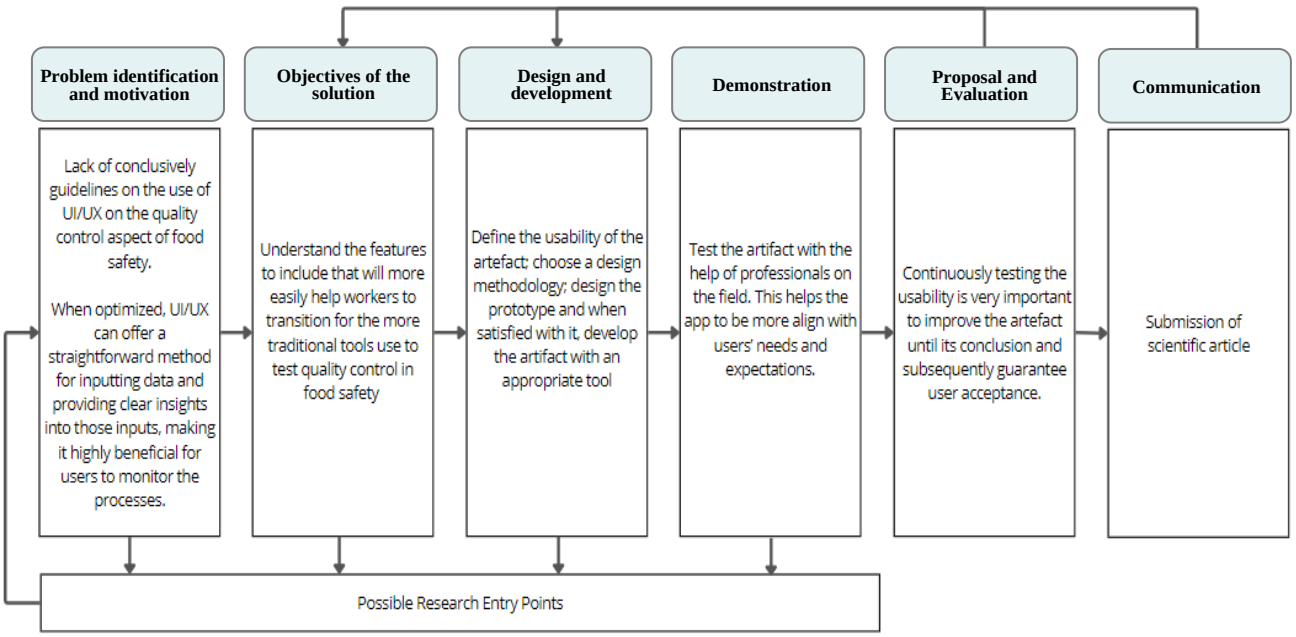

Figure 5 - Application of the DSR Methodology Schema

CHAPTER 4

Design and Development

4.1. Defining User Research

To interpret and validate the findings of the study made by David Gabriel regarding this kind of applications [39], an interview was conducted with 2 other experts in the food industry area. The information of which one is detailed in Table 6 and the questions asked to the interviewees are detailed in Appendix A.

Table 6 - User Research interviewees information

Gender	Age	Area	Current Role	Years of experience	Interview duration
Male	52 years	Food consulting	Commercial director	24 years	30 minutes
Female	31 years	Restaurant	Restaurant manager	5 years	30 minutes

With the integration of the two sets of responses, the empathy map shown in Figure 6 was created.

An empathy map is a visualization tool used to describe our understanding about a specific type of user/users. It is used extensively in UX design and product management to channel thinking into gaining deeper insights into the users emotional and psychological landscape. The tool helps better understand the user's environment, behaviors, concerns, and aspirations [41].

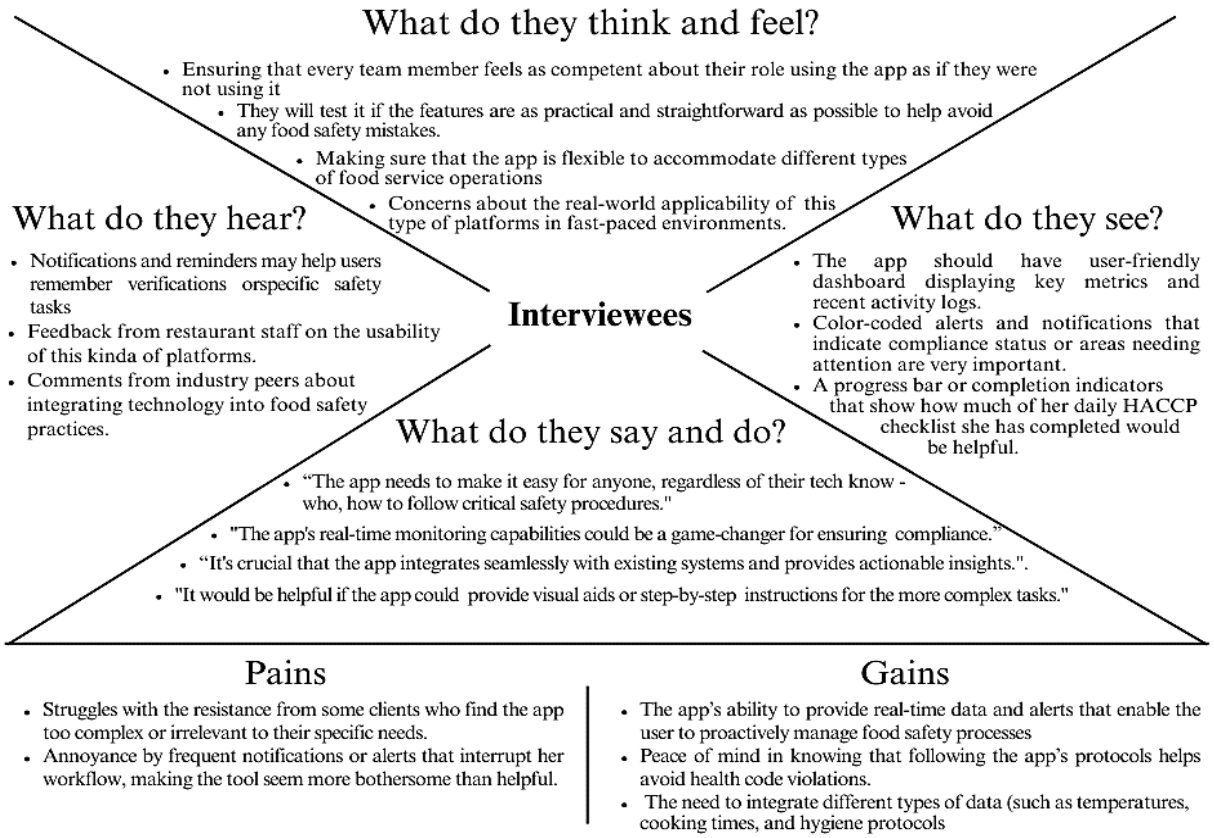

Figure 6 - Empathy map

To enhance the analysis and the decision-making process based on data collected from the empathy map, a user persona was meticulously developed. Drawing upon the primary goals, key challenges, personality traits, and skill sets identified by the research group, a fictional persona was constructed to accurately represent their collective attributes and insights.

This approach ensured a focused and relevant analysis. Consequently, Figure 7 visually depicts the crafted user persona.

Figure 7 - User Persona

4.2. Features and Information Architecture

After analyzing the feedback from the interviews, the most valuable features to incorporate in the mobile application were identified.

Consequently, the following features were selected to include in the mobile application: Create new hygienization record; Hygienization filtering system; Hygienization sort system; Procedures demonstration; List of suppliers and their information; Create new supplier; Supplies filtering system; Login Page; List of verifications; Verifications check; User information; Company information; Sign-up page; Sign-up information correction; Create new temperature record; Temperature filtering system;

Temperature sort system; Corrective actions; Idiom change; Notifications and reminders; Frequently asked questions

Given the complex nature of website architecture, sitemaps are design to organize website content in a logical and hierarchical manner. They act as a visual plan of the site's structure, helping to define the relationships between different pages and sections. For this reason, a site map was developed and is presented in Figure 8.

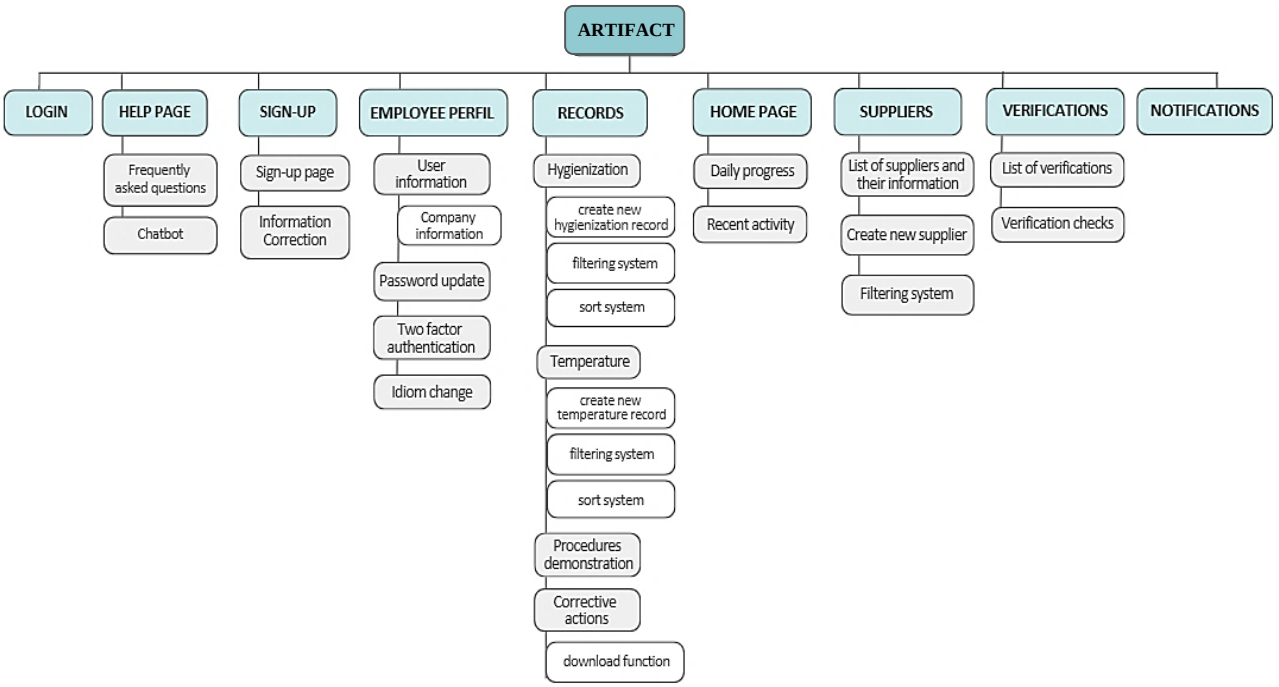

Figure 8 – Site map

4.3 Design planning

As mentioned before, the prototyping of the previous study served as the basis for this UI/UX development [39]. However, to make this mobile version, a style guide was developed and some screens were modified.

A style guide is used to establish standards and guidelines for creating and maintaining the visual appearance and user experience of a digital product, such as a website or application. Therefore, the following style guide was created (Figure 9).

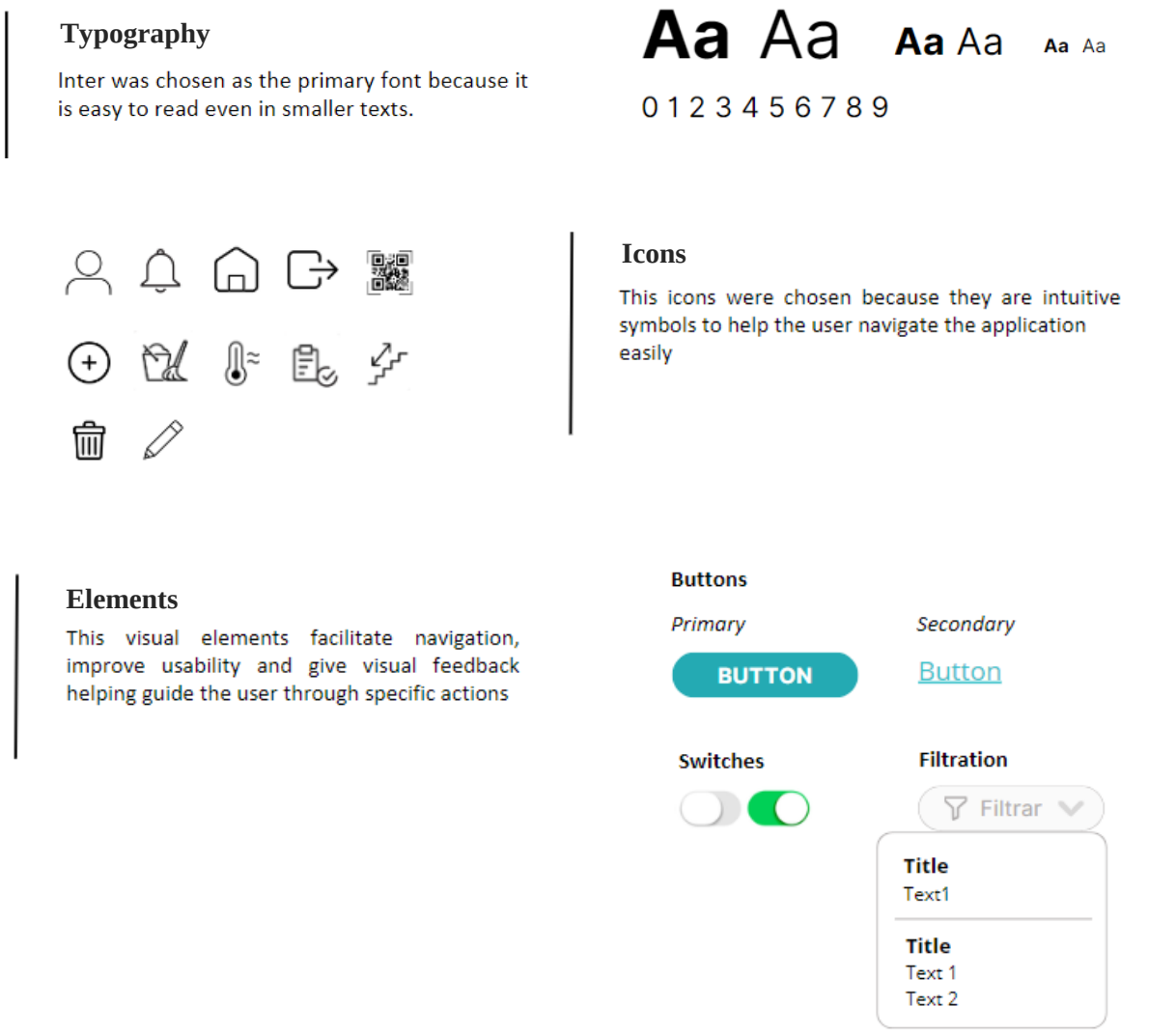

Figure 9 – Style guide used

4.4 Artifact development

To begin the development process, a tool to orchestrate the design was chosen. Figma is an online platform designed with a special focus on user interface (UI) and user experience (UX). This tool is cloud-based, which means it allows users to access and edit projects from anywhere and through any device with internet access.

In Figma, users can create and manage reusable elements such as buttons and menus, which can be used across various parts of a project. This feature not only ensures design consistency but also boosts efficiency in the workflow.

The platform is further enhanced by its compatibility to access a wide range of plugins, ranging from integration with other design tools to workflow optimization utilities. For this particular project, the *Icons8 – icons, illustrations and photos* plugin was employed.

One of the most striking features Figma offers is its sophisticated prototyping tool, that allows users to create interactive prototypes without the need for programming, making it easier to visualize and test navigation flows between different screens in an interface.

So, as part of the usability testing interviews, the Present or Preview feature of Figma proved to be essential because it connects the different prototype flows and allows to showcase the designs in a full-screen presentation mode. This feature is essential for demonstrating the working flow of the application, including interactions and animations, as it helps interviewees visualize how the final product will function in a real-world scenario.

Therefore, Table 7 outlines all the steps taken in developing this artifact in terms of feature development. By evaluating and attesting that all these features were compliant with professional standards, in the fifth iteration a saturation point was reach, therefore verifying the potential of the final application design.

Table 7 - Iterated features

DSR Iteration	Feature
First iteration	Create new hygienization record; Hygienization filtering system; Hygienization sort system; Procedures demonstration; List of suppliers and their information; Create new supplier; Supplies filtering system; Login Page
Second iteration	First iteration feature improvements; List of verifications; Verifications check; User information; Company information; Sign-up page; Sign-up information correction
Third iteration	Second iteration feature improvements; Create new temperature record; Temperature filtering system; Temperature sort system; Corrective actions
Fourth iteration	Third iteration feature improvements; Idiom change; Notifications and reminders; Frequently asked questions
Fifth iteration	Fourth iteration feature improvements;

CHAPTER 5

Proposal, Demonstration and Evaluation

Using the methodology described in the previous chapter, several iterations with professionals in the food safety area were conducted. For each iteration, an expert provided feedback by evaluating the iteration's development. The details of each iteration's process are outlined in the folder Interviews, which include scripts for the steps taken during each interview. On the other hand, the information about all the interviewees is compiled in Appendix B.

To ensure the interviewee's understanding of the purpose of the meeting, the study's context was introduced before each interview. The interviews were structured to address all critical questions necessary for the effective creation of the artifact. Upon completion of the steps outlined in the scripts, the interviewees completed a satisfaction questionnaire about the modules they reviewed, detailed in Appendix C.

The first interview was held via Zoom video conference to accommodate the busy schedule of the expert. Since it went well, the others were conducted using the same platform. Each interview lasted around 30/45 minutes. Despite the remote setup, Zoom allows the interviewees to navigate the interface independently and interact with each feature as if they were physically present, thus maintaining the authenticity of the remote interviews.

5.1. First DSR Iteration

To be able to create the artifact, research, design and testing methods were chosen as Figure 10 illustrates.

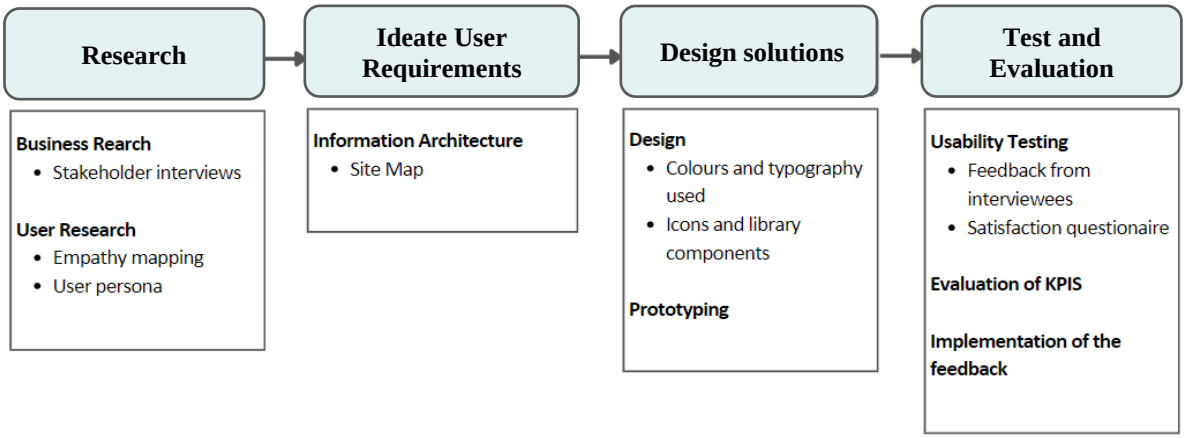

Figure 10 – Phases of the development of the artefact

The usability test of the artifact's design development was, as stated before, achieved with the help of experts such as the one in Table 8.

Table 8 - First interviewee information

Gender	Age	Area	Current Role	Years of experience	Interview duration
Male	55 years	Food safety consulting	CEO	26 years	30 minutes

5.1.1 Demonstration

As a way to present the initial artifact, 51 screens were developed, however only 27 were displayed in this iteration. The First Iteration folder shows all the initial screens but also the auxiliars to complete the prototype flow.

The prototype was built to allow users to navigate blindly with the app without any restrictions but, nonetheless, the expert was assisted in discovering the different pages by being ask to complete several sequenced tasks. The interviewee was also encouraged to express his predictions for the results of those requests. Perceiving this helped the interviewer comprehend the expert's intended conduct, which helped in implementing greater accuracy in the next versions.

The interviewee was tasked with evaluating seven key features. These features were the creation of a new hygienization record; the hygienization filtering system; the hygienization sort system; the procedures demonstration; the list of suppliers and their information; the creation of a new supplier; and the supplies filtering system. Before discussing these main topics, the expert was asked for their initial impressions of the homepage, as it is the first contact with the artifact when opening the application.

The overall feedback from this consultant is documented bellow.

5.1.2. Evaluation

Requesting feedback is one of the most used approaches to access user satisfaction. Therefore Table 9 reveals the feedback collected following the first iteration and identifies 4 positive aspects, 1 con and 3 suggestion improvements that are more directly related with the industry use of the application than with the UI/UX aspect of the artifact.

In addition to addressing the negative feedback outlined, it was considered essential to revise the sorting system. The consultant also noted the desire to be able to click on the "Recent Activity" history on the homepage and be redirect directly to the Records page, either to view or create a new record. Concerning the suppliers page, the interviewee stated that the capability to create new suppliers should be restricted exclusively to users who possess an admin profile and therefore the supplier profile contained excessive information for the regular user.

Table 9 - Evaluation of the first iteration artifact

Pros		
ID	**Feature**	**Stakeholder opinion**
P1.01	Home	The color pallet used is very clean and appealing to the eye for the consultant.
P1.02	Records	The filtering system seems simple and intuitive for the interviewee.
P1.03		The consultant thinks the procedures demonstration is easy to understand and visualize.
P1.04	Suppliers	The information on the main page seems sufficient.
Cons		
ID	**Feature**	**Stakeholder opinion**
C1.01	Suppliers	The interviewee thinks that the sort system, unlike the filtering system, might be difficult to locate.
C1.02		The consultant thinks that normal users should not have the ability to create new suppliers. There should be an admin profile to do that.
Proposed Improvements		
ID	**Feature**	**Stakeholder opinion**
I1.01	Home	To create a new record or access the record page the consultant would like to be able to click in the "Recent activity" history in the home page and be redirected to the Record page.
I1.02	Suppliers	The interviewee propose that the user should only have access to the name, product supplied and contact of the vendor. If there is an admin profile than he could have all the information.

Another way to evaluate user satisfaction is to use KPIs (Key Performance Indicators) which are quantitative metrics use to evaluate the success and effectiveness of actions made towards specific objectives.

The KPI *Task Success Rate* measures the percentage of times the user successfully complete tasks in the application without encountering difficulties or abandoning it.

$$\text{Task Success Rate} = \left(\frac{\text{Number of Sucessfully Completed Tasks}}{\text{Total Number of Tasks}} \right) \text{x } 100$$

A task was considered successful if the user completed it with no more than 2 clicks or within 15 seconds. On the other hand, if it took the user 3 or more clicks or more than 15 seconds to complete the task, it was deemed a failure. The results of this KPI in this iteration are portraited in the Table 10 below.

Table 10 - Results of the KPI Task Success Rate in the first iteration

Iteration	Total of tasks	Number of failures	IDs of the Failures	Number of successes	Result
First	9	2	#2 and #4	7	77.78%

5.2 Second DSR Iteration

The second prototype was developed by integrating insights from the previous interview, with the addition of new features. Thus, the initial screens and the new ones were showcase in this interaction and the folder Second Iteration displays them.

5.2.1 Proposal

Table 11 summarizes the features that needed enhancements and the ones that were actually implemented. Three of the suggested improvements targeted the content and visual aspects of components in the mobile application. On the other hand, the improvement C-02 was considered an additional component rather than essential, and therefore its implementation was paused until the second iteration.

Table 11 - Applied improvements based on the first iteration

ID	Improvement	Type of improvement	Implemented?
C1.01	The interviewee thinks that the sort system, unlike the filtering system, might be difficult to locate.	Visual	Yes
C1.02	The consultant thinks that normal users should not have the ability to create new suppliers. There should be an admin profile to do that.	Functionality	No
I1.01	To create a new record or access the record page the consultant would like to be able to click in the "Recent activity" history in the home page and be redirected to the Record page.	Accessibility	Yes
I1.02	The interviewee propose that the user should only have access to the name, product supplied and contact of the vendor. If there is an admin profile than he could have all the information.	Functionality	Yes*

*Only the first sentence was implemented because the second one will be evaluated again in the second iteration

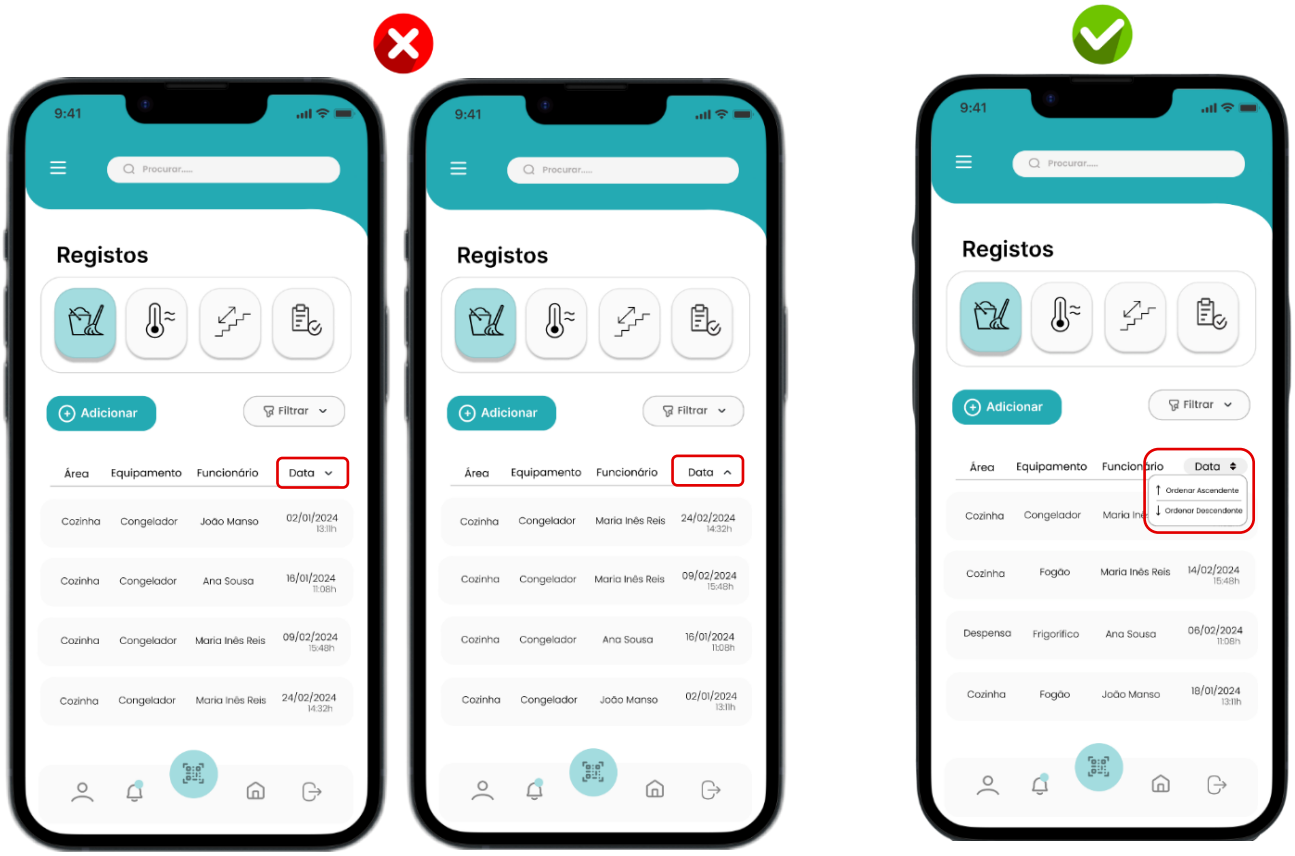

Figure 11 - Improvement made to the artifact by the second iteration (C1.01)

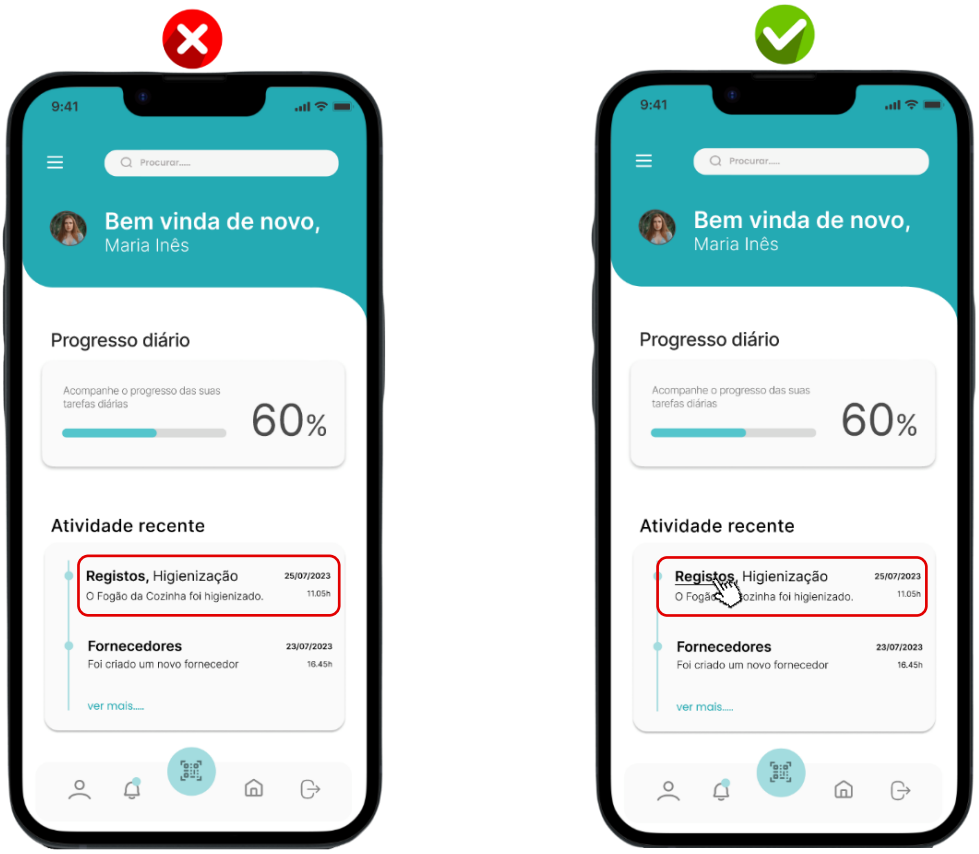

Figure 12 - Improvement made to the artifact by the second iteration (I1.01)

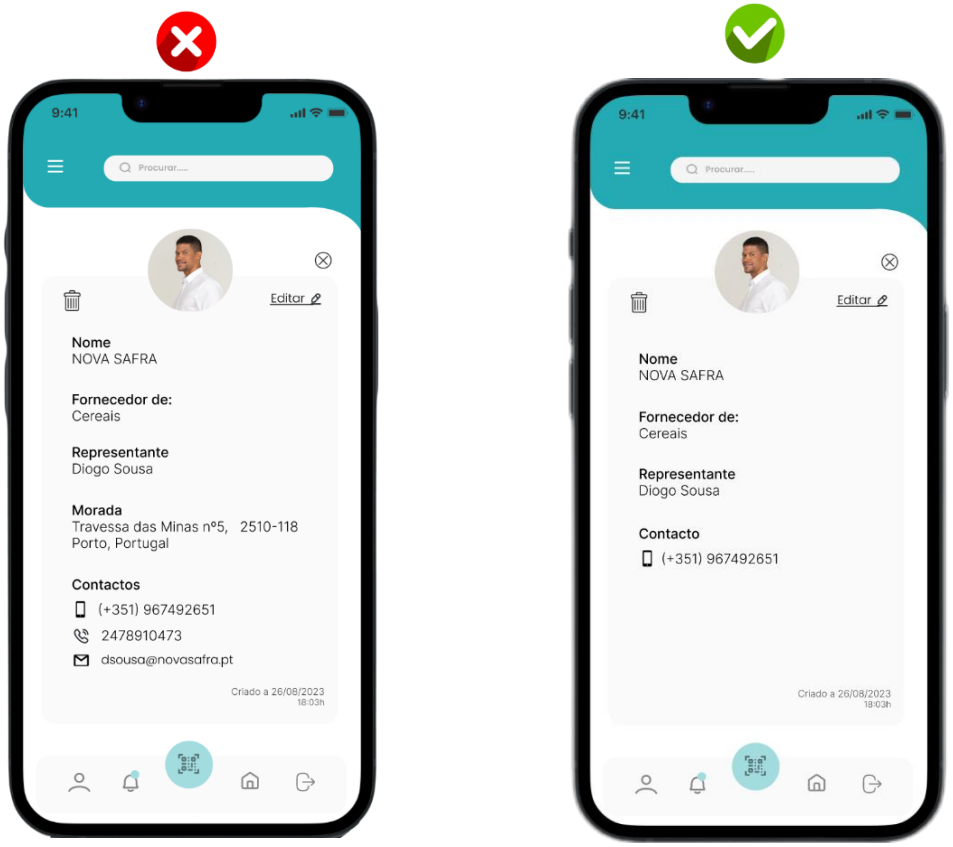

Figure 13 - Improvement made to the artifact by the second iteration (I1.02)

5.2.2 Demonstration

Regarding the second interview, the testing of the artifact was achieved with the help of another expert in the Food consulting area (Table 12).

Table 12 - Second interviewee information

Gender	Age	Area	Current Role	Years of experience	Interview duration
Male	52 years	Food safety consulting	Commercial director	24 years	45 minutes

Before the interview, the interviewee was provided with background information about the application and its intended use. The interviewee was being proposed with activities to accomplish through each step of the process but the configured workflows were what make the presentation much more seamless.

During this session, the interviewee examined six key components and also the features that were previously analyzed. Consequently, the main focus was on the Verifications, Profile, and Sign-up pages.

5.2.3 Evaluation

Table 13 demonstrates that the feedback gathered highlighted 3 positive aspects and 4 possible improvements.

The consultant has provided valuable feedback on enhancing user interaction with the system's interface. Regarding the Records page, while the iconography is helpful for users to differentiate between various types of records, the consultant suggests that including subtitles under the icons would make navigation into specific records even easier. Additionally, they recommend the introduction of a "Save password" button to improve user convenience on the page Sign-up. For the verification process, the consultant proposes a color-coded system where the verification check would initially turn yellow to indicate partial completion and then change to green once an admin profile confirms that the task has been completed correctly. Conversely, if a task is not completed satisfactorily, the button should return to grey, and the user should receive a notification about the non-conformity. Finally, once all tasks are completed and verified, the verification check list should permanently turn green to signal full compliance and prevent any further changes. This structured feedback aims to enhance both the functionality and user experience of the system.

Table 13 - Evaluation of the second iteration artifact

Pros		
ID	**Feature**	**Stakeholder opinion**
P2.01	Home	The consultant thinks that the choice in the different colors to make buttons and other important features stand out was really cleaver.
P2.02	Records	The iconography is suitable and helps users recall the various types of records.
P2.03	Profile	The information about the user and the company are sufficient.
Proposed Improvements		
ID	**Feature**	**Stakeholder opinion**
I2.01	Records	Despite the iconography helping users remember the different types of records when entering a specific record the consultant thinks it would be easier to still have the subtitles under the icons.
I2.02	Login	The interview thinks the page should have a button “Remember password”.
I2.03	Verifications	The consultant thinks that the verification check should turn yellow and then when an admin profile verifies that the task was actually completed well, then the check would turn green. If the task was not completed properly the button would go back to gray and the user would receive a notification that the task was not in conformity.
I2.04		After all the tasks are completed and verified the interview thinks that the verification should turn green and not be able to change anymore.

In the same manner as in the previous iteration, the KPI Task Success Rate was used, and the outcomes are presented in Table 14.

Table 14 - Results of the KPI Task Success Rate in the second iteration

Iteration	Total of tasks	Number of failures	IDs of the Failures	Number of successes	Result
Second	17	3	#5, #8 and #17	14	82.35%

5.3 Third DSR Iteration

Building upon the insights gained from the previous iteration and integrating new features, the third iteration was developed. This version includes several key screens, which are detailed in the Third Iteration folder. The enhancements and newly implemented features are summarized in Table 15.

5.3.1 Proposal

In this iteration, a total of five enhancements were made, focusing primarily on improving the content and visual elements of the mobile application. Specifically, improvements C1.01 and I2.03 were implemented based on expert recommendations, who suggested that introducing two types of profiles (admin and regular) would be beneficial.

Table 15 - Applied improvements based on the second iteration

ID	Improvement	Type of improvement	Implemented?
C1.02	The consultant thinks that normal users should not have the ability to create new suppliers. There should be an admin profile to do that.	Functionality	Yes
I2.01	Despite the iconography helping users remember the different types of records when entering a specific record the consultant thinks it would be easier to still have the subtitles under the icons.	Visual	Yes
I2.02	The interview thinks the page should have a button “Save password”.	Content	Yes
I2.03	The consultant thinks that the verification check should turn yellow and then when an admin profile verifies that the task was actually completed well, then the check would turn green. If the task was not completed properly the button would go back to gray and the user would receive a notification that the task was not in conformity.	Functionality	Yes
I2.04	After all the tasks are completed and verified the interview thinks that the verification should turn green and not be able to change anymore.	Visual	Yes

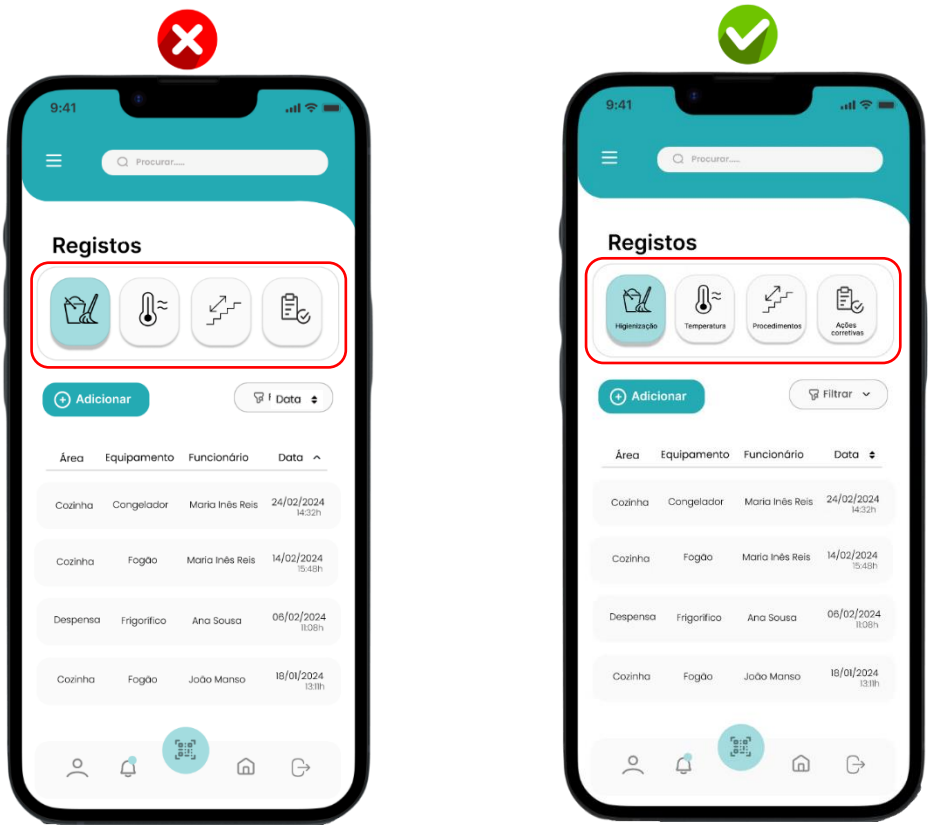

Figure 14 - Improvement made to the artifact by the third iteration (I2.01)

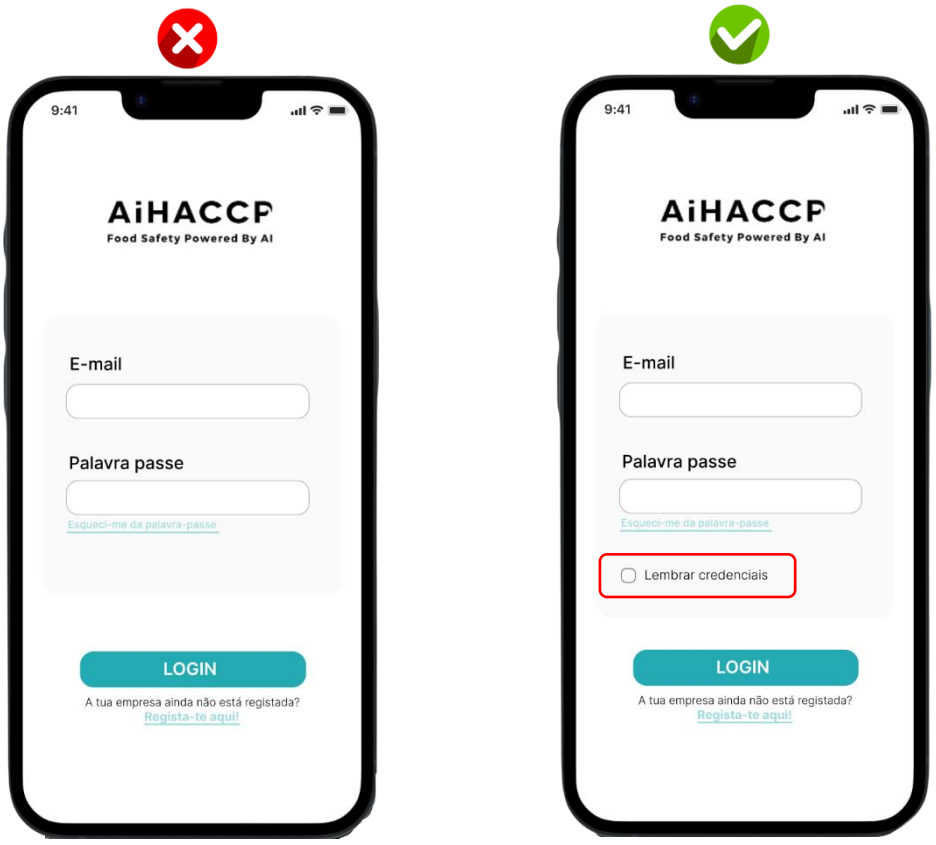

Figure 15 - Improvement made to the artifact by the third iteration (I2.02)

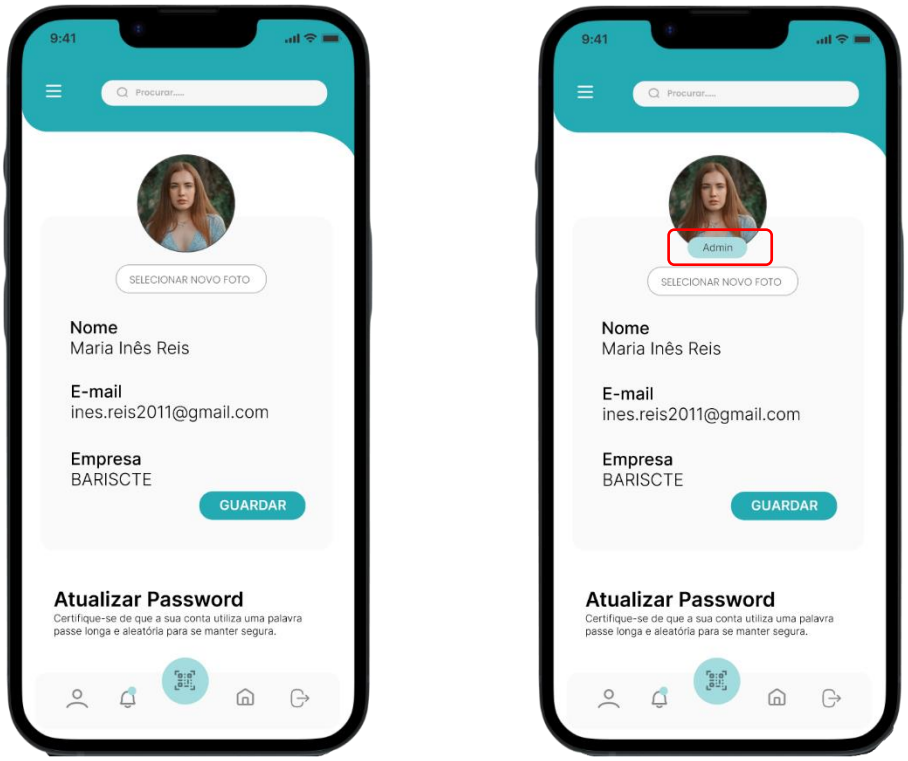

Figure 16 – The two types of profiles, regular (left) and admin (right)

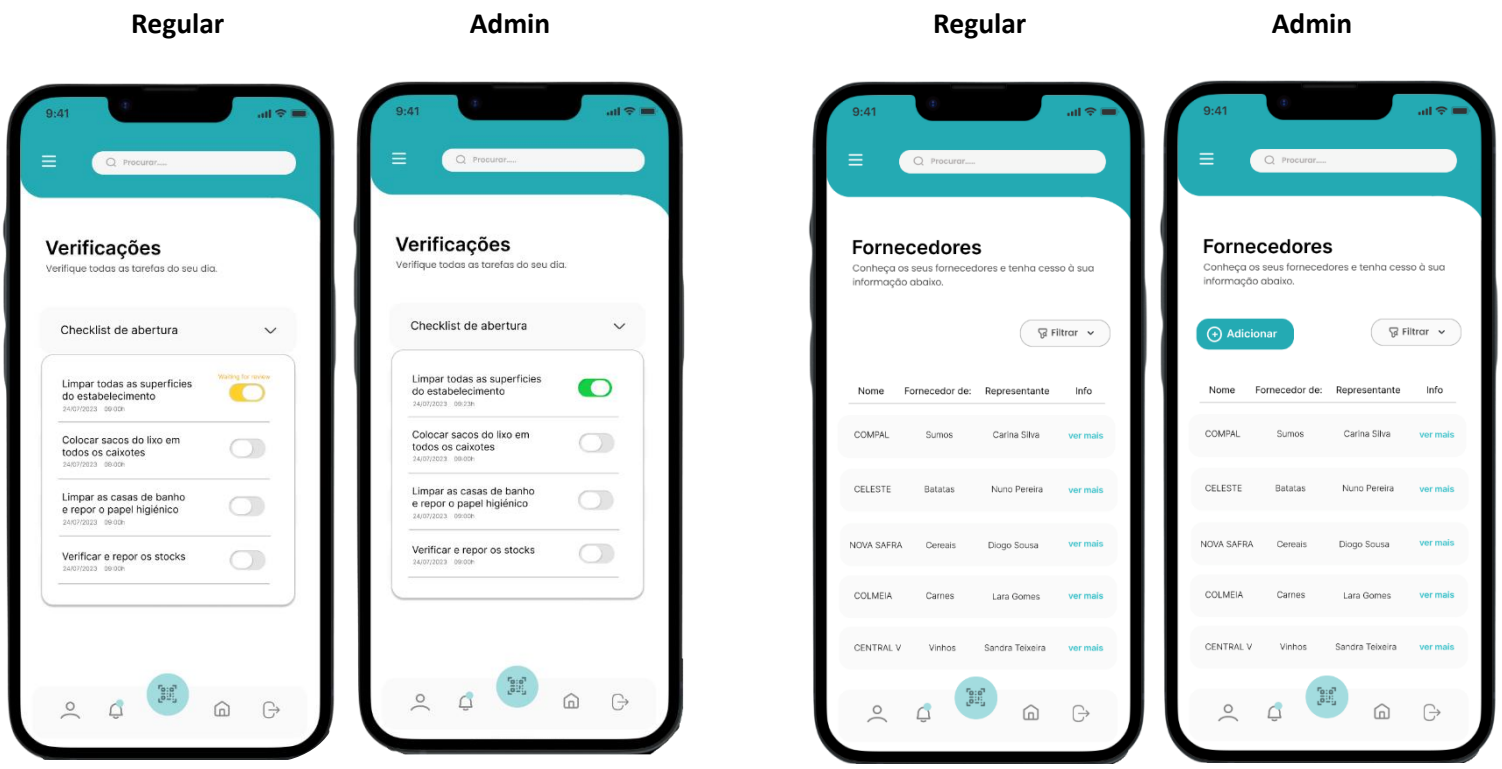

Figure 17 - Improvements made to the artifact by the third iteration (C1.02 e I2.03)

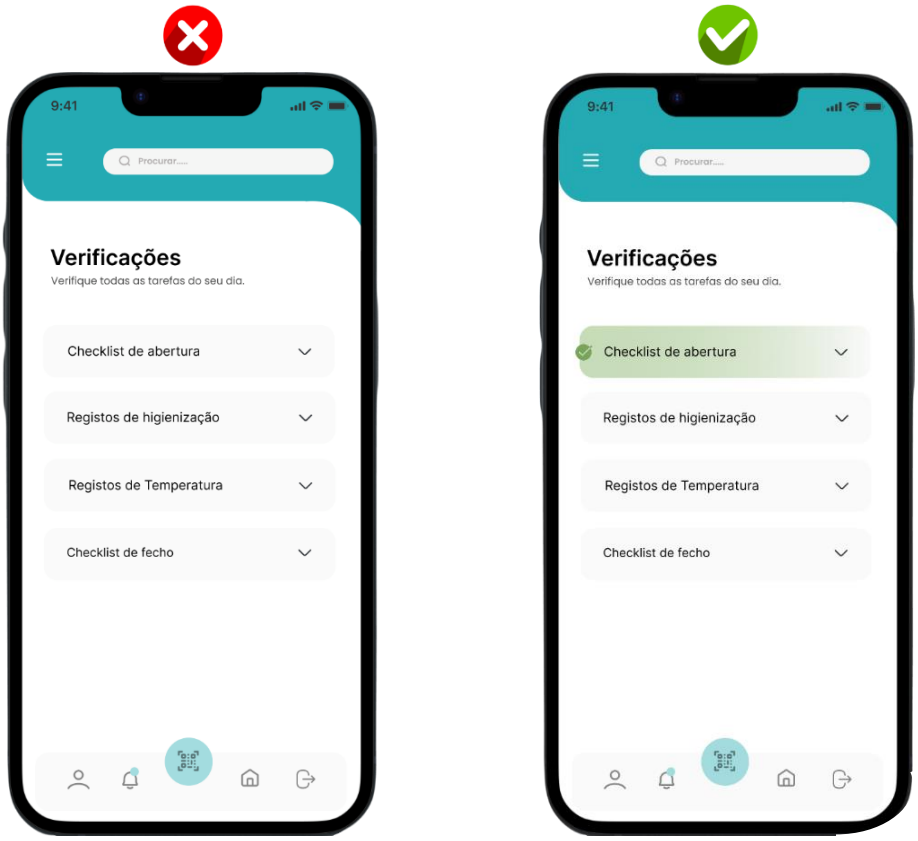

Figure 18 - Improvement made to the artifact by the third iteration (I2.04)

5.3.2 Demonstration

For the third interview, the artifact was tested with the assistance of a recent food truck owner who struggled to find and explore the HACCP plans available in the market, making this perspective particularly important. This expert information is compiled in Table 16.

Table 16 - Third interviewee information

Gender	Age	Area	Current Role	Years of experience	Interview duration
Female	23 years	Restaurant	Manager	1 year	45 minutes

As in the previous meetings, the interviewee was given background information about the application and its intended purpose beforehand.

During the session, apart from the features already evaluated, only the temperature logs and corrective actions were integrated.

5.3.3 Evaluation

The expert mentioned that the application boasts comprehensive features such as efficient management of temperature logs and critical records and streamlining verification processes.

However, she voiced concerns over the inefficiency of the filtering system and the lack of detailed pricing information for materials from suppliers.

To tackle these issues, improvements were made and are shown in Table 17. The filtering system was revamped to be more intuitive and efficient when there is more than one item selected. Additionally, a new field was introduced to include current pricing information for materials from suppliers, ensuring regular updates to maintain accuracy and empower admins to make informed decisions.

Table 17 - Applied improvements based on the third iteration

Pros		
ID	**Feature**	**Stakeholder opinion**
P3.01	Records	The interviewee thinks that the application efficiently manages temperature logs and the other essential records. Users can easily input and monitor temperature readings especially because of the color system used.
P3.02		The corrective actions are really helpful if the employee has any doubts about policies and anomaly corrections.
P3.03	Verifications	The application simplifies compliance with HACCP standards because ensures all necessary verifications are conducted efficiently, helping users maintain food safety protocols.
Cons		
ID	**Feature**	**Stakeholder opinion**
C3.01	Records	The interviewee thinks that the current filtering system is not as intuitive to understand if there is more than one item selected, so it would be very helpful to redesign the mechanism.
C3.02	Suppliers	The interviewee expressed dissatisfaction due to the absence of comprehensive pricing details from the different materials supplied. Access to pricing information is important for the administration to have all the information to make decisions.
Proposed Improvements		
ID	**Feature**	**Stakeholder opinion**
I3.01	Records	The interviewee thinks it should be possible to order the temperatures too, not only the date.

Similarly to the previous iteration, the KPI Task Success Rate was used and the results are detailed in Table 18.

Table 18 - Results of the KPI Task Success Rate in the third iteration

Iteration	**Total of tasks**	**Number of failures**	**IDs of the Failures**	**Number of successes**	**Result**
Third	21	3	#5, #20 and #21	18	85.71%

5.4 Fourth DSR Iteration

The version of the application, introduced in the this iteration, is detailed in the Fourth Iteration folder, showcasing all the screens essential to complete the prototype flows.

5.4.1 Proposal

The enhancements and newly implemented features, as summarized in Table 19, directly stem from improvements made to address issues with the filtering system and supplier information. These improvements were enacted to make the artifact more intuitive and efficient and aim to enhance user experience by facilitating easier navigation and providing valuable information.

Table 19 - Applied improvements based on the third iteration

ID	Improvement	Type of improvement	Implemented?
C3.01	The current filtering system is not as intuitive to understand if there is more than one item selected, so it would be very helpful to redesign the mechanism.	Visual	Yes
C3.02	The interviewee expressed dissatisfaction due to the absence of comprehensive pricing details from the different materials supplied. Access to pricing information is important for the administration to have all the information to make decisions.	Content	Yes
I3.01	The interviewee thinks it should be possible to order the temperatures too, not only the date.	Content	Yes

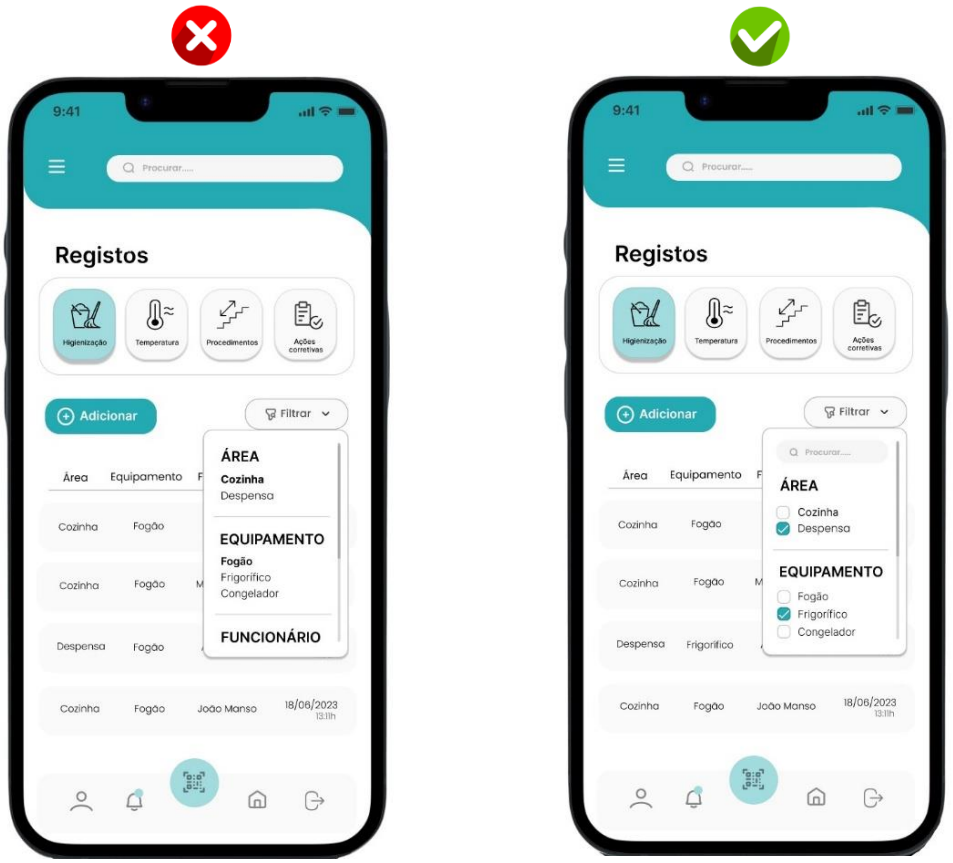

Figure 19 - Improvement made to the artifact by the fourth iteration (C3.01)

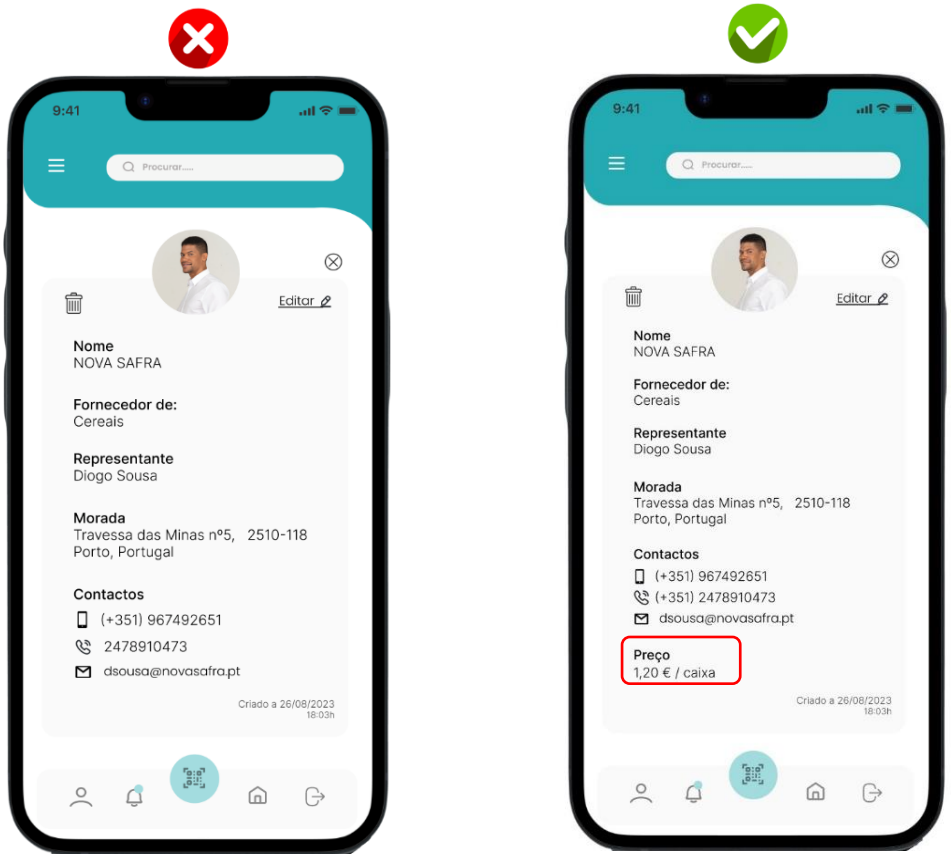

Figure 20 - Improvement made to the artifact by the fourth iteration for the admin profile (C3.02)

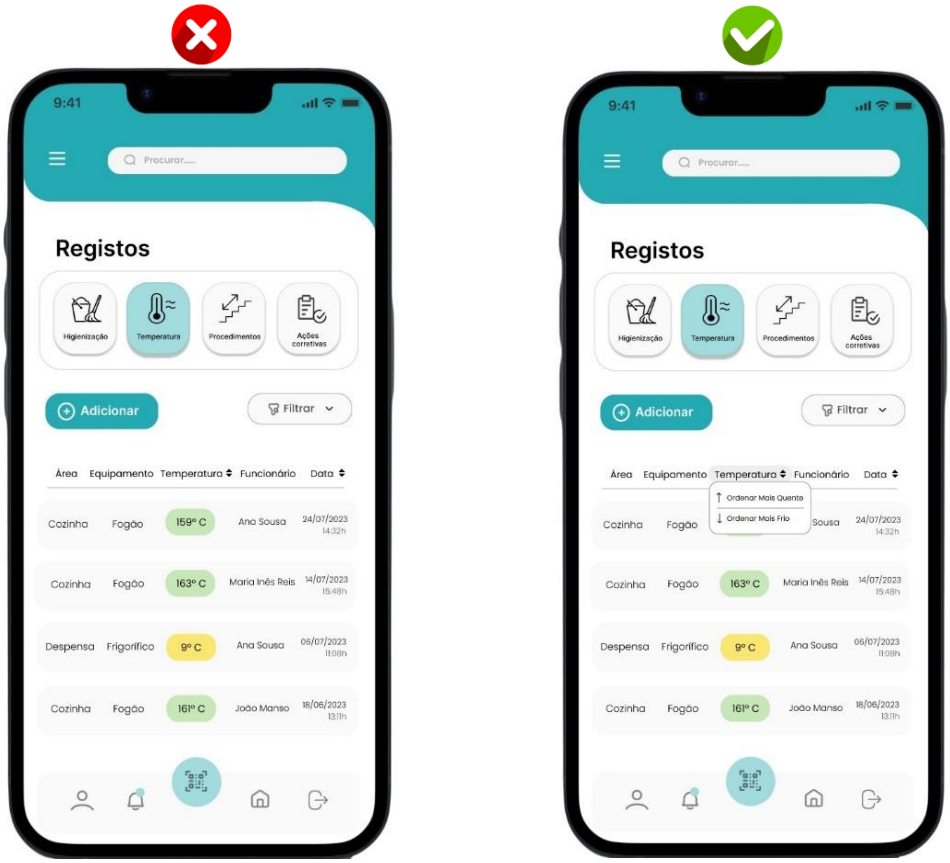

Figure 21 - Improvement made to the artifact by the fourth iteration (I3.01)

5.4.2 Demonstration

For this iteration, the artifact underwent testing with the help of a consultant specialized in the food safety industry. The interviewee information is comprehensively compiled in Table 20.

Table 20 - Fourth interviewee information

Gender	Age	Area	Current Role	Years of experience	Interview duration
Male	26 years	Food safety consulting	Consultant	4 years	45 minutes

In this iteration's presentation of the artifact, the only things that changed from the previous one were the addition of the pages: Notifications and Help. The Help page includes a Frequently Asked Questions section and a chatbot designed to assist users more effectively with any questions about the app's functionality.

5.4.3 Evaluation

After demonstrating the fourth iteration of the artifact, the interviewee noted that from a business perspective, a highly promising application was being reach. The interviewee's sole suggestion was regarding the process of creating records. All the feedback provided by the consultant is detailed in Table 21.

Table 21 - Applied improvements based on the fourth iteration

Pros		
ID	**Feature**	**Stakeholder opinion**
P4.01	Home	The interviewee believes that the recent activity feature is an excellent addition, as it allows users to quickly access their most frequently used features.
P4.02	Records	The consultant values the use of colors in the temperature records and thinks is very effective and the option to filter the records by color is even more beneficial. This enhances the usability by allowing users to quickly identify and focus on specific data.
P4.03	Notifications	The notifications are really efficient to alert the users when there is any inconsistency or tasks not completed correctly.
P4.04	Help	The chatbot is eye-catching and the recently asked questions may be helpful to the user if there is any problem that the chatbot can't identify.
Proposed Improvements		
ID	**Feature**	**Stakeholder opinion**
I4.01	Records	The interviewee thinks that there should be instructions regarding the treatment of records if they don't meet the expectations since there is already a few applications in the market that have that feature.

The KPI Task Success Rate was applied once again and the results obtained are displayed in Table 22.

Table 22 - Results of the KPI Task Success Rate in the fourth iteration

Iteration	Total of tasks	Number of failures	IDs of the Failures	Number of successes	Result
Fourth	24	3	#19, #21 and #23	21	87.50%

5.5 Fifth DSR Iteration

The final iteration focused on validating the entire artifact. This iteration was designated as the last one because the previous iteration had already yielded consistent similar feedback across most screens.

5.5.1 Proposal

Since the new features added don't change any functionalities, only enhanced them, the feedback collected during this iteration helped consolidate that a consensus was reached. In conclusion, the screens shown in this iteration are in the Fifth Iteration folder.

Table 23 -Applied improvements based on the fourth iteration

ID	Improvement	Type of improvement	Implemented?
I4.01	The interviewee thinks that there should be instructions regarding the treatment of records if they don't meet the expectations since there is already a few applications in the market that have that feature.	Content	Yes

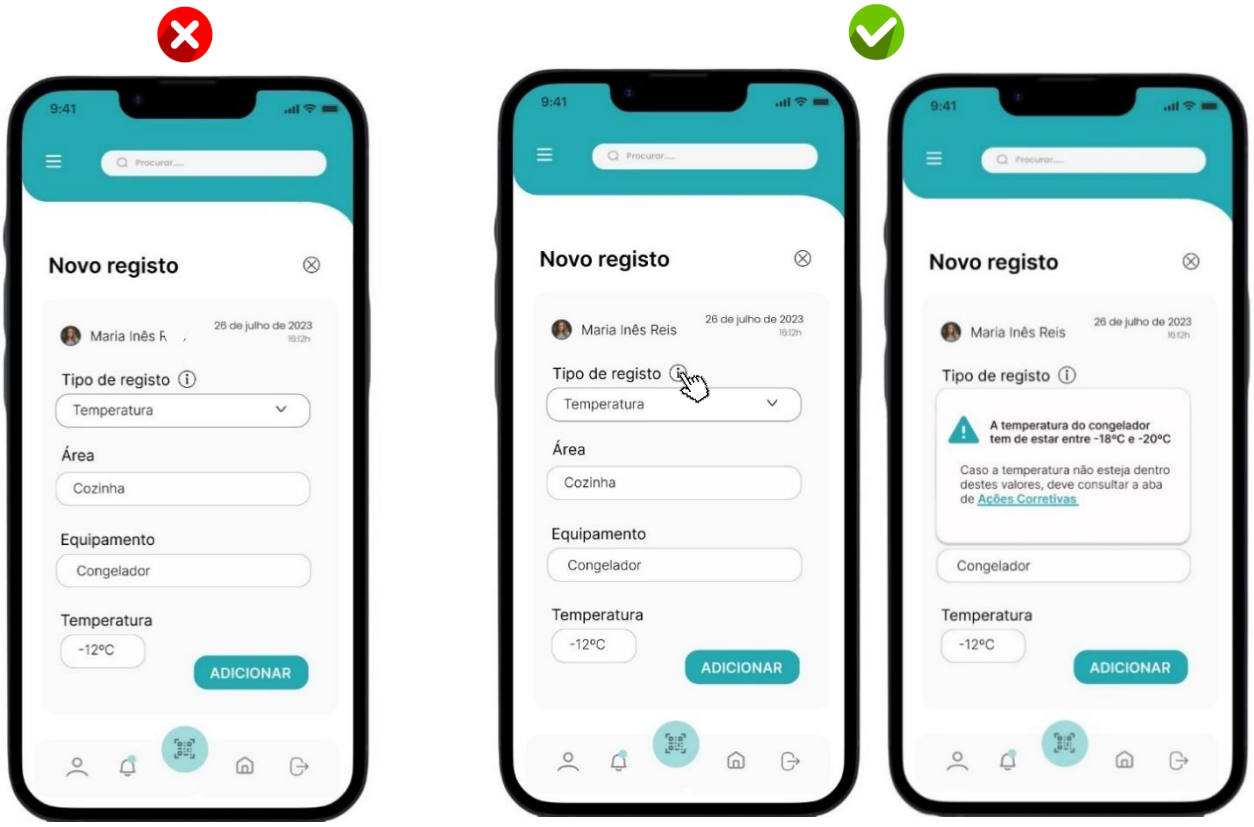

Figure 22 - Improvement made to the artifact by the fifth iteration (I4.01)

5.5.2 Demonstration

During the fifth and final interview, the artifact was tested with the help of a restaurant manager. The expert information is summarized in Table 24.

Table 24 - Fifth interviewee information

Gender	Age	Area	Current Role	Years of experience	Interview duration
Female	31 years	Restaurant	Restaurant manager	5 years	45 minutes

As demonstrated, the enhancements introduced in this iteration primarily focus on significantly improving usability and increasing market acceptance. These refinements are not crucial for the functioning of the application but are still important to help meet the diverse needs and expectations of its target audience and industry standards.

5.5.3 Evaluation

Following the presentation of the artifact, it was noted that the expert's only notes focus on the use of English in certain sections of the app. The expert emphasized that, as the application is in Portuguese, all text should be consistent to ensure cohesion making this the improvement I5.01 (“Make all the application the same language.”)

After makings those repairs and given that the feedback on the application had largely converged towards a common perspective, it was concluded that this should be the final iteration.

As in all the other iterations, the *Success Task Rate* was applied and the results are in Table 25.

Table 25 - Results of the KPI Task Success Rate in the fifth iteration

Iteration	Total of tasks	Number of failures	IDs of the Failures	Number of successes	Result
Fifth	24	2	#5 and #22	22	91.%

5.6 Evaluation of Test Results

A straightforward method for measuring user satisfaction and usability, as stated before, is the use of KPIs (Key Performance Indicators). The KPI *Task Success Rate* was applied to all the iterations and the results are shown in Table 26.

Table 26 - Results of the KPI Task Success Rate by iteration

Iteration	Total of tasks	Number of failures	IDs of the Failures	Number of successes	Result
First	9	2	#2 and #4	7	77.78%
Second	17	3	#5, #8 and #17	14	82.35%
Third	21	3	#5, #20 and #21	18	85.71%
Fourth	24	3	#19, #21 and #23	21	87.50%
Fifth	24	2	#5 and #22	22	91.67%

A thorough examination of the findings reveals that even if the total number of tasks for each iteration grows, the absolute number of failures does not decrease monotonically and the success rate rises over time, indicating an overall improvement in the processes.

The same results as Table 27 are displayed in Figure 23, but split by features.

Analyzing both the Table and the Figure, it is a possible to see a repeated failure of the feature *Records* specifically in the task with ID #5 across multiple iterations, which signals a potential issue that may be specific to this task or a set of conditions affecting it. As a result, an enhancement was implemented by placing the *Demonstration of Procedures* feature in a separate tab, making it more accessible for users. Given the creation of a new tab for the *Demonstration of Procedures*, it became evident that relocating the feature *Corrective Actions* to its own separate tab would also provide a more logical and cohesive user experience (I6.01), Figure 24.

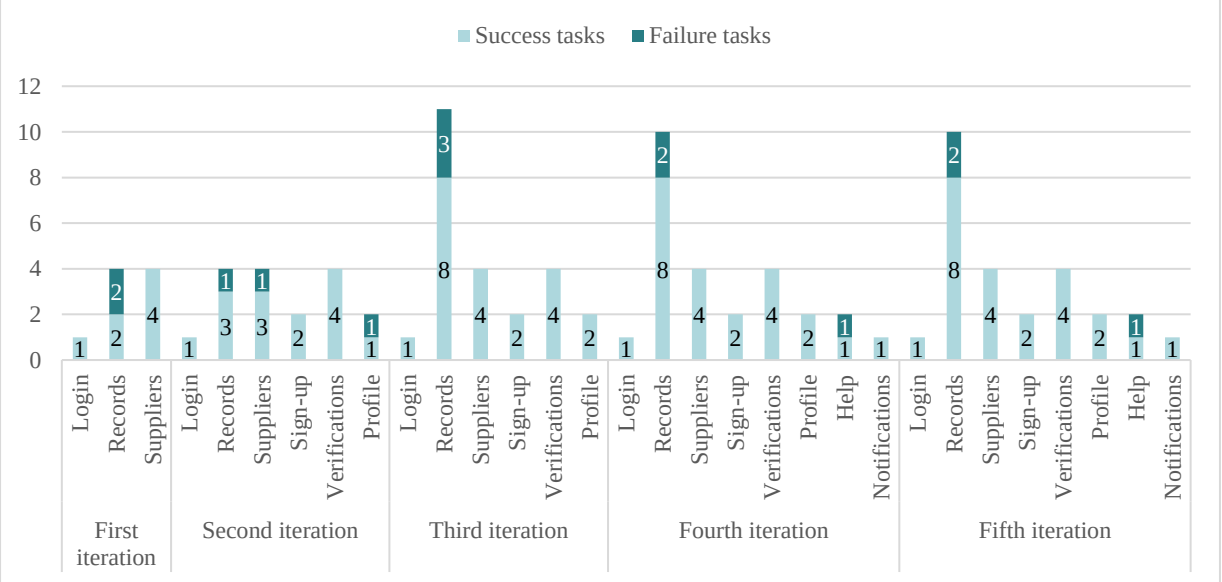

Figure 23 - Count of task completion by feature

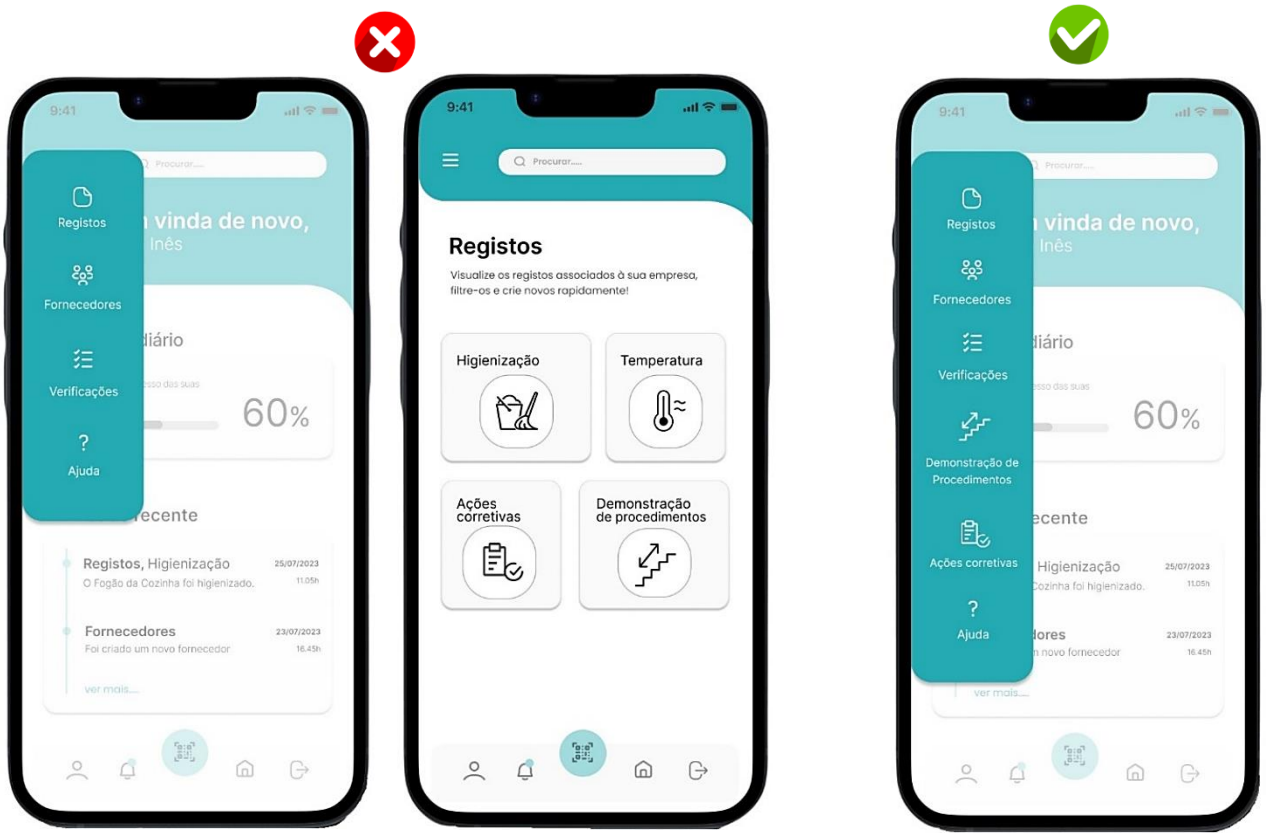

Figure 24 - Improvement made to the artifact by the author (I6.01)

Another method to evaluate the application by assessing user satisfaction relies in directly requesting feedback. This makes analyzing the responses from the Satisfaction Survey crucial. The responses for the first module are illustrated in Figure 25.

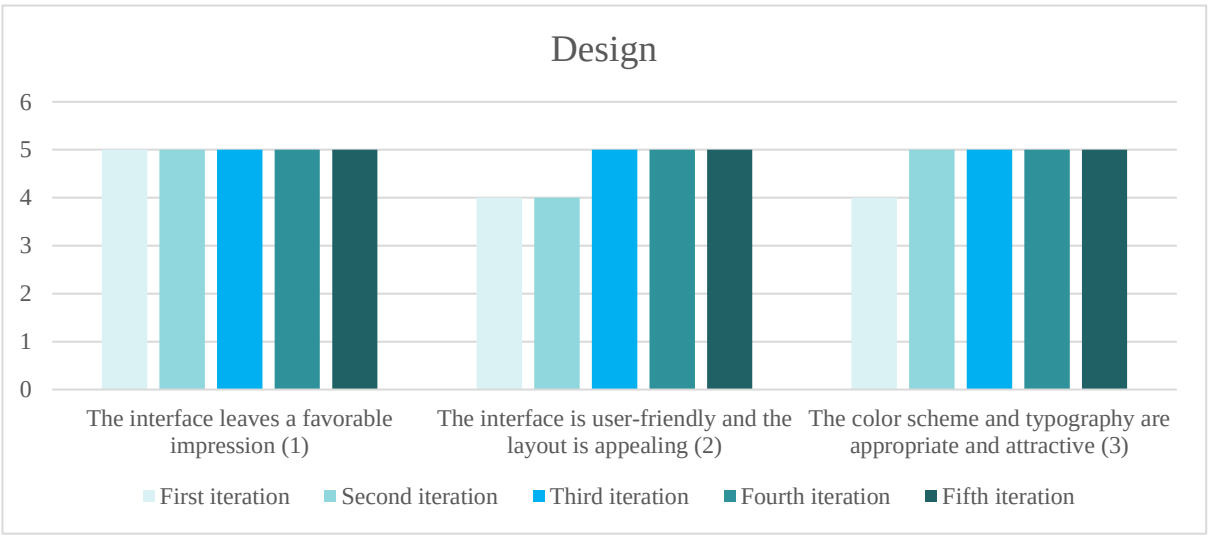

Figure 25 - Rating for each iteration based on the answers from the Satisfaction Survey (Design module)

The first criterion obtained unanimous positive feedback, with all respondents awarding it a score of 5, reflecting strong approval.

For the second aspect, the majority of participants also rated it a 5. Although, in the initial two iterations, it received a rating of 4, suggesting that, at that time, certain elements of the layout could benefit from further refinement which was done during the other three iterations.

Lastly, the criterion, "The color scheme and typography are appropriate and attractive" was widely praised, with most respondents giving it a 5. However, one expert rated it a 4 during the first iteration, implying that while the visual design was generally effective, slight adjustments could further align it with user preferences.

In summary, the chart reflects a generally positive perception of the interface design of the application, particularly in terms of its overall impression and visual appeal.

Another aspect that the questionary wanted to respond was regarding the usability of the application and the chart in Figure 26 shows the answers of the experts.

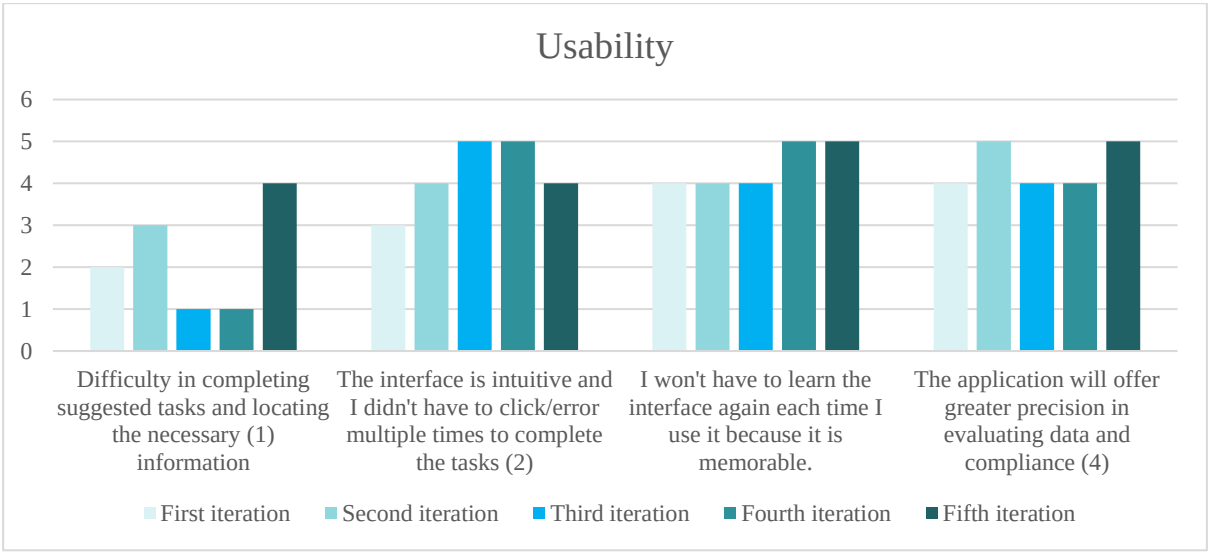

Figure 26 - Rating for each iteration based on the answers from the Satisfaction Survey (Usability module)

The criterion, "Difficulty in completing suggested tasks and locating the necessary information" received a broad spectrum of responses, ranging from 1 to 4. This indicates that users encountered varying levels of difficulty, highlighting an area in need of significant improvement to facilitate smoother task completion and easier feature discovery. These improvements were addressed through the successive iterations.

The second criterion, garnered more positive feedback, with the majority of respondents awarding it a 4 or 5, expect in the first iteration, which the rating was a 3. Similarly, the criterion "The interface is memorable, and I won't need to relearn every time I use it" received strong ratings increasing from 4 to

5. This suggests that users perceive the interface as intuitive and easy to remember, reducing the likelihood of needing to relearn how to navigate the app after initial use.

Finally, the fourth criterion, also received similar positive feedback. This indicates that users believe the app has the potential to enhance productivity.

In conclusion, the chart reflects a generally positive perception of the interface's usability, particularly with regard to its intuitiveness, memorability, and capacity to boost productivity.

To conclude the analysis on the *Satisfaction Survey's responses*, the next chart evaluates several aspects related to the components and resources of the interface. The interviewees responses are present in Figures 27 and 28.

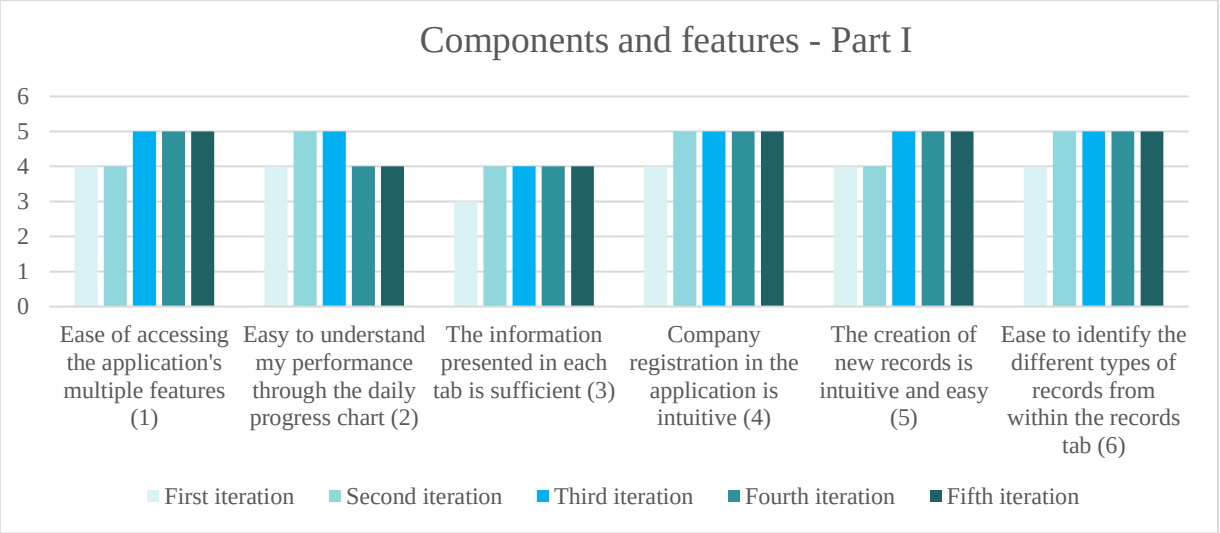

Figure 27 - Rating for each iteration based on the answers from the Satisfaction Survey (Components and Features module - 1)

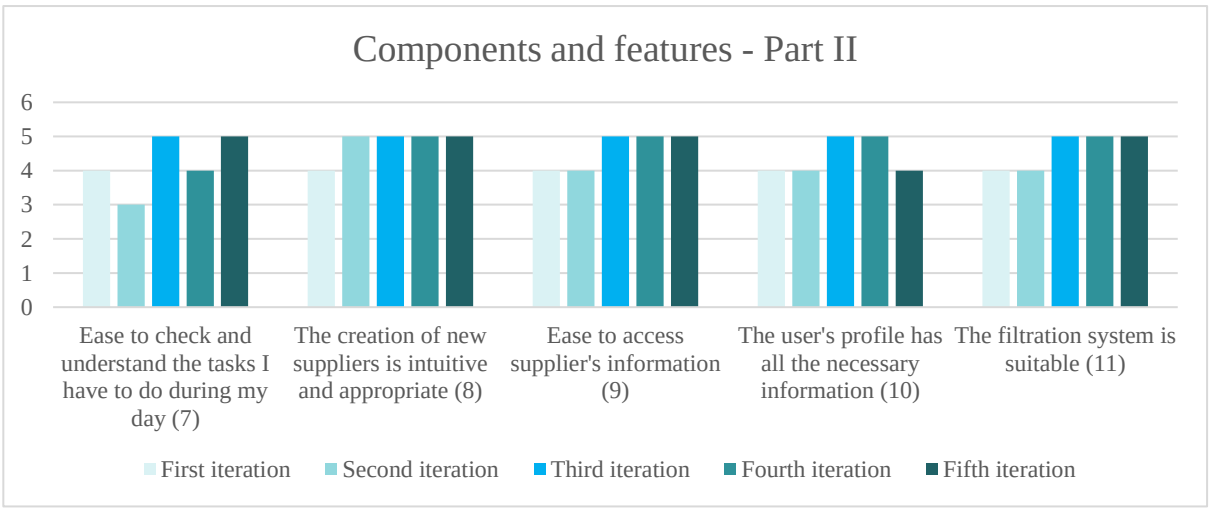

Figure 28 - Rating for each iteration based on the answers from the Satisfaction Survey (Components and Features module - 2)

The responses to the first, fifth, nineth and eleventh aspects are mostly positive, with a significant portion of users rating it a 5, though two experts rated it a 4 in the first two iterations. This indicates that overall, the interviewees found it easy to use and intuitive.

The second and tenth criterion also received mostly positive feedback but less than the previous one because the rating is not increasing throughout the iterations.

The third criterion, related to the quality of the information provided by the system, received more unbalanced responses. Although most respondents rated it a 4, one user gave it a 3. This suggests that while the information is generally seen as valuable, there may still be minor inconsistencies in clarity or usefulness.

The fourth, sixth and eight criteria show that regarding registration in the app, identification of the different records and creation of new suppliers, the feedback is predominantly positive, with most users giving it a 5, indicating smooth and efficient processes.

The seventh criterion suggests that this aspect had more changes during the process than all the other aspects because the responses regarding this category were volatile, yet in the fifth iteration, the desired agreement was achieved.

5.7 DSR Synthesis

At the end of all the iterations, it was possible to gather a significant number of enhancement proposals, which are compiled in Table 27. All 14 improvements were accomplished successfully.

One suggestion that initially seemed unnecessary gained validation through ongoing interviews, as multiple agents eventually highlighted the same need. For instance, the improvement C1.02, which was not implemented after the first iteration, was later incorporated following the second iteration.

Table 27 - Compiled iterations improvements by iteration

First iteration			
ID	**Improvement**	**Type of improvement**	**Implemented?**
C1.01	The interviewee thinks that the sort system, unlike the filtering system, might be difficult to locate.	Visual	Yes
C1.02	The consultant thinks that normal users should not have the ability to create new suppliers. There should be an admin profile to do that.	Functionality	No
I1.01	To create a new record or access the record page the consultant would like to be able to click in the “Recent activity” history in the home page and be redirected to the Record page.	Accessibility	Yes
I1.02	The interviewee propose that the user should only have access to the name, product supplied and contact of the vendor. If there is an admin profile than he could have all the information.	Functionality	Yes*
Second iteration			
ID	**Improvement**	**Type of improvement**	**Implemented?**
C1.02	The consultant thinks that normal users should not have the ability to create new suppliers. There should be an admin profile to do that.	Functionality	Yes
I2.01	Despite the iconography helping users remember the different types of records when entering a specific record the consultant thinks it would be easier to still have the subtitles under the icons.	Visual	Yes

I2.02	The interview thinks the page should have a button “Save password”.	Content	Yes
I2.03	The consultant thinks that the verification check should turn yellow and then when an admin profile verifies that the task was actually completed well, then the check would turn green. If the task was not completed properly the button would go back to gray and the user would receive a notification that the task was not in conformity.	Functionality	Yes
I2.04	After all the tasks are completed and verified the interview thinks that the verification should turn green and not be able to change anymore.	Visual	Yes
Third iteration			
ID	**Improvement**	**Type of improvement**	**Implemented?**
C3.01	The current filtering system is not as intuitive to understand if there is more than one item selected, so it would be very helpful to redesign the mechanism.	Visual	Yes
C3.02	The interviewee expressed dissatisfaction due to the absence of comprehensive pricing details from the different materials supplied. Access to pricing information is important for the administration to have all the information to make decisions.	Content	Yes
I3.01	The interviewee thinks it should be possible to order the temperatures too, not only the date.	Content	Yes
Fourth iteration			
ID	**Improvement**	**Type of improvement**	**Implemented?**
I4.01	The interviewee thinks that there should be instructions regarding the treatment of records if they don’t meet the expectations since there is already a few applications in the market that have that feature.	Content	Yes
Fifth iteration			
ID	**Improvement**	**Type of improvement**	**Implemented?**
I5.01	Make all the application the same language.	Content	Yes
Made by the author			
ID	**Improvement**	**Type of improvement**	**Implemented?**
I6.01	Since the “Demonstration of procedures” feature was failure in most of the interviews, the author decided to put that feature and the “Corrective actions” in new tabs to make them easier to access.	Content	Yes

CHAPTER 6
Conclusions

By incorporating essential UI/UX design concepts, this study sought to investigate how an effective interface can optimize quality control processes within the food safety industry.

Each iteration of the system relied on the DSR methodology which integrates iterative testing with professionals, allowing for ongoing refinement and enhancement of the user experience and the design. This iterative approach ensured that the system became progressively more efficient, ultimately leading to an optimized tool for managing food safety processes and ensuring that the system met real world needs of its future users.

Empathy mapping and the creation of user personas are additional UI/UX approaches utilized in the study that helped gain a deeper understanding of the challenges faced by food safety professionals by creating detailed user personas, the design process focuses on addressing specific pain points, such as the difficulty of navigating complex safety protocols or managing compliance across multiple checkpoints.

As a result of this investigation, a user-friendly interface was developed, tailored specifically to the unique requirements of food safety professionals. While there may be an initial investment of time in adopting the system, the interface is far more accessible and efficient compared to conventional food safety management tools, making it an appealing alternative for professionals looking to leverage technological advances in their work. Additionally, because the system can be used on mobile devices, this enables remote access to crucial information and tasks.

The successful adoption of this system will reflect the quality and relevance of the UI/UX design approaches employed, highlighting the importance of user-centered design in creating effective tools for food safety management. This research demonstrates that by focusing on the specific needs of users and integrating their feedback throughout the design process, it is possible to create interfaces that significantly improve both user satisfaction and operational efficiency.

In conclusion, this document helped respond thoroughly to which requirements are necessary for food safety professionals (RQ1) and outlines the design approaches that can optimize their quality control processes (RQ2). Food safety professionals need UI/UX designs that prioritize ease of navigation and visual clarity to effectively manage quality control, but, real-time data display and simplified task completion are also essential for timely hazard monitoring and compliance tracking.

On the other hand, regarding the optimization of quality control processes, UI/UX approaches similar to the mobile version that is presented in this study, which includes iterative design and efficient data visualization, can streamline tasks. This kind of mobile design can simplify complex processes and incorporating error prevention features that will help professionals work more efficiently, improving decision-making and reducing mistakes.

6.1 Contributions

This thesis makes several important contributions to the understanding of the role that UI/UX design plays in improving food safety management systems. The research provides a practical framework for incorporating stakeholder feedback throughout the design process, ensuring that the end product is aligned with the needs of food safety professionals.

Moreover, the study offers practical guidelines for developers aiming to improve food safety management tools, with a particular emphasis on the importance of iterative design, usability testing, and stakeholder engagement. These guidelines can serve as a foundation for future development efforts, helping ensure that new systems not only meet regulatory requirements but also enhance user satisfaction and operational efficiency.

6.2 Limitations

Although the study successfully implemented significant UI/UX improvements tailored to food safety professionals, there were still limitations that must be acknowledged.

One major constraint was the size of the sample of industry professionals who participated in the iterative design process. While their insights were invaluable, this sample may not fully represent the vast diversity present across different sectors of the food safety industry.

Additionally, the research was bound by time and technological limitations, which impacted the scope of the final system. While the design focused on usability and real-time monitoring, participants were only aloud limited time to evaluate the app's functionalities, which maybe have let to certain usability issues being overlooked since only specific user tasks were incorporated into the interface for testing.

6.3 Future work

In the future, it would be fascinating to see the management system for food safety developed in this study progressively grow into a platform that supports food safety professionals in their quality control processes.

Based on the feedback collected, the design of statistical dashboards and data visualization tools should also be explored. Research into the most effective types of visualizations, as well as the optimal color schemes for conveying critical information quickly and clearly, could significantly enhance the user experience.

Besides this, conducting longitudinal studies would be essential to evaluate the long-term impact of the UI/UX improvements made in this research. Such studies could track how the system performs over time, assessing its durability, scalability, and overall effectiveness in real-world settings. Understanding

how food safety professionals interact with the system on an ongoing basis would provide valuable insights into areas for continuous improvement and future innovation.

Finally, the future work should also involve the integration of emerging technologies such as Artificial Intelligence and Machine Learning into the UI/UX design process. These technologies could enable more predictive and adaptive systems, capable of identifying potential food safety risks before they become critical issues. For example, AI could analyze patterns in data to forecast contamination risks, while ML could personalize user interfaces based on individual habits and needs, making the system even more efficient and user-friendly.

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APPENDIX A

Survey: First set of Interviews

As part of my Master thesis in Computer Science and Business Management, the design and usability of a food safety management system are being explored and evaluated.

The purpose of this questionnaire is to gather information to assist me in better understanding the intended user's environment, behaviors and concerns in order to easily interpret the data and define the important features of the application.

Personal indicators

Instructions:
Please answer the questions bellow regarding your personal experience.
Note: All the questions with an * are obligatory.

Age*:

Nationality*:

Professional Area*:

Current role*:

Years of experience*:

Questions

What tasks do you carry out on a daily basis? *

What are the main difficulties you experience when doing it? *

What would make it easier to do it/ What changes could be made to achieve it? *

Do you like the HACCP plan you use? *

Would you be willing to use a digital version of this plan? *

Would you like to use a digital version of a plan that allows the user to create records of hygienization/temperature, receive notifications about inconsistencies, view details about suppliers and many other useful features? *

Other observations you would like to make:

APPENDIX B

Iteration	Gender	Age	Area	Current Role	Years of experience	Interview duration
First	Male	55 years	Food safety consulting	CEO	26 years	30 minutes
Second	Male	52 years	Food safety consulting	Commercial director	24 years	45 minutes
Third	Female	23 years	Restaurant	Manager	1 year	45 minutes
Fourth	Male	26 years	Food safety consulting	Consultant	4 years	45 minutes
Fifth	Female	31 years	Restaurant	Restaurant manager	5 years	45 minutes

APPENDIX C

Survey: Second set of Interviews

As part of my Master thesis in Computer Science and Business Management, the design and usability of a food safety management system are being explored and evaluated.

The interview you just participated in was conducted and the following responses will be used to collect information about the usability and overall user experience of the food safety management application which will help me have a more accurate interpretation of the data and the outcome.

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Personal indicators

Instructions:
Please answer the questions bellow regarding your personal information.
Note: All the questions with an * are obligatory.

Age*:

Nationality*:

Professional Area*:

Current role*:

Years of experience*:

Satisfaction with the application

Instructions:

Please answer the questions bellow regarding your experience with the application.
The rating 5 corresponds to *Strongly Agree* and the rating 1 to *Strongly Disagree*.

Design

	1	2	3	4	5
1. The interface leaves a favorable impression	☐	☐	☐	☐	☐
2. The interface is user-friendly and the layout is appealing	☐	☐	☐	☐	☐
3. The color scheme and typography are appropriate and attractive	☐	☐	☐	☐	☐

Usability

	1	2	3	4	5
1. Difficulty in completing suggested tasks and locating the necessary	☐	☐	☐	☐	☐
2. The interface is intuitive and I didn't have to click/error multiple times to complete the tasks	☐	☐	☐	☐	☐
3. I won't have to learn the interface again each time I use it because it is memorable.	☐	☐	☐	☐	☐
4. The application will offer greater precision in evaluating data and compliance	☐	☐	☐	☐	☐

Satisfaction with the application (Continuation)

Components and features

	1	2	3	4	5
1. Ease of accessing the application's multiple features	☐	☐	☐	☐	☐
2. Easy to understand my performance through the daily progress chart	☐	☐	☐	☐	☐
3. The information presented in each tab is sufficient	☐	☐	☐	☐	☐
4.Company registration in the application is intuitive	☐	☐	☐	☐	☐
5. The creation of new records is intuitive and easy	☐	☐	☐	☐	☐
6. Ease to identify the different types of records from within the records tab	☐	☐	☐	☐	☐
7. Ease to check and understand the tasks I have to do during my day	☐	☐	☐	☐	☐
8. The creation of new suppliers is intuitive and appropriate	☐	☐	☐	☐	☐
9. Ease to access supplier's information	☐	☐	☐	☐	☐
10. The user's profile has all the necessary information	☐	☐	☐	☐	☐
11. The filtration system is suitable	☐	☐	☐	☐	☐

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