FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Analysis, design, and evaluation of a restaurant recommendation platform for people with food allergies

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Mestrado Integrado em Engenharia Informática e Computação

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Abstract

Nowadays, food allergies are creating more and more attention amongst the public and around the world due to its significant increase. Both children and adults are affected by this problem, researchers estimate that 3%-4% of adults and 5% of children experience food allergies in western countries, a number that has grown considerably in the last decades. There is always a possibility of a severe allergic reaction to happen, and in a worst-case scenario, it can be life-threatening. Since there is no treatment for the disease, it is imperative that people with food allergies avoid the allergens. Therefore, to avoid contact with allergens people with food allergies have to take a lot of precautions when it comes to eating.

To minimize the risks of allergic reactions, individuals with these allergies usually use their homes as their "safe place", where the presence of the allergens is prohibited. However, when it comes to eating out, they need to be extremely careful because utensils and hands can contaminate an otherwise allergen-free food portion. As a result, people living with food allergies are often restricted to eating at a small number of restaurants that they know and trust.

The proposed solution to this problem is to develop a prototype where people living with food allergies can review/rate their experiences at restaurants, with the goal of helping other people choose where to eat based on previous experiences provided by people with similar characteristics. The prototype is specifically developed based on ideas presented by individuals with food allergies as a way to design an adequate solution that fits these individual's needs. I performed 19 exploratory interviews and 6 interactive interviews, 25 in-depth interviews in total. All the interviews were analyzed using the thematic analysis methodology from which emerged four central themes: how the learned to live with the food allergy problem, why dining out is a problematic task, how food allergic people avoids the tremendous problem of cross-contamination and how individuals with food allergies find allergy-friendly restaurants. With the information collected, a prototype for a restaurant recommendation platform was built and evaluated by a summative usability test with 8 participants.

Resumo

Hoje em dia, as alergias alimentares chamam cada vez mais à atenção em todo o mundo devido ao seu crescimento. Quer crianças quer adultos são afetados por este problema, investigadores estimam que, nos países ocidentais, 3%-4% dos adultos e 5% das crianças sofrem de alergias alimentares, este número tem vindo a crescer nas últimas décadas. Ter alergias alimentares faz com que exista sempre um risco de uma reação alérgica acontecer, num caso severo a vida da pessoa pode ser posta em causa. Atualmente, não existe cura. Assim sendo, a melhor forma de se evitar reações alérgicas é evitar ao máximo o consumo do alergénio. As pessoas com alergias alimentares tomam bastantes precauções de forma a evitar o contacto com o mesmo.

Por norma, estas pessoas utilizam as suas casas como um local "sagrado e seguro" uma vez que, a presença de alergénios é extremamente proibida, de forma a minimizar-se os riscos de contacto. Porém, quando existe uma necessidade ir almoçar ou jantar fora a saúde destas pessoas fica dependente de outras e como resultado, pessoas que vivem com alergias alimentares frequentam um número muito restrito de restaurantes. Normalmente, só frequentam restaurantes com os quais têm confiança pois já tiveram experiências agradáveis.

A solução proposta para resolver este problema passa por criar um protótipo onde pessoas que vivem com alergias alimentares possam comentar e avaliar as suas experiências nos restaurantes de forma a potenciar um aumento nas opções de escolha de outras pessoas.O protótipo foi desenvolvido especificamente com base em ideias apresentadas por pessoas com alergias alimentares como uma forma de projetar uma solução adequada face as necessidades das mesmas. Foram realizadas 19 entrevistas exploratórias e 6 entrevistas interativas, 25 entrevistas no total. Todas as entrevistas foram analisadas com a metodologia de análise temática, desta análise surgiram quatro temas centrais: como aprender a viver com alergias alimentares, o porquê de jantar fora ser uma tarefa problemática, como o é que evitam o tremendo desafio da contaminação cruzada e como é que os indivíduos com alergias alimentares, encontram restaurantes de forma a evitar uma reação alérgica. Com as informações recolhidas, um protótipo para uma plataforma de recomendação de restaurantes foi construído e avaliado por um teste de usabilidade sumativo com 8 participantes.

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João Almeida

"Tell me and I forget. Teach me and I remember. Involve me and I learn."

Benjamin Franklin

Contents

List of Figures

LIST OF FIGURES

List of Tables

Abbreviations

HCI	Human-Computer Interaction
IgE	Immunoglobulin E
PD	Participatory Design
QoL	Quality of Life

Chapter 1

Introduction

In this chapter, the context and the research problem are explained as well as the motivations and main goals of this dissertation. The structure of the dissertation is described at the end.

1.1 Context

Allergic problems are growing worldwide, and food allergies are not out of this picture. It is estimated that this health condition affects between 200-250 million people worldwide and there is no cure [PCHL12]. A food allergy happens when the immune system considers a particular food to be dangerous and reacts to it [wfa]. This health condition can affect both children and adults and underestimate its severity is hazardous because it can cause anaphylactic reactions, which are severe enough to be life-threatening [Pan10]. An anaphylactic reaction can lead to an anaphylactic shock, where people starts to have breathing difficulties and the blood pressure suddenly drops [hea]. In the United Kingdom, food allergies caused an increase in the number of emergency visits to the hospital [GSSA04].

The impact of food allergy on the quality of life (QoL) of people is substantial.[1] Many studies proved that the QoL of people with food allergies is very affected, such as, Cohen et al. [CNMFS04] expressed that mealtime preparation, emotional aspects, and social life are affected by food allergies. Others studies had similar conclusions, for instance, a study in the United States, showed that social limitations, in the caregiver perspective, is what worries them most [SSS+10b]. Every outdoor activity is affected, such as school events, school trips and parties [BDM+06] because the fear of a child experiencing an allergic reaction is significant for the caregiver. Usually, children are excluded from these events, or their parents follow them until they understand all

[1] Quality of life can be defined as "the subjective value a person places upon satisfaction with his or her own life" [TJM00] cited in [FdB09](p.13). QoL studies generally make use of standardized questionnaires, like the health-related quality of life questionnaires to measure and study that impact on health, physical, social, and emotional aspects [LS11]. In the specific case to measure the QoL of people with food allergies, the food allergy quality of life questionnaire is used [Lan14].

the essential aspects about their allergy and the consequences that the contact with the allergens can have [Lan14]. MacKenzie et al. [MRVLD10], elucidate how food allergy affects teenagers, and how restricted they are from social activities. In the words of a 13-year-old interviewed by MacKenzie said "It kind of annoys me when I go to barbeques...because it's a bit embarrassing going to your friend's barbeque...and bringing your own buns" [MRVLD10] cited in [LS11](p.241). It's possible to observe that not only people with food allergies have their quality of life significantly affected but also the caregivers suffer a lot from this problem. Both have their social life very restricted, and they live with daily stress because of the fear of a potential allergic reaction[2]

The increasing amount of research in this field has shown that being diagnosed with a food allergy is associated with a negative impact on health-related quality of life [LS11] where the social life is one of the aspects most affected. In order to reduce this burden, technology can play a prominent role by supporting the lives of people with food allergies.

1.2 Problem

The QoL of people experiencing this health condition is significantly affected, and as a rule, these people live in a very limited and cautious way to avoid contact with allergens. For this, they have several strategies, but in some cases, they have no way to control it. For example, when they dine out in a restaurant, people with food allergies have a hard time finding a trustable place.

People living with food allergy usually have a more limited social life. A study in Australia pointed out that dining out and traveling were the highest-rated challenges of the participants [HV12]. There are many cases where a food allergic reaction occurs in a restaurant, for instance, in Britain, 14% of people with food allergies have reactions in restaurants [ULP+05]. Other study related to fatalities caused by food-induced anaphylaxis concluded that approximately 67% of the studied people experienced anaphylactic reactions outside home, like restaurants and friends' homes [BMFS07]. Hence, people with food allergies face a lot of challenges when it comes to eating out because the food allergen can be "hidden" for example in sauces or a result of poor hygiene of kitchen utensils, allergens can be transmitted.

One of the main problems faced by these individuals are the social events, and one of the most affected is eating outside home. A study done in Australia identified this problem, in a list of daily life challenges, dining out was at the top [HV12]. Approximately 38% of survey respondents showed interest in using an eating out guide developed to people with food allergies [HV12].

1.3 Motivations and Goals

A food allergy could be life-threatening, and its prevalence is increasing. The challenges previously mentioned demonstrates the difficulties and the danger of living with allergies. Due to these

[2]The caregivers are, typically, the parents. But, they also can be people responsible for the meals, for instance, relatives (grandparents), teachers, etc.

dangers, as a rule, food-allergic people have their restaurants choices very reduced. Many families always go to the same restaurants because they had previously enjoyable meals [AKKH03].

Food allergy has a significant negative impact on the daily lives of people suffering from it. It affects 6% of young children and 3% to 4% of adults [SS06]. Therefore both children and adults are affected by this problem. Researchers estimate that 3%-4% of adults and 5% of children experience food allergies in western countries [SS10]. However, children are more affected than adults, and female children appear to be less affected than males [SS14]. It's estimated that food allergy affects 8% of children in the United States [GSW+11]. Analyzing these facts, it's easy to conclude that this health condition has a tremendous impact on our society.

The health of people with food allergies is dependent on other people when there is a need to eat out for a meal. This becomes a problem in their life because anxiety and fear towards an allergic reaction for some individuals can be extensive. Restaurants and their staff are not usually aware of how to handle this problem, many of them do not have the necessary training to avoid allergic reactions or the skills to deal with an emergency. A study made in São Paulo showed that all the managers agreed that food handlers don't have training in food allergies [ACF+10], also regarding hygiene 75% of the managers believed they do not have the right appliances to eliminate traces of allergenic food [ACF+10]. This situation is problematic because cross contamination or unexpected ingredients can trigger a reaction [FDS01]. A more recent study showed that, even though managers and staff have sufficient knowledge about the problem, they were concerned about if an emergency occurs how they will handle the situation and also incorrectly believed that people with food allergies could harmlessly eat a little amount of the food they are allergic to [RBH+16].

It is possible to observe that dining out is a big problem, so the main goal of this project is to analyze, design and evaluate a possible prototype that allows people with food allergies increase their options to eat out safely. The participatory design approach was followed, which is a Human-Computer Interaction (HCI) methodology. It's imperative to have close contact with food allergic people to collect all the requirements needed and decide how the prototype should be designed so, in the end, the result satisfies their needs.

1.4 Research Questions

The following research questions guided this work:

- RQ1: How do people live with food allergies?
  - How do people with food allergies learn to live food allergy problem?
  - What are the eating out challenges faced by people with food allergies?
  - What are the practices of people with food allergies to avoid cross-contamination in restaurants?
  - What are the practices of people with food allergies to find a restaurant that suits their allergy?

- RQ2: How a restaurant recommendation system should be designed to help people with food allergies find a restaurant that suits their allergy profile?

1.5 Contributions

The main contributions of this thesis are:

- Comprehending the context of people living with allergies
  - Challenges faced by people with food allergies when eating out;
  - Everyday practices of people living with food allergies to avoiding cross-contamination in restaurants;
  - Everyday practices of people living with food allergies to find a restaurant;
- Design of a restaurant recommendation platform for people with food allergies.

1.6 Structure

This document is structured into four chapters:

- **Chapter 2** introduces the background information about the food allergies as well the existing projects/technologies aimed to aid persons with food allergies.
- **Chapter 3** presents the methodology followed in this work. It starts with a brief introduction to HCI and Participatory Design, and then the work methodology is detailed.
- **Chapter 4** describes the findings from the interviews conducted in this work.
- **Chapter 5** presents the solution proposed for the eating out problem faced by people with food allergies based on the findings described in chapter 4.
- **Chapter 6** describes the results obtained from the usability test performed.
- **Chapter 7** reflects on the general discussion about the research process used in this dissertation, the lessons learned throughout the project development and the platform characteristics.
- **Chapter 8** reflects on the conclusions of this dissertation and the work that needs to be done in the future.

Chapter 2

Literature Review

Food allergies are growing worldwide, and the tremendous impact that they have on the quality of life of patients or those who have to care for people with this health condition has boosted an increase in studies related to this problem.

Chapter 2 is dedicated both to a literature review of the problems affecting persons with food allergies and to study the existing technologies also concerning this group of people.

2.1 Food allergy problem

Food allergy is a significant health condition that affects adults and children, and its continuous growth is a huge problem because these people tend to have a restricted life due to the danger of having a potentially life-threatening reaction. The impact of food allergies in people's quality of life is severe [LS11], where most of this impact is related to social events [CNMFS04] [SSS+10b]. Simple decisions like going to a friend's party or choose a restaurant to eat are hard choices to do [HV12] because in these environments, they are not in control and the fear of having an allergic reaction is enormous. A study in the United Kingdom showed many anaphylactic reactions occur outside people's home [Pum04]. Usually, this health condition has a big impact one's daily life decisions because, in a critical case, an anaphylactic reaction occurs which can be life-threatening and on top of it there is no cure to this problem [Pan10]. In the United States, food allergy seems to account for 30,000 anaphylactic reactions, 2,000 hospitalizations approximately, and possibly 200 deaths each year [YBK+99].

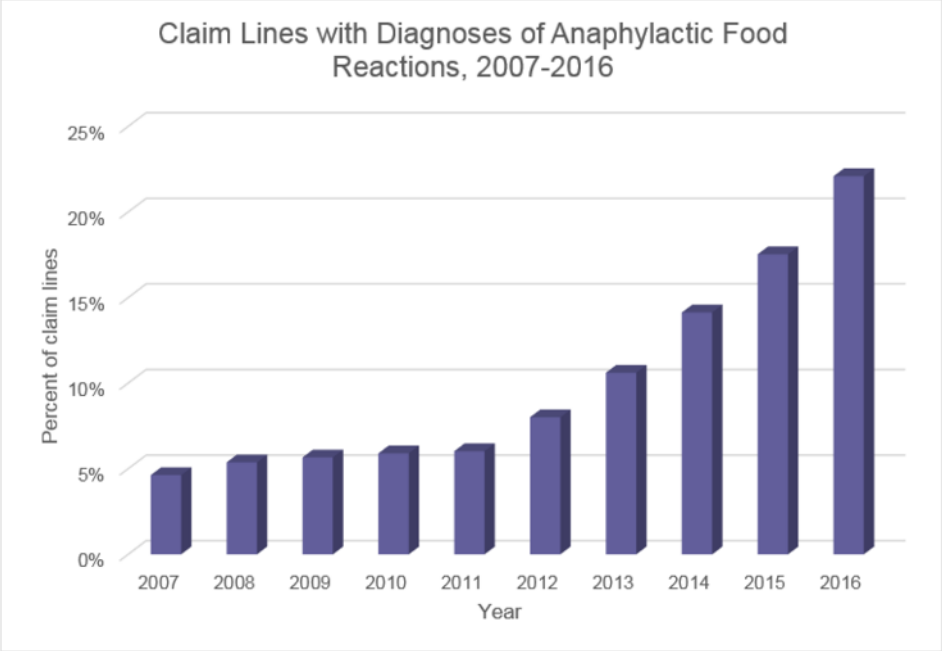


Figure 2.1: Growth of Diagnoses of anaphylactic food reactions. [Cle]

A food allergy is an adverse health consequence resulting from a specific immune response that happens when the immune system recognizes a particular food to be dangerous and reacts to it [BAB+11] [wfa]. The food that triggers an allergic reaction is called an allergen. Due to an allergic reaction, a set of different reactions can happen [wfa]. These reactions will be described later in the section.

Any food can trigger an allergic reaction but the most commons food allergens vary between different countries. Milk, eggs, peanuts, soy, wheat, tree nuts, fish, and shellfish are the most common food allergens in the United States [CS09], it's possible to see in Table 2.1 the prevalence of various food allergies on adults and young children. On the other hand citrus fruits, chocolate, apples, hazelnut, strawberry, fish, tomato, eggs, and milk were most common self-reported allergy in Russia, Estonia, and Lithuania [EMW+04]. But, tree nuts, apples, pears, kiwis, stone fruits, and carrots were the most popular self-reported food allergy in Sweden and Denmark [EMW+04]. It's possible to see that allergens differ between the countries in Northern Europe.

Food	Adults	Young Children
Egg	1.3%	0.2%
Fish	0.1%	0.4%
Milk	2.5%	0.3%
Peanuts	0.8%	0.6%
Shellfish	0.1%	2.0%
Tree Nuts	0.2%	0.5%
Overall	3.7%	6%

Table 2.1: Based on the most recent studies this table shows the prevalence of various food allergies in the United States [Sam04].

Food allergies can be classified in: [Sam99] [SS09] [NWS06] [LB06]

- Immunoglobulin E (IgE) mediated: Are mediated by antibodies belonging to the Immunoglobulin E (IgE) and occurs shortly after eating when the IgE antibodies react with the allergen. Is the most common type of food allergies and may end in an anaphylactic reaction [wfa].
- Cell-mediated: The cell component of the immune system is the responsible for trigger the reaction and mostly involve the gastrointestinal tract [Sam99] [SS09] [NWS06] [LB06]. May occurs some hours after eating when the body's immune system reacts with the allergen but doesn't involve the IgE antibody [wfa].
- Mixed IgE mediated-cell mediated: Both IgE and immune cells are responsible reaction [Sam99] [SS09] [NWS06] [LB06].

2.1.1 Food allergy diagnosis

To diagnose food allergies, it is crucial that the clinician put some effort into understanding the medical history of the patient [Sam03], especially if the food-induced allergic reaction is apparently IgE mediated [SS10].

It's important to get the following information, and I'll cite [Sam03]:

1. the food responsible for the reaction
2. the quantity of the suspected food ingested
3. the length of time between ingestion and development of symptoms
4. whether similar symptoms occurred when the food was eaten previously
5. whether other factors (e.g., exercise) are necessary
6. when the last reaction to the food occurred.

Exclusion diets are generally used in the diagnosis but are rarely used alone because its success depends if the patient maintains a rigorous diet to avoid of all forms of the allergen and also demands that the correct allergen is identified [Sam03].

For IgE-mediated disorders, skin prick tests are commonly used to see the sensitivity of the patients to specific foods [Sam99]. In general, skin tests have an accuracy of 90% on predicting negative values, so they are beneficial for eliminating IgE-mediated food allergies [SS10]. Another way to test IgE-mediated food allergy is by using serum immunoassays to discover food-specific IgE antibodies [HA04]. The patient is more than 95% likely to be allergic if the food IgE level exceeds the predicted value [Sam03]. In case of undetectable IgE levels, there is a chance of 10% to 25% to a reaction occur [Sam01].

The oral food challenges are beneficial to clarify food triggers and confirm the diagnosis [CS09]. The most accurate method is double-blinded and placebo-controlled [CS09], this method is the gold standard for the diagnosis of food allergies [Sam99]. The foods used in the double-blinded and placebo-controlled food challenge comes from the result of skin test or the analysis of the patient history [Sam03].

Allergen challenges may be needed in some cell-mediated food allergies, like protein-induced enterocolitis [SES98]. In others cell-mediated food allergies, the patient may need several feedings to trigger symptoms [Sam03].

2.1.2 Clinical Disorders

There are a set of disorders that can happen when an allergic reaction occurs. Different reactions involving the skin, gastrointestinal tract, and respiratory tract can occur taking into account the type of food allergy, IgE mediated, cell mediated or mixed [Sam03]. In Table 2.2 it's possible to see all the different food allergies disorders. It's also important to know that the immune system of one person can be more tolerant to a particular food compared to others, even though both are allergic to the same food. Thus, it's possible to conclude that the quantity of food required to trigger a reaction is variable.

2.1.2.1 Immunoglobulin E (IgE) mediated

Regarding cutaneous reaction, acute urticaria is very common due to contact with food. The exact predominance of acute urticaria and angioedema is unknown, but these symptoms are among the most frequent symptoms of food allergic reactions [Sam03].

A gastrointestinal reaction occurs due to cross-reacting allergens causing the oral allergy syndrome, in other words, the immune system sees the pollen and similar proteins in food harmful [ACoA], mainly birch, ragweed, and mugwort pollens [Sam99]. Not everyone with pollen allergy experiences oral allergy syndrome, but patients allergic to ragweed may react to bananas, melons, cucumber, and those allergic to birch pollen may react to apples, almonds, carrots, hazelnut, kiwi, peach [ACoA]. The symptoms may include itchy mouth, scratchy throat, or swelling of the lips, mouth, tongue, and throat [ACoA].

Respiratory reactions are represented by rhinoconjunctivitis which is characterized by nasal congestion, runny nose, post-nasal drip, sneezing, red eyes (conjunctivitis), and itching of the nose or eyes [oAoQ]. Rhinoconjunctivitis alone is rarely a sign of food allergy, although it usually accompanies other food allergic symptoms [Sam03].

The severity of the signs and symptoms varies. In the severe case, an anaphylactic reaction occurs, and among other things can lead to breathing difficulties [wfa]. This reaction is dangerous and must receive treatment as fast as possible because it can be life-threating [wfa].

2.1.2.2 Mixed IgE mediated-cell mediated

Concerning cutaneous reactions, atopic dermatitis characterizes food allergies. Atopic dermatitis, also called eczema, is a skin problem prevalent in children [oD]. It usually begins during early infancy [SS99] and is characterized by dry and scaly patches that appear on the skin [oD].

Gastrointestinal reactions are focused on the esophagus. The esophagus is a tube connecting the throat to the stomach [wfa]. The infiltration of eosinophils characterizes allergic eosinophilic esophagitis and gastroenteritis on the esophagus, stomach, or intestinal walls [SSB01]. An inflamed esophagus makes swallowing food very painful and challenging [wfa]. Allergic eosinophilic gastroenteritis can be seen at any age [SRW+87], on the other hand, allergic eosinophilic esophagitis is commonly seen during infancy through adolescence [SSB01]. Weight loss or failure to thrive is a sign of this allergic eosinophilic gastroenteritis [Sam03].

Acute bronchospasm characterizes respiratory reactions and co-exists typically with other food-induced symptoms, on the other hand, asthma is an unusual manifestation [JBBS94]. When cooking food the vapors or steam emitted can trigger an asthmatic reaction [CPD+95].

2.1.2.3 Cell mediated

The most common cell mediated food allergies affect the digestive tract [wfa]. The symptoms can take a longer time to appear comparatively to IgE mediated allergy [wfa].

Dermatitis herpetiformis and food-induced contact dermatitis characterize cutaneous allergies. Dermatitis herpetiformis is a chronic blistering skin disorder characterized by intensely itchy, intensely pruritic papulovesicular rash usually distributed symmetrically over the extensor surfaces and buttocks [HI92]. Food-induced contact dermatitis is generally related to food handlers, notably seen with those who work with raw fish, shellfish, meats, and eggs [Jud94].

Regarding gastrointestinal reactions, food protein-induced proctocolitis affects infants in their first year of life and is characterized by an inflammation of the lower part of the intestines [wfa]. Generally, food proteins transferred in maternal breast milk or to milk- or soy-based formulas triggers a response [MCG+94] [Lak00]. Food Protein-Induced Enterocolitis Syndrome (FPIES) is usually observed in infants before three months of age but may be delayed in breastfed babies [SES98] and is characterized by vomiting and diarrhea, occurs when the gastrointestinal system reacts to a particular food" [wfa]. It tends to affect most often young infants and if the

allergens are avoided the symptoms go away. The most common food related to FPIES is: "dairy, soy, rice, oat, barley, green beans, peas, sweet potatoes, squash, and poultry" [wfa].

In respiratory reactions, Heiner syndrome is an unusual but reversible form of a food-induced disorder mostly induced by cow milk [LKCH78].

Type		**Disorders**
IgE mediated		
	Cutaneous	Urticaria
		Angioedema
		Morbilliform rashes
		Flushing
	Gastrointestinal	Oral allergy syndrome
		Gastrointestinal anaphylaxis
	Respiratory	Acute rhinoconjunctivitis
		Bronchospasm (wheezing)
	Generalized	Anaphylactic shock
Mixed IgE and cell mediated		
	Cutaneous	Atopic dermatitis
	Gastrointestinal	Allergic eosinophilic esophagitis
		Allergic eosinophilic gastroenteritis
	Respiratory	Asthma
Cell mediated		
	Cutaneous	Contact dermatitis
		Dermatitis herpetiformis
	Gastrointestinal	Food protein-induced enterocolitis
		Food protein-induced proctocolitis
		Food protein-induced enteropathy syndromes
		Celiac disease
	Respiratory	Heiner syndrome

Table 2.2: Food allergies disorders [Sam03].

2.1.3 Management and Treatment

A cure for food allergies doesn't exist. Therefore, the primary management includes avoiding the food that triggers allergic reactions and having a plan in case of an emergency [SS14]. A strict elimination of the allergen, which means a strict diet is the best therapy to prevent an allergic reaction [Sam99].

In case of an anaphylactic reaction occurs, then epinephrine should be used. This medicine is easy to use with an auto-injector, and it needs a prescription [wfa].

Antihistamines and steroids are other possible treatments. To alleviate some symptoms antihistamines can be used and to relax the cells of the immune system attacked by chemicals during the allergic reaction steroids should be used [Sic06].

Both patients and caregivers should be encouraged to learn how to self-injectable epinephrine is used, recognize the first symptoms, and how to activate the emergency services [SS06].

2.1.4 Impact on the Person

When a person is diagnosed with a food allergy, the diagnostic has a considerable impact, because the constant threat scenario of having an allergic reaction, like life-threatening anaphylaxis is stressful [Lan14]. To avoid this situation, they need to be well informed and receive the appropriate training to deal with an emergency situation [Lan14]. As said in previous sections, living with food allergies is related to a negative impact on the quality of life [LS11]. Food allergic people face many restrictions daily, and the main impact is reflected in the social activities they can engage. One of the most affected activities is eating out [HV12] because these people are terrified of having an allergic reaction once they are not in control of what they are eating.

MacKenzie et al. [MRVLD10], elucidates how food allergy affects teenagers, and how restricted they are from social activities, for instance:

- a 13 years old female said "I've missed out on 4 parties because I just don't want to go. I didn't want the aggravation of the food because they don't understand my nut allergy. So I missed out because I just didn't want the hassle at all." [MRVLD10] cited in [LS11](p.241)
- an 18 years old female said "It makes me more conscious of trying to be safe and trying to be prepared. But it doesn't stop me doing things...It makes me apprehensive about going out for meals and doing the odd thing, but it doesn't stop me doing what I want to do." [MRVLD10] cited in [LS11](p.241)

A different study in United Sated pointed out similar facts, Sampson et al. [SMFS06] mentioned that adolescents living with food allergies had less concern with dating than their health condition, and in a life-threatening case they were "cautious, alert, limited, frustrated, vulnerable, and responsible".

Food allergies can influence the school attendance of the child, a study in the Netherlands concluded that compared to healthy controls those with food allergies have a higher school absence, maybe because of the greater health condition burden [CRB+02] [CRB+06]. Other study showed that exists an increase in bullying in children living with allergies, like having their allergen-free food deliberately contaminated [FKW17].

Research showed that elevated anxiety, stress, or social isolation could be the result of having food allergies [AAMC+16].

Eating out is a tremendous problem for people with food allergies. For example, a lot of food-induced anaphylaxis happen outside home. Bock et al. [BMFS07] concluded that 20 out of 31 people underwent a reaction away from the home environment, places like restaurants, school,

work and friends' houses [BMFS07]. Another study in the United Kingdom had similar conclusions, and most fatalities were outside of the home like at work, school or nursery, restaurants and at camp [PG07]. There are many cases where a food allergic reaction occurs in a restaurant, for instance, in Britain, 14% of people with food allergies had reactions in restaurants [ULP+05]. These reactions usually result from cross-contamination or surprising ingredients [FDS01]. A study in the United Kingdom showed that a lot of anaphylactic reactions occur outside people's home [Pum04]. Only in restaurants occurred 25% of this reactions. When it comes to an allergic reaction in restaurants, in most cases people thought the food they were eating was safe [SMR92]. A more recent study showed that, even though managers and staff have sufficient knowledge about the problem, they were concerned about in a case of an emergency their ability to handle this situation might not be the best. They also incorrectly believed that people with food allergies could harmlessly eat a small amount of the food they are allergic to [RBH+16].

2.1.5 Impact on the caregiver

Food allergies can produce a notable impact on the quality of life of people who care for people with food allergies. Simple tasks are affected, for example, grocery shopping can become time-consuming. Providing safe and nutritious food can be challenging since children may need a strict diet. Also planning social events such as partying or eating out can be very stressful because there is a constant fear that an allergic reaction will occur [BDM+06].

Bollinger et al. [BDM+06] showed how food allergies have an impact on nearly all aspects of daily life. Approximately 70% of families reported a significant impact on family meals preparations, on social activities outside home the effect is also substantial, like birthday parties, sleepovers and field trips. The impact increase when the caregiver is not present. These families also avoid simple activities that most families take for granted, like going to restaurants. For many parents, it's challenging to separate from their child [BDM+06].

Others studies had similar conclusions, Cohen et al. [CNMFS04] expressed that mealtime preparation, emotional aspects, and social life are affected by food allergies. Springston et al. [SSS+10b] used the Food Allergy Quality of Life-Parental Burden to investigate the impact of food allergy on caregiver quality of life, and concluded that social limitations, in the caregiver perspective, is what worries them most.

Sometimes, the primary responsibility for the child's food allergy relies upon mothers. This responsibility can create tension within the family due to the lack of cooperation which can result in severe damage relationships [MCGH05].

When the food allergy is severe, parental overprotection can continue beyond childhood. For instance, young adults who experienced anaphylaxis feel their parents more overprotective than young adults who never underwent this type of reaction [HD08].

The most significant frustrations for the caregivers involve a lack of public knowledge, an unwillingness of others to help and support, irregular medical information and mislabeling of products [MCGH05]. The caregivers emphasized the frustrations caused by hostility from others, mainly from school personnel and family [MCGH05]. More than 30% of caregivers, to discuss

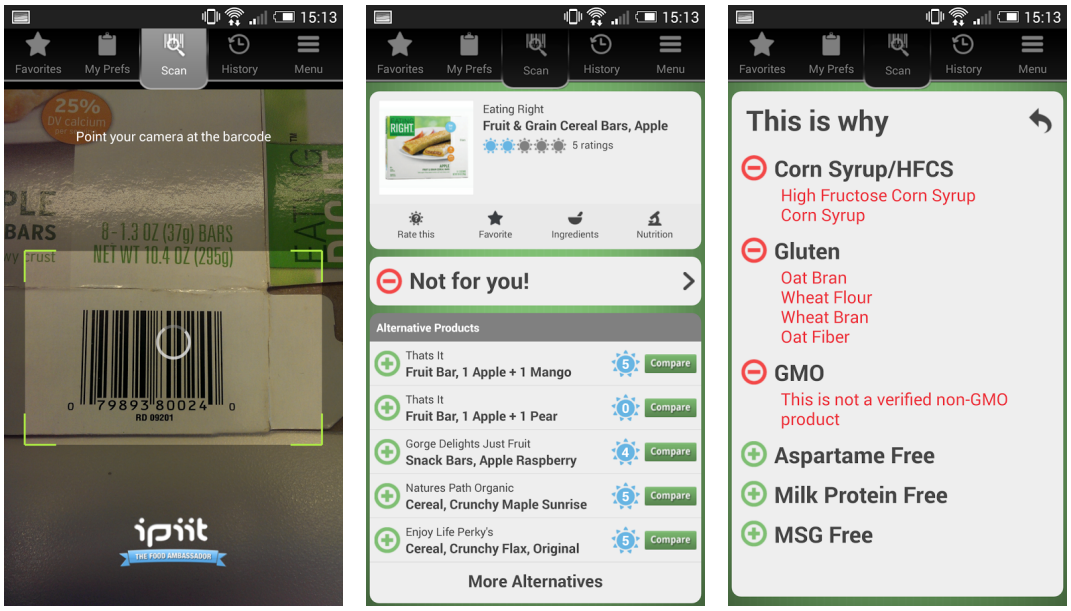
with school personnel in charge of the possible problems involving their child's allergy, do more than one visit per month to school. [SNMF01]. The responsibility and hypervigilance deposited on the caregiver are related to a decreased in their quality of life since triggers stress, worry distress and anxiety [SNMF01].

2.2 Technology for people with food allergies

The problems and impacts analyzed previously allow us to conclude that living with food allergies is a challenge in which most of the basic decisions made on a daily basis are affected, but fortunately, there are technologies designed to help the daily lives of people living with food allergies. After an in-depth study on them, a categorization of these technologies was performed. In the end, the table 2.3 aims to summarise the analysis to provide an overview of existing technologies.

2.2.1 Tools that allow people with food allergies to avoid buying food that contains allergens

There are a set of tools that allow people with food allergies to avoid buying food that contains allergens at groceries. These technologies enable the user to scan the food barcode and know its ingredients. Analyzing and comparing this information with the user's allergies is possible to conclude if the analyzed food contains food allergens. An example of these technologies is the **ipiit** application that allows the barcode scan and also suggests similar products that still fits in the user profile [ipia]. There are other similar applications like **Spoon Guru** [Gur] and a more specific one dedicated to gluten allergic people the **Gluten Free Scanner** developed by Scan Gluten Free [Fre].



(a) Scanner (b) Result (c) Why

Figure 2.2: ipiit application views [ipib].

2.2.2 Tools that allow people with food allergies to testing food

There is a set of high-tech tools that gives the possibility to test the food. The user needs to use a sample of food to know their ingredients. These tools can be divided into the following techniques: chemistry and near-infrared spectroscopy [Gri16].

2.2.2.1 Harnessing Chemistry

One of the techniques consists in mixing some food samples with antibodies. There are some devices based on the antibodies technologies, like **Nima** [Nima] and **Allergy Amulet** [Amu]. To use **Nima** the user inserts a small food portion in the Nima test capsule, put the test capsule in the sensor, press start and wait a few minutes for the result. [Gri16] The **Allergy Ammulet** works similarly.

These tools have a negative point because if a person is allergic to different foods is required a different device for each food allergen.

(a) Food sample [Nimb].

(b) Test [Nimc].

(c) Learn [Nimd].

Figure 2.3: The three steps to test the Nima.

The other chemistry technique consists in detect allergens using colorimetric assay, based on this article [Atla] this technique "works by chemically coloring the allergens in a solution and then measuring them by the concentration of the color.". An example of this technique is the **iTube**, developed by a team led by Aydogan Ozcan. It needs to be attached to a smartphone to detect the allergen [Atla]. To start the process of allergen analysis, "a sample is ground up by the user and mixed with hot water and an extraction solvent in a test tube. After this is allowed to settle for several minutes the sample is mixed with a series of chemical reagents. The prepared sample and a control tube are then placed in the device, lit by LEDs and measured optically using the phone's camera and an app that compares the sample and control to measure allergen concentrations." [Atla]. The test results can be seen in the application.

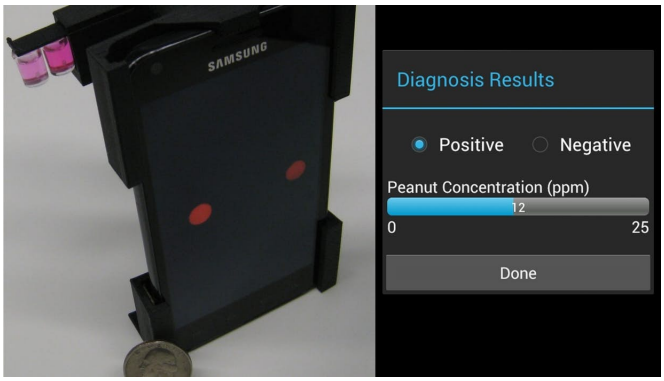
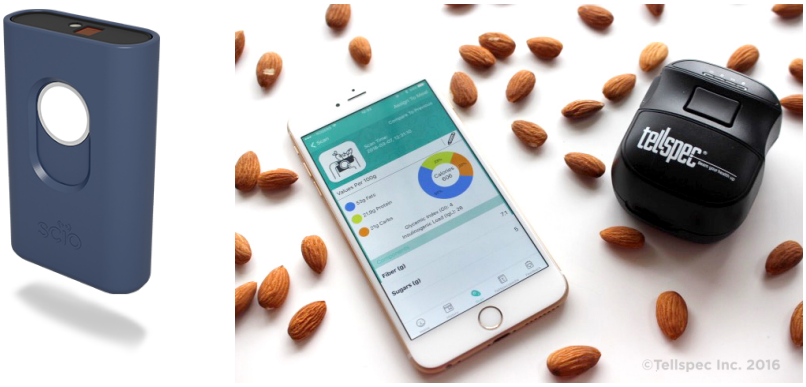


Figure 2.4: iTube Device [Atlb].

2.2.2.2 Near-infrared Spectroscopy

The other technique for testing food is the near-infrared spectroscopy, which is a light-based technique to analyze and identify materials based on reflected wavelengths, to quickly scan food [Gri16] even though it's not so accurate like iTube. Two devices use spectroscopy: the **SCiO**, developed by Consumer Physics [Phya], at first it was not designed to target people with food allergies, but due to its functionalities can be used by them, like identifying different types of oils and milk. [Gri16]. And the **Tellspec** [Tela], this system consists of a wireless scanner that communicates with a cloud engine to analyze the food spectrum. The result is displayed in the application. [Gri16]



(a) SCiO device [Phyb]. (b) Tellspec device [Telb].

Figure 2.5: Near-infrared Spectroscopy Devices

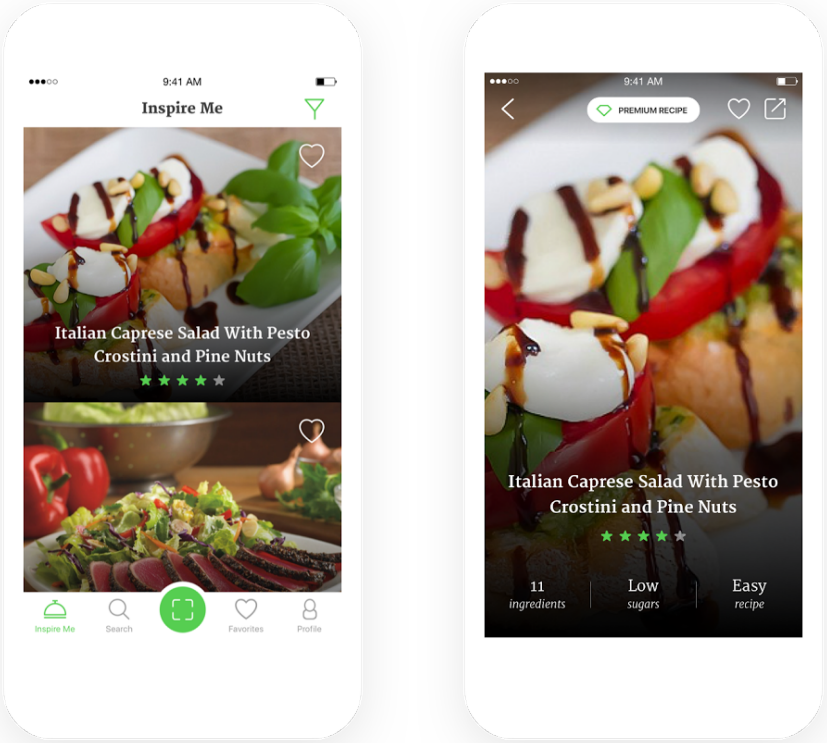
2.2.3 Medicine Reminders

To support people living with allergies who have been prescribed their life-saving emergency medication for anaphylaxis, some platforms can be used to remind them to renew the prescription. The **EpiClub** is the leading example, with EpiClub is possible to enable quick and easy expiry reminders. EpiClub has different options to remind the user to renew the prescription before the

expiration date, by SMS or email. It also has information about food allergies such as anaphylaxis problems [Epi].

2.2.4 Recipes Recommendations

People with food allergies have many food restrictions and sometimes becomes difficult to diversify their meals. Thus, to increase the creativity, variety, and dynamism of their meals, recipe recommendation systems have been developed. **Receitas sem Alergias** [Pla] was created to help increase the number of recipes options. This platform returns a varied set of recipes that do not contain allergens that have been previously selected. The **Spoon Guru** [Gur] application, in addition to scanning barcodes, also allows the search for recipes that satisfy the user's profile. It has an excellent design and is simple to use.



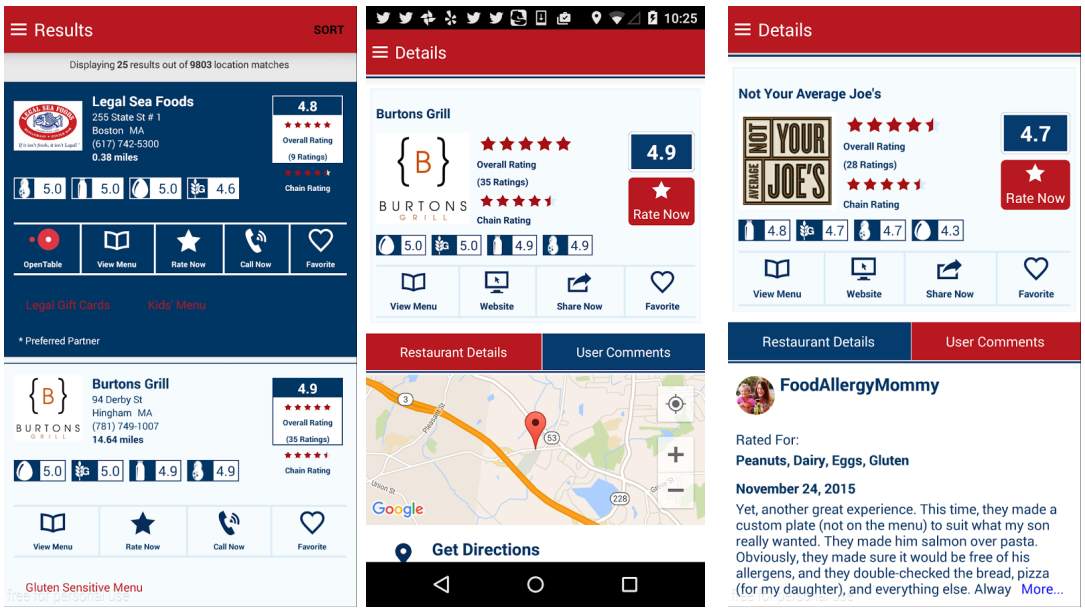
(a) Recipes search. (b) Recipe result.

Figure 2.6: Recommendation Recipe Example of Spoon Guru App [Pla].

2.2.5 Restaurants Recommendations Platforms

The main purpose of this dissertation is to study the problem that people with food allergies have when having a meal, especially outside home and design and evaluate a possible solution to this problem. Some platforms try to address this problem, such as **AllergyEats** [Allb], where the goal is to increase the number of restaurant options that people with food allergies have. This

application was one of the earliest to tackle this problem, and it has support for the US market and Disney in France. There are other applications like **Nima App** [NL] that allows people to discover thousands of Nima-tested restaurants across the United States and **Find me gluten free** [GFC] that allows people to find gluten friendly restaurants. Unfortunately, both of them only target gluten allergic people. Lastly, there a prototype in development called **AllergyBot**, which is a chatbot that "aims to assist young adults with food allergies to find information about restaurants' accommodation" [HZL+17].



(a) Search Results (b) Restaurant information (c) Restaurant Reviews

Figure 2.7: AllergyEats application views [Alla].

2.3 Summary

Food allergy is a health condition that has a massive impact on our society, affecting both the patient and their caregiver as seen in the sections 2.1.4 2.1.5. Their quality of life is significantly affected, but fortunately, a large number of solutions that make it easier for people living with food allergies are presented in the previous section 2.2. It's evident that people confront different difficulties daily, tasks and decisions that for other people are simple and basic for food allergic people are a dilemma, for instance, go to lunch or dinner outside is difficult as seen in section 2.1.4. Technologies allow to improve and work around these obstacles.

The focus of the study of this dissertation is, clarify the difficulty that these people feel about going to lunch or dinner out and design a solution to this problem with the end-users. In section 2.2.5 it's possible to see that there are already some solutions that want to fill this problem: Find me gluten free, AllergyEats, AllergyBot. But these solutions have some cons, for example, Find me gluten free is only for people with allergies to gluten, as for AllergyEats and AllergyBot their reviews are not as detailed as they should be. The reviews in a system like this are crucial to

making a decision, and both the AllergyEats and the AllergyBot do not have as detailed and detailed reviews as they should be. That is, the level of allergy that a person has to an allergen varies from person to person, and the reviews of these systems do not allow the perception of how allergic a person is to a portion of food. Having this information is vital because, as said in previous sections there is a risk of cross-contamination. Also, the staff and the restaurants don't have all the conditions needed to receive people with food allergies.

In conclusion, there is a vast set of technologies aimed at improving the quality of life of people with food allergies. As it is displayed at Table 2.3 there are excellent solutions to enhance the quality of life of people living with food allergies, such as technologies to help with groceries shopping by scanning the product's barcode, like ipiit application, devices to test food to help to avoid the allergen like Nima which allows the person to perform tests to gluten or peanuts, and medicine reminders like EpiClub to notify the user about the medicine prescription, recipes recommendations system to help people with food allergies to have a diverse and different diet like Receitas sem Alergias, and restaurants recommendations Platforms to support the dining out problem faced by people with food allergies. All of the solution work on mobile, and only two of them, EpiClub and AllergyEats, on Desktop.

Technologies	Medicine Reminders by SMS or email	Scan Food	Test Food	Restaurant Recommendation	Recipes Recommendation	Food allergies Information	Mobile	Desktop	Free
ipiit		X				X	X		X
The Gluten Free Scanner		X				X	X		X
Spoon Guru		X			X		X		X
Nima			X				X		
Allergy Amulet			X				X		
iTube			X				X		
SCiO			X				X		
TellSpec			X				X		
Receitas sem Alergias					X		X		X
EpiClub	X					X	X	X	X
Find me gluten free				X			X		X
AllergyEats				X			X	X	X
AllergyBot				X			X		

Table 2.3: Technologies Resume

Chapter 3

Methodology

The goal of this chapter is to illustrate the methodology to be followed in order to get a solution to the problem previous explained. This chapter starts with a brief introduction to HCI (Human-Computer Interaction) and then describes the HCI methodology chosen to perform the project, participatory design. This chapter also includes a literature review.

3.1 Introduction to HCI

Nowadays technology plays a vital role in our society. It's present in different areas, like education, work, leisure activities, health. ACM defines Human-Computer Interaction as "concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" [HBC+92].

It's essential to understand how humans interact with technology to develop and design useful systems. If a system is hard to use, then the system can be considered as worthless. In HCI, it's imperative to consider two concepts: functionality and usability. The functionality of a system is defined by "the set of actions or services that it provides to its users" [SSS10a](p.2). However, functionality only provides value to a user if he or she can efficiently use the system. The usability of the system can be defined, then, as a measure of how adequately the goals of the user are accomplished through the system's functionality [SSS10a].

HCI field tries to improve the interactions between users and technology in order to accomplish the user's needs, HCI is concerned with and I'll cite [SSS10a]:

1. Methodologies and processes for designing interfaces.
2. Methods for implementing interfaces.
3. Techniques for evaluating and comparing interfaces.
4. Developing new interfaces and interaction techniques.

5. Developing descriptive and predictive models and theories of interaction.

3.2 HCI Methodologies

There is a diverse number of methodologies in HCI, but looking at the scope of this project the Participatory Design (PD) methodology stands out in order to develop a solution that targets the needs and challenges of end-users. In section 3.2.1 I'll explain why.

3.2.1 Participatory Design

The participatory Design methodology is an approach that attempts to develop solutions and technologies with close and active involvement of the end-users and stakeholders through all the phases and cycles: requirements collection and specification, prototype development, implementation, and evaluation [SSL+08]. PD can be seen as an effort to involve and understand better real users, and as necessary and vital in producing more suitable, and user-friendly products or services [LDT+05]. Capture the user feedback at every stage of the process is crucial, PD attempts to build more appropriate and user-friendly products by understanding and involve the user in all stages [LDT+05]. Every individual is significant since everyone has something to offer and to in the design process. With the appropriate tools, they can express their creativity to produce and generate new ideas [San03].

The PD methodology will be used to develop a solution for the research problem because it increases the probability to design a technology that satisfies the user's needs. In order to obtain better-finalized design solutions, the inclusion of users through all stages is a key [WDA14]. This user involvement potentiates a better requirements gathering and improves the exploration of user needs [WDA14]. "A thorough understanding of user capabilities, often only available by direct user involvement in the participatory design process, is paramount." [WDA14] (p.626).

In his study, Wilkinson et al. [WDA14], showed that involve the users at early stages improves the creation of new ideas because they are often acutely aware of problems with existing technologies [WDA14]. Also, one of the significant insights gained in his study by applying the PD approach was the psychological influence of the design has upon user self-esteem [WDA14]. Wilkinson concluded that "Users will not adopt, enjoy, or potentially buy, products that stigmatise them and emphasise their disability, but they are capable and qualified to suggest ways in which such stigmatising effects might be minimised. This in turn, can increase a products commercial potential as well as increase product use, uptake and adoption." [WDA14](p.629).

The PD approach also helps to get a more accurate picture of user requirements and the continuous feedback and opinions about the prototypical design solutions to improve the result of the end design, thus, in the end, the technology will be more practical, understandable, convenient, and natural, to a broader market [WDA14]. Even though some studies showed that there is a risk that users may become technology advocates instead users representatives, they are willing to share ideas and solution and sometimes they can be more innovative than business innovators [MSE04] [MMK03].

"We are no longer simply designing products for users. We are designing for the future experiences of people, communities, and cultures who now are connected and informed in ways that were unimaginable even 10 years ago." [SS08](p.10).

"The following model model is not dissimilar to the International Standard for Human-Centred Design of Interactive Systems (ISO 9241-210:2010) [Par], but is arguably more modest and emphasizes the way in which the participatory design group can and, ideally, should be involved throughout every stage of the design process" [WDA14](p.618).

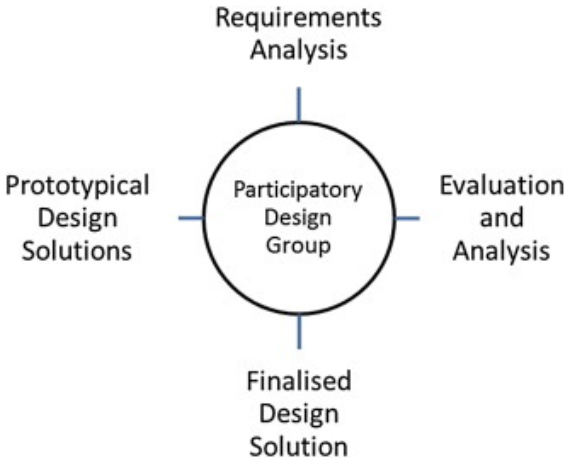


Figure 3.1: Participatory Design Phases [WDA14]

For each phase of the Participatory Design methodology, there are several techniques that can be applied to achieve the goals of the project.

3.2.1.1 Requirements Analysis

The first phase of PD is the Requirements Analysis, in the phase elicitation requirements is applied. "Requirements elicitation is all about learning and understanding the needs of users...with the ultimate aim of communicating these needs to the system developers" [ZC05]. In order to develop the system, the elicitation of requirements is crucial to get a better picture of how its design should be [ZC05].

Data collection

This study used the in-depth interviews method to guide all the investigation and collect data about the daily challenges and practices of food allergic people. (see Table 3.1). This technique allows us to establish the first contact with the users and initiate their involvement in the project. Also, in-depth interviews allow us an approximation with the user that makes possible to get more detailed information, to gather particular data about the research problem. It provides an effective way to collect vast quantities of data quickly [ZC05], with the right questions new ideas appear.

Data sources	Number	Context
In-depth interviews	25	- 19 exploratory interviews - 6 interactive interviews - Audio-recordings: 15 hours and 17 minutes

Table 3.1: Overview of data collection method

In-depth Interviews

A popular method used in qualitative research to collect data is in-depth interviews [LKW03]. In-depth interviews require conducting intensive individual interviews to investigate their perspectives and viewpoints on a particular subject, area, idea, program or situation [BN06]. This type of interviews are advantageous when is intended to get detailed and complete information regarding person's beliefs, ideas, and behaviors or to examine and investigate new subjects or problems in depth [BN06]. Interviews provide meaning to other data, allowing a complete picture of the research problem [BN06]. Compared to other data collection methods such as surveys, in-depth interviews give much more detailed and comprehensive information [BN06]. They also provide a more comfortable atmosphere since people may feel more relaxed having a conversation with a person instead of filling out a survey [BN06]. During interviews, we can discover about culture, values, about the challenges people face in their lives and people's inner experiences [Wei94]. By interviewing we can learn about themes that otherwise would be unachievable [Wei94]. Interviewing rescues information, practices, and challenges that would otherwise be lost [Wei94]. In-depth interviews are a time-intensive evaluation exercise because it demands time to get the participants to conduct interviews, to transcribe them, to analyze the results and it also depends on participants available time [BN06]. To gain an in-depth understanding of people lives, problems, challenges and practices is mandatory to have an active interpretation of practices and meanings that are often taken for granted.

The participants were recruited in two ways. The first contact with them occurred through the Portuguese Association of Celiac branch at Porto. After explaining clearly the goal and purpose of the work, several connections were established. Four people showed interest in participating, and so we exchange contacts to, later on, get in touch. Then to increase the number of participants I sent an email throughout the Faculty of Engineering of the University of Porto, explaining the project goals and trying to engage the people to help me with this work. With this email, I got some answers, and fortunately, enough people were willing to help and actively participate in all different stages of the work. Here were recruited Integrate Masters students and Ph.D. students. They had more time to be part of the project compared to the people recruited at Portuguese Association of Celiac at Porto store opening. In the end, nineteen participants were recruited, one person from the Portuguese Association of Celiac branch at Porto since the others couldn't help and eighteen from the email. The age range of participants varies from 20 to 69 years old. They had diverse backgrounds and similar levels of education.

Most interviews were conducted at Fraunhofer AICOS meeting rooms, while others were conducted online using Google Hangouts[1] because some participants were not available to attend in person. Doing the interviews at Fraunhofer AICOS meeting rooms brought a lot of advantages. I was able to talk with the participants in a cozy and comfortable place. This environment allows me to create a connection with them and quickly acquired their trust which results in extraordinarily open talks about food allergy problem.

The interviews were conducted in two phases: Exploratory interviews and Interactive interviews. These are described below. Twenty-five participants were interviewed, nineteen on the exploratory phase and six on the interactive phase.

Phase 1: Exploratory interviews

The first phase of interviews was exploratory. I used an interview guide (see appendix A), but the conversations were open to potential themes that the participants might want to talk. The interview guide approach topics like food allergy treatments, diagnosis, how living with this problem is, challenges, difficulties, practices, and how they use technology because of the allergy. Even though I had a guide, I always tried not to focus the conversation on the topics of the script. More sensitive topics were left to the end of the interview to increase empathy and trust and usually, I turned off the tape recorder at this time. Notes of the topics were taken later on my notebook. Participants were interviewed alone and in total 19 interviews were held. The Table 3.2 contains information about each participant.

The interviews were recorded with my smartphone. All the interviews were focused on the participant and rarely took notes since these would be transcribed. Notes were taken in specific cases, like themes that I wanted to explore later. The Interviews were transcribed verbatim and coded for themes by myself using a thematic analysis methodology, explained later in the section 3.2.1.1.

[1] Google Hangouts is an online platform developed by Google to communicate with other people, includes messaging, video chat [Wikb].

Participant	Age	Sex	Food Allergy or Intolerance
IP1	69	M	Celiac
IP2	22	M	Lactose and caffeine Intolerant
IP3	31	F	Lettuce, cabbage and wheat flour
IP4	23	M	Nuts
IP5	27	M	Gluten and milk protein intolerant
IP6	23	M	Lactose and chocolate intolerant
IP7	22	F	Lactose intolerant
IP8	21	F	Lactose intolerant
IP9	22	M	Eggs
IP10	33	F	Chocolate, strawberry, beans, peas, canned
IP11	26	F	Lactose intolerant and sea food
IP12	35	M	Lactose and gluten intolerant
IP13	22	F	Celiac
IP14	20	M	Some types of fish, was lactose intolerant and egg allergic
IP15	25	F	Lactose intolerant, nuts, fruits with stone, intolerance induced by physical exercise to farinaceous
IP16	22	M	Lactose intolerant and shellfish allergic
IP17	22	M	Fat fish like salmon
IP18	23	F	Lactose intolerant
IP19	27	M	All kinds of sea food, except fish

Table 3.2: People involved in exploratory interviews (IP1 stands for participant 1)

Phase 2: Interactive Interviews

The second phase of interviews was interactive. The goal was to inspire discussions about the information that should be presented on the restaurant recommendation platform. I tried to engage the participant and let them imagine possible details and features that the system should have to allows the users to find a restaurant to eat. I brought information from the first analysis and previous quotes. Afterward, scenarios were created like "if you search for a restaurant what information do you need to see?", "what are the things you need to see on a review to make it a valuable and significant review?".

In these interviews, the level of interaction was much higher, which resulted in constant exchanges of ideas with the participants. Participants were interviewed alone and in total 6 interviews were held. The Table 3.3 contains information about each participant.

The interviews were recorded with my smartphone. In these interviews, I took more notes compared to the first phase. The Interviews were transcribed and coded for themes using a thematic analysis methodology, explained later in the section 3.2.1.1.

Participant	Age	Sex	Food Allergy or Intolerance
IP20	23	M	Lactose and chocolate intolerant
IP21	23	M	Nuts
IP22	27	M	All kinds of sea food, except fish
IP23	22	M	Eggs
IP24	22	M	Lactose intolerant and shellfish allergic
IP25	27	M	Gluten and milk protein intolerant

Table 3.3: People involved in interactive interviews (IP20 stands for participant 20)

Thematic Analysis

During the interviews, the researcher should always be alert to potential new ideas that can come across. These ideas are different from participant to participant, and so the interviews performed will not be equal. Therefore, the collected data will be different and not structured. Towards this problem, the thematic analysis method will be used as an advanced method to analyze qualitative data.

The thematic analysis allows the researcher to identify, analyze, and report patterns or themes within data. The dataset is organized and detailed in a meticulous way [Boy98].

The thematic analysis comes with useful advantages, like flexibility and is a valuable method to work with participatory research methodology because it can highlight similarities and variations across the data set and that's why it will be applied in this study [BC06].

Based on [BC06], in order to apply the thematic analysis six phases are needed:

- Phase 1 - Becoming Familiar with the data: This is the initial phase, is when the researcher begins to become familiar with the data. Reading and re-reading the data is crucial at this stage, starting to analyze the data actively helps to find meanings and patterns. Taking notes is key to developing possible codes. It's imperative to start transcribing the data at the phase. [BC06].

- Phase 2 - Generating initial codes: The second phase of thematic analysis starts by looking for recurring patterns and generate an initial list of items based on them. The production of the initial codes from the data starts in this phase. Codes can be seen as an interesting piece of data to be analyzed [BC06]. Coding for people practices helps to get meaningful and rich codes. To organize and have meaningful data is necessary to do something called coding [Tuc05]. At this phase, we should coding for the maximum number of themes.

- Phase 3 - Searching for themes: At this phase, it's important to start looking for codes and try to understand how they can be combined to reach themes in the data and also think about the relationships between codes and between themes. To [BC06](p.10) a theme "captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set." In the end, we should have a

collection of possible themes, and sub-themes, and all the codes related to them [BC06]. In the phase, I used mind-maps (see appendix B) to help me organize the first themes that have arisen.

- Phase 4 - Reviewing themes: At this stage, a refinement of the themes collected in step 3 needs to be done. An analysis should be made to understand if there are themes that collapse with each other or if there are themes that are not a theme. This phase can be divided into two levels: level one consists of reviewing all the grouped data for each theme and analyzing whether it forms a consistent pattern. If we form a coherent pattern, we are ready to move to level two; otherwise, it is necessary to consider the theme itself, or perhaps the data is not in the right place [BC06]. Level two is similar to level one, but all revision and refinement are applied to all datasets. In the end, we should know what the different topics are and how they are connected and the overall narrative expressed by them about the data [BC06].

- Phase 5 - Defining and naming themes: At this stage, is when we define and refine the themes that will be presented for analysis, is when we analyzed the data within them. Which means "identifying the "essence" of each theme and determining what aspect of data each theme captures." [BC06](p.22). It's necessary to understand the story of each theme and how it fits into the overall story of the data. It is necessary to identify which themes are important and why. In the end, it is imperative to identify and define the themes clearly [BC06].

- Phase 6 - Producing the report: This is the final phase when the thematic analysis is written to convince the reader of the quality and validity of our study. This analysis should be compact, consistent, logical, exciting and provide enough evidence of the themes within the data [BC06]. It's beneficial to read some papers that applied thematic analysis to see how they wrote their story.

3.2.1.2 Prototypical Design Solution

After the requirements analysis is done, the prototypical design solution starts.

Prototypes will be made to provide support and a possible solution to the investigation. A benefit of using prototypes is that they inspire the users, to play an active role in producing the requirements [Grob].

In this project, it will be used low-fidelity prototypes since the project is in an embryonic stage. We want to test different ideas quickly to understand if the information is enough and displayed in a right way to help the user find their's goals, in this case, find a restaurant due to their allergy naturally and appealingly. Since the project is at an early stage and I'm focusing on usability and how the information is displayed high-fidelity prototype will not be used because take too long to build and change. A functional prototype can take weeks to create and doing is a time-consuming process as well [Ret94].

Low-fidelity prototyping allows the platform designer to investigate a vast quantity of ideas quickly at an early stage of the development and test the interface design with real users [Ret94].

Low-fidelity prototyping works because it focuses on the usability of the product and maximizes the number of possibilities that the designer has to improve design before coding. Adequate testing and evaluation should be developed to take all the advantages of low-fidelity prototyping [Ret94]. Even though low-fidelity prototypes do not look like the final product, this strategy will be used because it brings benefits to the development team and the users. In a technical point of view, this technique carries the possibility to explore different ideas and designs really quickly, in the user view low-fidelity prototypes put less pressure on them, because of the fact they understand that the prototype isn't finished and the changes can be made really quickly encourage the user to give feedback about the functionalities [Grob].

The technique selected to develop low-fidelity prototypes was clickable wireframes. "A Wireframe is a visual representation of a product page that the designer can use to arrange page elements" [Blo]. They are simple, and by creating linking wireframes, it's possible to have an interactive prototype [Blo]. With clickable wireframes, existing design deliverables can be reused, and layouts can be easily and quickly changed [Blo]. The main advantage of clickable wireframes towards paper prototypes is the fact of not require an external person to act as a facilitator throughout the testing session [Blo].

To develop the clickable wireframes the tool Quant-UX [Qu] was used. This tool is appropriate to transform ideas into prototypes quickly functional. The prototypes behave like a real application since the user can navigate between screens and enter data[2]. To test with the user, I use my smartphone by merely scanning a QR-Code. This tool is also useful to analyze the usability tests because the user's path is recorded and I can extract that from charts, user journey, and heatmaps.

3.2.1.3 Evaluation and Analysis

This phase is related to Evaluation and Analysis and it will happen in parallel with the prototype design solution.

"When you focus on the user and not the product, you learn what works for the users, as well as what doesn't work, what pleases, what puzzles and what frustrates them." [Bar10](pag.10). Understanding the users' experience allows me to conclude whether the design meets their expectations and goals or not [Bar10]. The usability testing technique was used to perform the prototype evaluation because it is an effective way to learn what works and what doesn't work in the prototype [Groa] and is designed to identify if an interface promotes the ability to a user to perform routine tasks. International Organization of Standardization (9241-11) define usability as "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [ISO]. Effectiveness and efficiency are related to the accuracy and speed that the user completes a certain goal [Bar10]. Satisfaction is related to if the user is satisfied with the information presented and the way how it

[2]The Quant-UX tool allowed me to perform the Wizard of Oz technique on the usability tests. Wizard of Oz is a research exercise in which a human simulate the response of the system when the subject interacts with the system [HM12], but instead of having the researcher simulate the system response these responses were programmed on Quant-UX. The responses programmed in prototype replicate a real platform usage environment.

is displayed if the design is appealing and the overall experience was good [Bar10]. In the participatory design approach, the users are involved in all stages, and the usability testing gives us the possibility to get direct information and feedback on how the end-users use the system [Nie94]. The usability tests will help me measure if the prototype meets its purpose. To create usable and inclusive products, it's crucial to consider individuals' prior background, the circumstances of use and environment of interaction when performing usability evaluations [Nie94]. Without any doubt, the product has to perform the functionality for the intended use but is essential that is presented and displayed in a way so that the user can easily understand and use it [WS02].

I performed 8 usability tests with the participants from the interviews phase. All the tests were recorded using a video camera to record both, audio and image. Since I made a deep qualitative analysis to understand the problems, challenges, practices that they face every day I've done only 1 iteration on the usability tests. Therefore, the usability test was summative, where the goal was to test if they can perform a task for the primary purpose of the platform, find a restaurant that can serve a non-allergic meal, and to see if the prototype contains the information needed and if it is displayed correctly. I try to test more the satisfaction of the user, even though the effectiveness and efficiency were tested since the prototype was developed on Quant-UX, so it has functionality and allows navigation between pages. This deep analysis, brought us quite a few positive points for the usability test as users confessed that the information it contained was perfect and sufficient for them to choose a restaurant safely. The Table 3.4 shows information about each participant.

Participant	Age	Sex	Food Allergy or Intolerance	Computer or Mobile Experience
IP1	22	M	Lactose intolerant and shellfish allergic	Yes
IP2	27	M	Gluten and milk protein intolerant	Yes
IP3	22	F	Lactose Intolerant	Yes
IP4	22	M	Eggs	Yes
IP5	33	F	Lactose intolerant and shellfish allergic	Yes
IP6	20	M	Some types of fish, was lactose intolerant and egg allergic	Yes
IP7	23	M	Lactose and chocolate intolerant	Yes
IP8	27	M	All kinds of sea food, except fish	Yes

Table 3.4: People involved in usability testing (IP1 stands for participant 1)

In order to perform the usability testing I used two moderating techniques: Concurrent Think Aloud and Retrospective Probing. Concurrent think aloud is used to recognize and interpret participants' thoughts by having them think aloud when they perform the task and interact with the prototype [Usab], retrospective probing is used at the end of the section to ask questions about the participant's thoughts and actions [Usab]. It's necessary to take notes to approach the desired

topics at the end of the section [Usab]. To observe participants interacting with the prototype I use scenarios to involve and engage the user with the prototype. They should be used to provide some guides to the users so they can understand what they need to do, should be realistic but not to specific to promote liberty and flexibility to identify problems [eUCD]. Before start writing the scenarios I identified the most important things that the user should accomplish with the prototype:

- Find a restaurant that suits their allergies
  - Find restaurants nearby them (unplanned situations) and also in a specific place (planned cases like vacations, trips, travels), using filters to find the perfect one
  - Analyze the restaurant information
  - Contact the restaurant to clarify doubts about recipes or practices to avoid cross-contamination
  - Find the path to the chosen restaurant
- Help others achieve the previous goal by doing a review
  - A profile is require to do a review

The scenarios were developed to cover all this thing. In appendix C is possible to observe the 8 scenarios performed by the participants. The scenarios provide context and replicate real situation to engage the user.

3.3 Summary

This chapter described the methodology followed in this thesis. I've pointed out the methods and techniques approached in different phases of the participatory design, like data collection methods used, thematic analysis, prototyping and methods used to perform the usability testing 3.2.

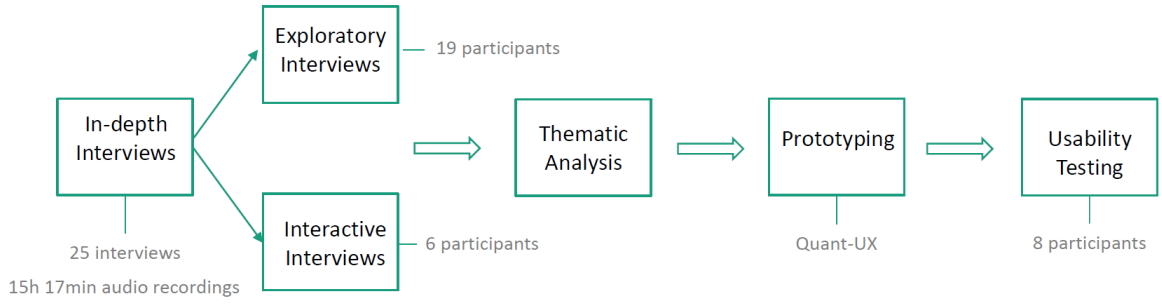


Figure 3.2: Different phases performed during the participatory design methodology.

Chapter 4

In-depth Interviews Analysis

The following chapter describes the practices and challenges of people with food allergies. The developed work results from the in-depth interviews analysis using thematic analysis methodology.

4.1 Findings: In-depth Interviews Analysis

To illustrate how people face and self-manage food allergies in daily life, I focus on four central themes from my in-depth analysis: Firstly, how people with food allergies live with this health condition, secondly, why dining out is a problematic task, thirdly, how they avoid the tremendous challenge of cross-contamination and fourthly, how individuals with food allergies find allergy-friendly restaurants.

4.1.1 Learn to live with food allergy

Learning to live with the food allergy is crucial to have a healthy daily life avoiding an allergic reaction. Avoiding meals that contain their specific allergy is challenging and difficult to accomplish, a rigid diet can help, but this can be difficult to perform especially for people with more than one food allergies. Even with a strict diet can be pretty hard because avoiding the allergen can be difficult, like IP12 pointed out he's exposed to allergens in a lot of places and on top of that stop eating what they like is difficult, like most of them mentioned. It may take some time for them to become aware that they cannot eat certain things. Looking for substitutes for foods with allergens is not always easy because although the variety has increased compared to previous years there is still little offer and frequently the prices are higher as some participants pointed out.

IP16:*" Sometimes I went with my parents to the seafood, and they ate seafood rice, and I ate meat. And I love meat, but I could see that seafood looks delicious but could not eat. What bothers me is: I sometimes want to eat and I can not, it annoys me a little."*

The majority of participants confessed that they are cautious with everything. For instance, IP15 mentioned that even a kiss in the mouth could be sufficient to trigger a reaction if the other person ate something with the allergen. They have to pay attention to everything they eat. Reading labels became a part of their daily lives ever since diagnosis. By paying attention to food labels, they started to understand that the allergen is present in everything, in food that never crossed their minds. A considerable problem as pointed out by IP15, IP18, and IP19 is the fact that a lot of products say "may contain traces of the allergen" and they cannot consume these. According to IP19, this problem may occur because different products are manufactured in the same place, and cross-contamination can happen.

IP15:*" When reading the labels, I began to notice that nuts are something prevalent in all products. If the label says "may contain" was enough to trigger a reaction. Even today everything that says "may contain" I do not touch it [eat it]."*

Living with this problem from a young age makes the process easier as some participants confessed. For instance, IP1 was diagnosed with 65 years old, and it has been tough for him to deal with. In contrast to this, IP15 has lived with her food allergy since childhood and feels it is easy to know what to do. Other allergies have appeared in adulthood, and for her, the adaptation was more straightforward because she already had experience with food allergies. Most of the participants' use trial and error to understand what they could eat. A curious fact mentioned by IP15 was the fact that she has two products lists made by her during this trial and errors tests: a list with products that she can consume and another list with products that she cannot eat. Having both lists enables her to know quickly what she still needs to test.

To get more information about his problem IP1 confessed that he goes to conferences where the celiac disease is discussed. In such events, he exchanges impressions with other patients and learns about research in the area.

Most of the people cannot take pills or enzymes to prevent a reaction when even knowing that they will ingest the allergen, but participants with lactose intolerance talked about enzyme they take which makes possible to ingest food that may contain the allergen without trigger a reaction; they use it in particular cases like the need to take an antibiotic which usually is coated with lactose or to eat something they love. IP15 pointed out that the enzyme has counterparts linked to sugar and that's why they only use it in specific and sporadic cases.

IP18:*" To take antibiotics is a terror." ... "The outside of the pill is coated with lactose, and I can not take any of those things. In one situation I had to take a medication that contained lactose, and I took it together with the enzyme to not trigger a reaction."*

The daily life of the people is significantly affected by an allergic reaction, that's why they are so cautious and careful about avoiding the allergen. Having an allergic reaction can result in

weight loss, to miss a working day, an even more strict diet, poor sleep, classes lost, and discomfort. IP10 confessed that in childhood she was very ashamed to go to school because she gained many scars due to the allergic reaction. When they are feeling the first symptoms, they take the medications right away, frequently antihistamines or in severe cases the EpiPen which contains adrenaline. Having the medication with them always is a must. The antihistamines usually give much sleepiness, and the EpiPen has a high price and validity of 1 year. For instance, based on [tre] one injection (0,3mg) costs €89. The IP15 confessed a traumatic situation that she had been through, once the EpiPen wasn't enough to stop the reaction, and she had to go to the hospital where she got intubated.

IP15:*" when the doctor came to see me, asked me to stand up, began to analyze, I began to feel very bad, and I fainted. It was very fast, I had to go to the emergency unit of the hospital of Braga, and they had me intubated, and I do not remember the rest."*

IP3, IP8, and IP18 pointed out that food allergic people must always be aware and watchful because doctors have already prescribed pills or creams that contained the allergen even knowing their allergic background.

IP18:*" The doctor passed me an antihistamine, I trusted him and when I got home and took the prescribed medicine. I did not go to see if it had lactose or not, after a while, I started to have an allergic reaction I went to see the label of the medicine, and it had lactose."*

4.1.2 Challenges of eating out

One of the most significant challenges for people living with food allergies is eating out. Eating indoors for them is easier because their home is where they can control what they eat and store, they have full control of the purchased food, and is their safe place. Nowadays there is an increase in the supply of products, the number of choices grew for them, but as a rule, products for people with food allergies are more expensive. Especially at home, they do not run the risk of cross-contamination because they already know what they should do to avoid it.

IP13: *" Eating it's boring mostly in restaurants because I can still eat at home with no problem...in my family when someone eats a toast I cannot eat toast as it is obvious but I also cannot use the same butter because there is a risk of cross-contamination."*

In family dinners, it's a problem because they do not want to have extra work or force the family to prepare something just for them and make other people stop eating what they like because of them. Most of all, they do not want to be judged by other people. IP18 pointed out that lately they already cook something for her, but it's very complicated because people do not always remember. IP8 mentioned that she missed anniversaries in her childhood and she's still afraid of

the possibility to be served contaminated food at a restaurant.

IP7: *" I feel a bit bad telling people that I have this problem and that I can not eat it, I do not know I don't want to give extra work...I do not want them to think that I'm picky or that it's a diet or mania of mine."*

The number of challenges and difficulties faced when they choose to dine out are plenty. The most challenging thing is the fact that the staff of the restaurant doesn't have the information, knowledge, and needed care concerning people with food allergies. Almost every single person interviewed has complained about this problem. IP7 said when she asks a question about ingredients to the staff they don't take it seriously. To her, they don't understand how bad or uncomfortable an allergic reaction can be, when IP13 says that she's celiac it is always something new to restaurant staff. Hence, due to the lack of information and training of the staff at restaurants, people with food allergies feel anxious when eating out as they face the risk of having an allergic reaction.

IP1:*" As much as I tell people that I'm allergic to gluten many of them ... I even went so far as to say, "Look, I'm celiac" and they asked me if this was a religion. So the lack of knowledge in many places about what it is a celiac patient is real."*

As a result of this lack of knowledge problem, individuals with food allergies started avoiding places that they would typically go before the food allergy diagnosis. For instance, IP1 confessed that in the past, he had lunch every Wednesdays with friends at a restaurant, and he had to stop going. The lack of care by the staff causes an inappropriate service, because even though the person specified what they could eat, sometimes the waiters bring a dish with the allergen. They don't understand the severity of the problem because the waiter get mad when they have to reorder. IP13 mentioned an example of this, she went to a branch in Lisbon, and she specifically asked: "Look I wanted the scrambled eggs, but I can not eat anything with flour, etc.". The waiter brought the eggs with bread. She had to reorder the meal because she cannot eat bread, and he was all upset and answered: "But just take the bread from above.". Here it was evident that the waiter didn't have any awareness or knowledge of cross-contamination. Some participants experienced an allergic reaction due to the lack of information and communication of the staff, for instance, IP15 once in the college canteen, the dish of the day were codfish balls, and she asked how the codfish balls were made, and they said it only contained potato and cod. She ate and soon she had an allergic reaction due to lactose and got worse and worse. She asked the staff again what ingredients contained in the codfish balls, this time they said it included milk also. IP15 had several difficult days due to the reaction because the serving staff did not know how the food was prepared.

Since cross-contamination is something complicated to avoid it turns out to be one of the main problems of food allergic reactions. At the slightest carelessness it's easy to cross-contaminate food with allergens. Cross-contamination occurs when the same utensil is used to cook different

meals, or when the same oil is used to prepare different things or when the restaurant has poor overall hygiene.

IP1: *" In a hotel well known here in Porto I asked for something simple to avoid a reaction, only a steak with dry rice ... the steak was grilled, it must have been made on the grill where they possibly made other steaks with certain sauces or with margarine and translated into a bad example, the steak had contamination. I've had more examples of this... and so I gave up."*

Another challenge faced by people with food allergies is the difficulty to detect the allergen because it can be hidden within others ingredients, in particularly in more refined restaurants due to their sauces.

IP9: *" In the midst of those flavors it is easy to disguise the little quantity of egg that enters there [the dish]."*

Due to the challenge of trying to detect the allergen people typically have to ask lots of questions since every restaurant has its own way to cook and even cooked the same dish different restaurants can use different ingredients in their confession. So a meal that generally doesn't contain the allergen could have it, which makes difficult the choice of a plate. Sometimes a modification of the dish is not possible, so they have to rely on simple things without sauces, for instance, IP19 order a "Francesinha"[1] and since "Francesinha" is a meat dish, he never thought about the possibility of the recipe to have something related to shellfish.

IP13: *" For example, they (restaurant staff) season things with beer and the beer is made from wheat, and I can not have it."*

Also, the restaurants' menu usually has little detail on their lists. Nowadays, some restaurants, but not the majority, have the allergens that a specific plate can contain. For instance, IP19 have only seen this list once. When the restaurant offers the list of allergens in the menu, people's confidence increases immediately since it suggests that the restaurant is informed about food allergies. Choosing what to eat becomes an easy task and also in new places makes a better customer experience. For instance, this allergen list on the menu helped IP9 a lot at a Chinese restaurant because he could see which dishes he could eat.

IP18: *" I went to a restaurant and came in the menu all kinds of allergies and even found it strange, unusual."*

[1] Francesinha is a typical dish originating in Porto, Portugal. It contains beef steak, sausage, fresh sausage, ham (a kind of ham) and cheese later melted. It is topped with the famous hot sauce based on tomato, black beer, and port wine [Nos].

Not knowing places to have an allergen-free meal is something that happens, IP3 confessed that it is difficult to find an affordable place to eat which has consideration for people with food allergies when they cook. As a rule, these restaurants have a higher price.

IP5: *" I do not know many places with options for a person not to starve to death."*

4.1.3 Everyday practices of avoiding cross-contamination in restaurants

Cross-contamination is a massive problem at restaurants that can lead to an unexpected food allergy reaction. To avoid this problem, people with food allergies rely upon some practices like adapting their meals. When IP1 needs to eat in a place that he doesn't trust he has two ways to handle this: eats previously at home or he packs his lunch and eats it at the restaurant.

IP1: *" for example, I go with my kids to lunch or dinner out I cannot have lunch or dinner ... I have to have lunch at home or take a lunch-box with me"*

Others waste a lot of time cooking their meals to the next day to avoid eating in restaurants, which sometimes becomes difficult as they spend a lot of time preparing their meals and don't have time to do other things. IP3 mentioned that she needs time to do other things instead of cooking every day, but if they do not prepare their meals they will starve because they don't know places to have a safe lunch. Sometimes it's challenging to cook because to them is difficult to have a diverse diet and not eat the same thing over and over again. IP15 mentioned that sometimes getting a substitute isn't an easy task because she quickly gets sick of always eating the same thing, in IP15 specific case this happened with oats.

IP15: *" Every day I cook, lunch and dinner which facilitates much in the part of the meals...I have to come with controlled meals every day, and if I do not bring it, I will go hungry."*

While eating out at a restaurant, people with food allergies have great care. First, they try to understand the restaurant concerns toward allergies by looking or asking, mostly if they are careful about the cross-contamination problem. Understanding the hygiene of the staff and the restaurant is crucial. IP3 pointed out if she cannot understand this, she changes to another restaurant. All this process is boring like IP19 confessed because they can not just enter into a restaurant and have a meal without worries.

IP3:*" There are several things that I need pay to understand about the restaurant: the hygiene, if the dish is clean or if the staff has clean hands...If I cannot understand this, I will not stay there."*

Every order made by them is carried out very carefully. Reading the menu is a must, IP4 and others pointed out if the restaurant provides a list they always take time to read it carefully. All this process is tedious because like IP6 said other people need to wait for them to decide what they

can eat. While reading the menu is mandatory, the frustration comes along right away since only a few options are compatible with their allergies.

IP5: *" When I ask if there's anything gluten-free or no milk, they never have...Imagine, I'm going somewhere that I don't know almost 100% sure that they will not have anything"*

IP15: *" What for anyone is standard, going to a cafe and eat anything: cake, croissant, a snack. For me it's unthinkable, I can have water and not much more.*

Another activity they engage in is asking the waiter if the dish contains the allergen. Many do this, and it's here that they feel of the lack of knowledge or information of the staff of the restaurant. IP11 confessed that when this happens, she feels there is a lack of information and knowledge she usually changes her order because she doesn't feel comfortable about the fact the waiter doesn't understand the allergy or cannot explain what the dish contains.

4.1.4 Everyday practices of finding a restaurant

To avoid an allergic reaction, people living with food allergies frequently go to places that are familiar to them, places that they have been before and where the overall experience was flawless. Many participants have this habit because, as IP7 said, they already know that the restaurant has options to people with food allergies or the menu of the restaurant is detailed enough to allow them avoiding the annoying part of questioning everything to have a safe meal. IP13, IP11, and IP18 confessed that if they know how the dishes are done and what ingredients the restaurant uses, and because of it, they return to the same restaurant over and over again. Like I said before in section 4.1.2 detecting the allergen is difficult, and one of the reasons it's the fact of each restaurant has its own way to cook. Knowing the restaurant and the ingredients used allows them to avoid many questions. IP13 gave a perfect example of this, for instance, one thing that bothers her a lot are the Knorr broths, they have gluten, and often people when doing rice, which does not contain gluten, use Knorr broths which contains gluten. To clear some doubts, they pointed out that sometimes they call the restaurant before going. People with food allergies might feel embarrassed or anxious to ask about the menu. They tend to go to familiar places because when they ask something, the staff will answer and they feel confident about answering any allergy-related questions. In section 4.1.2, the participants confessed that the staff gets mad when they ask something for instance when they reorder the dish because the served dish contained the allergen.

IP7: *" this restaurant is a restaurant that I like to go to...something that they do is to put the ingredients that each dish takes. I think this is, honestly the only one who does this...If there is more restaurant with that, it greatly facilitated the choice."*

People with food allergies sometimes share and ask their families and friends for information. They usually talk about hygiene in restaurants, which is something essential due to the cross-contamination, prices, how the restaurant can adapt meals and if they are polite and try to fix any problem that can happen as IP19 mentioned. IP10 said that the restaurant atmosphere is important since due to the day we could want to go to a quiet or fun restaurant. All of them confessed that opinions or advices provided by someone with food allergies have tremendous value. They don't commonly ask for information from people with food allergies because they don't know people with this problem, for instance, IP1 mentioned that even in a congress, about the celiac disease, he didn't find anyone in the same condition as him because his problem is severe. The only person that IP13 knows with the same problem is her grandmother. The main reasons why people value the opinions of other with allergies is because they are extra careful like IP9, IP14 and IP17 pointed out. They know how to talk appropriately about their issues and how to give a good advice, as IP3 and IP9 said and they know how bad it is to have an allergic reaction, and its consequences as seen in section 4.1.1. These people will recommend restaurants that have the proper care, and as the IP15 mentioned this exchange of information increases the number of safe places to eat. In her case, she exchanges a lot of information with a lactose intolerant friend. Knowing the severity of the allergy is important because like IP18 if you have a low level you can eat things that may say "contains traces of milk" but a medium or high level can't eat these things. Most of the participants didn't know the clinical level of the allergy but characterized the allergy level in an empiric way like low, medium or high level.

IP15: *" who has the health condition perceives more and feels much more and knows more, and knows what you are going through."*

To find a restaurant and avoid the tedious work to question everything or to know in advance if the restaurant has something for them, people with food allergies tend to do an online search. Most people have mentioned that the first things they try to know are whether the menu is varied and diverse to see if they can eat something, they search for sauces because as seen in section 4.1.2 sauces are a massive problem due to the hidden ingredients. They try to get information about the allergen on the menus, but the details are frequently missing. They tend to do this search previously to avoid the time spent on reading the list at the restaurant and bad surprises.

IP5:*" I usually use a lot to see the menu to know what I can eat."*

Some of them take time to read the reviews section to try to understand the quality price of the restaurant, like IP2, IP3, IP16, IP17, and IP25 pointed out, they search for the employees' knowledge or the hygiene of the place. These things are essential to help them to make a choice, but they mentioned that frequently all these details are missing. Some of the participants indicated that they don't like to spend time reading unuseful reviews.

IP17:*" I usually see the reviews, in zomato[2] or so, and from there I decide whether or not I go."*

From the interactive interviews, it was possible to understand the information and critical areas people would like to see on an online platform to help them to find a restaurant that can prepare a meal for them. Throughout the exploratory interviews, it was clear that the challenges people living with food allergies face when eating out and what type of information is most valuable to them to make a choice. In the interactive interviews, I went deeper into the kind of information that they would like to see in an online search and features that bring value to them. I used examples and previous quotes from the exploratory interviews to engage the people and to let them imagine the platform and its information. I asked them to perform actions in their heads like for instance search a restaurant or see a review to understand what information they would like to see and then I compared to the data already collected. They would use an application like this in two situations: first in an unplanned way like if they want to find a nearby restaurant that fits their allergy because their starving and second when planning a dinner or for instance a vacation in a specific place they want to know the restaurants the area. So having a search by nearby restaurants and a search by a particular restaurant or location is a must. To perform this search they mentioned that having a profile shouldn't be required, a user should have a profile if he wants to review a restaurant in order to present his information in the review.

IP20: *" I believe that would be an interesting feature to have, the possibility to check other location instead only the current one. For instance, you're planning a trip, and it would be interesting to see restaurants in another country."*

When searching for a restaurant, there are some filters that people would like to have like prices, distance, opened place and cuisine or restaurant type. The last one is important for them because there are people who have allergies just because of smelling the vapors of cooking or when the restaurant is more traditional, they tend to avoid because there the staff has little knowledge, and the menu is not detailed enough. The information about the rating of the place has value to them and make more comfortable making a restaurant choice because they tend to give priority to higher rating restaurants. A detailed menu and a customized menu (a menu that does not contain the allergen) for their allergies is vital. Having photos of what other people ate is also important because as IP10 pointed out she eats with her eyes, and also one thing are photos taken by the restaurant, and another thing are photos taken by people. When it comes to the review section, I presented to them the information that a review would have based on the analysis of the exploratory interviews, like allergy support, food, service, quality price and atmosphere and all of them agreed with this information and said that is enough. The only issues raised by them was the fact that they did not want to read reviews without content and how will they know that the reviewer is legitimate. It was curious because they proposed some ideas to fix these problems like IP23 pointed out to the person credibility issue "Next to the review you can put the username and

[2]Zomato is a restaurant search platform which provides information and reviews on restaurants [Wikc].

right to the side you can put a number of reviews to see if this person uses this application a lot or if the person isn't genuine and maybe the average of rating that this person gives. This measure allows the users to evaluate by themselves when seeing a review. And the also can motivate to review because this brings credibility to the person." The last piece of information need for them is the details of the restaurant like contact to make a reservation or clear some doubts about the ingredients that they use to cook their meals as IP19 and IP13 mentioned, and the directions to the place, if possible the information about the fastest way to get there adds value as IP24 pointed out.

4.2 Summary

This chapter presented how food allergic people learned how to live with their problem, the challenges faced by them when they have to eat out, and the everyday practices to avoid cross-contamination and to find a restaurant. It was clear the numerous daily challenges faced by them and how simple daily life decisions are affected by the allergy. Grocery shopping and prepare the meals every day is time-consuming, eating out is difficult and there an enormous number of activities performed to try to eat safely. They have to be very organized, careful and watchful to avoid a reaction because it has a tremendous impact on the next days and in a worst-case scenario, it can be life-threatening. These findings are crucial to understanding why eating out is a problem and to realize the information that people need and value to choose a restaurant in a safely and quickly. At table 4.1 a list of the principal findings regarding each theme that emerged from the in-depth interviews analysis is presented.

Themes	Principal Findings
Learn to live with food allergy	Rigid diet, looking for substitutes is challenging, reading labels exhaustively, cautious with everything.
Challenges of eating out	Eating indoors is easier, the restaurant staff has a lack of knowledge, participants experienced reactions at the restaurant, asking lots of questions.
Everyday practices of avoiding cross-contamination at restaurants	Eating previously at home or pack the lunch and eat it at the restaurant, understand the restaurant concerns about food allergies, mainly about cross-contamination, understand the hygiene of the restaurant and staff.
Everyday practices of finding a restaurant	Going to trustworthy places, ask family and friends for restaurant recommendations, advice provided by food allergic people is valuable and missing online information about the restaurant concerns regarding food allergies.

Table 4.1: Principal findings regarding each theme.

Chapter 5

Solution Proposal: A restaurant recommendation platform for people with food allergies

The following chapter, discusses in detail, the design of the restaurant recommendation platform inspired by the in-depth interviews analysis. Each feature and information presented is based on participants response in the interviews.

5.1 Restaurant recommendation platform Functionalities

Based on the insights from the fieldwork, I designed a low-fidelity prototype of a restaurant recommendation platform with the following features: personalized profile, nearby and specific restaurant search, view detailed menus, reviews, and other users profile, all of which to address the difficulties in dining out felt by people with food allergies. The mentioned features will be described later.

The solution will incorporate all the information needed so food allergic people can perform a safe choice to eat out. This platform has only on target: people living with food allergies.

The platform, in this initial phase, was designed for an Android smartphone, a Samsung Galaxy S7 Edge using the Quant-UX prototyping tool. But when developing the high-fidelity prototype, it should work on every smartphone, tablet, and computer.

Section 4.1.4 mentioned that from the interactive interviews participants admitted that they would use the platform in two situations: in a planned situation and an unplanned situation. For them, a planned situation consists in events that they have time to plan, for instance like IP20 said: "(...) you're planning a trip, and it would be interesting to see restaurants in another country.". An unplanned situation consists of finding a restaurant nearby that fits their allergy. In order to achieve this, GPS functionality on the smartphone should be turned on to get the current location.

5.1.1 Build a personalized profile

Creating a profile is simple, firstly the application requires the name, email, and password, this information can be provided by Facebook, Twitter, Google Plus (Figure 5.1). Secondly, users are presented with a list of the most common allergens (Figure 5.1). If the user is allergic to a common allergen, they can select it from a list. If their allergy is not one of the most common ones, the user can select "other allergy" on Figure 5.1, a different and bigger list than the previous one is shown, and since there are some more unusual and rare allergies the user can add it by hand clicking on "Add it" to have their allergy associated to their profile. To each allergen picked the user needs to give a level (Low, Medium or High) if he doesn't know the level he can skip (Figure 5.1) using the "Don't Know" button. As seen in section 4.1.4, the participants didn't know the clinical level of the allergy but they use empiric ways to express it like low, medium or high level and this was the terminology chosen to characterize the severity of the allergy in the prototype.

Having said this, multiple participants agreed that the platform should allow the user to skip the login and Sign Up process in order to get restaurant results quicker. The Figure 5.1 presents the skip option labeled as "I'll create an account later" in the Sign Up Screen. Having a profile is only required to do a review about a restaurant, because as seen in section 4.1.4, advice or opinion about a restaurant from a person with food allergies is more valuable than from a person without this problem and if that person has similar allergy even better. Understanding the allergy level is also important because, as seen in section 4.1.4 the level is related to the amount of food allergens that a person can tolerate. So to food allergic people, it is vital to understand who did the review, the person's allergy and how severe the allergy is.

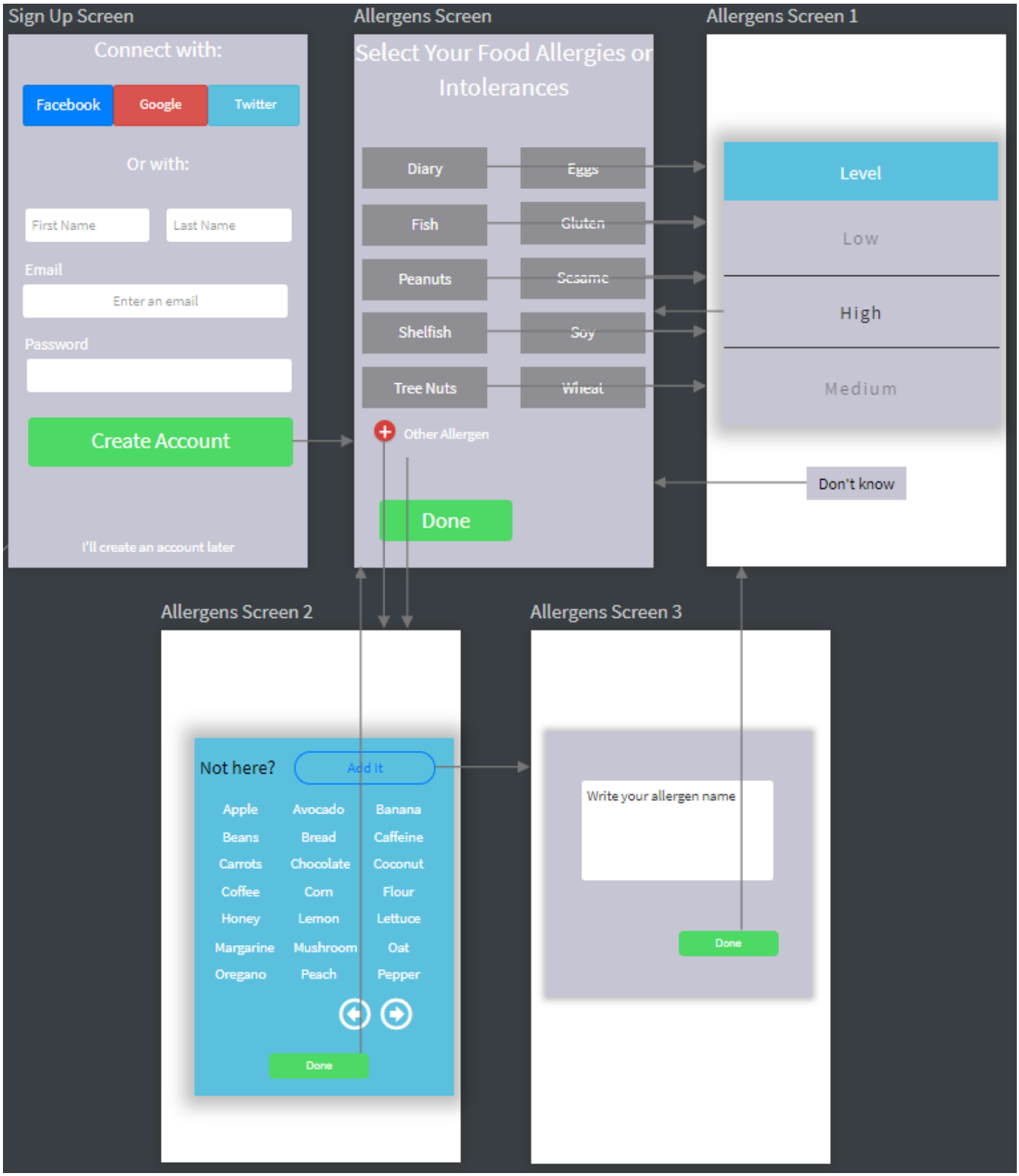


Figure 5.1: Flow to create a personalized profile

5.1.2 Search for restaurants

After creating a profile or skipping that option, the user is presented with the main screen of the platform to perform the restaurant searches (Figure 5.2). To see all screen, the user currently has to scroll the page. In a planned situation, the user can search by restaurant, locations, cuisine and press the "Go!" button to perform the search. In an unplanned case, the user can click on the button "Search Restaurants Around You.". As seen in 4.1.4, for the interviews participants this two type of searches are required. The user should select the allergen or allergens before searching for a restaurant to perform a search which takes into account their allergy, if he already has a profile and if he wants to search a restaurant he should press the button "Your Own"(Figure 5.2) to perform a search which takes into account the allergy stored in the person's profile. Also in this screen, the user can access to his profile with the navigation bar on top using the left button, and if he doesn't have a profile he can create it by clicking on "Create a profile to save your allergies".

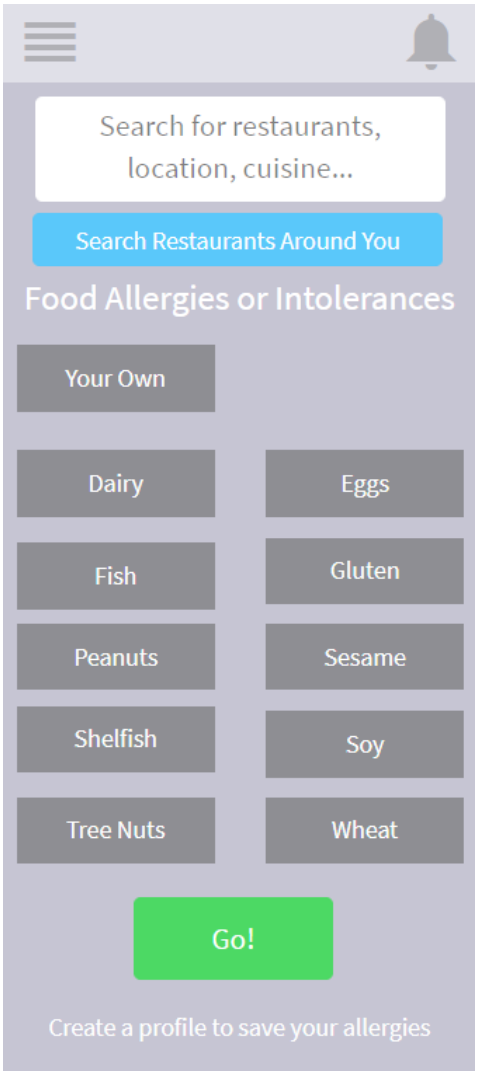


Figure 5.2: Main screen of the platform to perform the restaurant searches

The result of the search is a list of restaurant that suits their allergy. For usability purposes, the user can see the results in two views: the list view (Figure 5.3) and the map view (Figure 5.3). The results presented on the list view, by default are sorted by the distance with the closest one appearing on top. To perform a more specific search, the user can filter the restaurant information and also sort by the result list. These two options are discussed on the interactive interviews (section 4.1.4) with them, so the fundamental filters for them the by price, cuisine, distance and opened/closed places and they can sort by rating (highest/lowest), distance and price (highest/lowest). The information presented in each section about the restaurant was also discussed in the interactive interviews, and to participants, price[1], rating, name, number of reviews, distance, and if the place is open were the most significant information(Figure 5.3).

[1]For the participants the price is essential to have on the filters, as seen in section 4.1.2 it's difficult for them to find a cheap restaurant that takes into account their allergy. So the price is more important to them than people without food allergies.

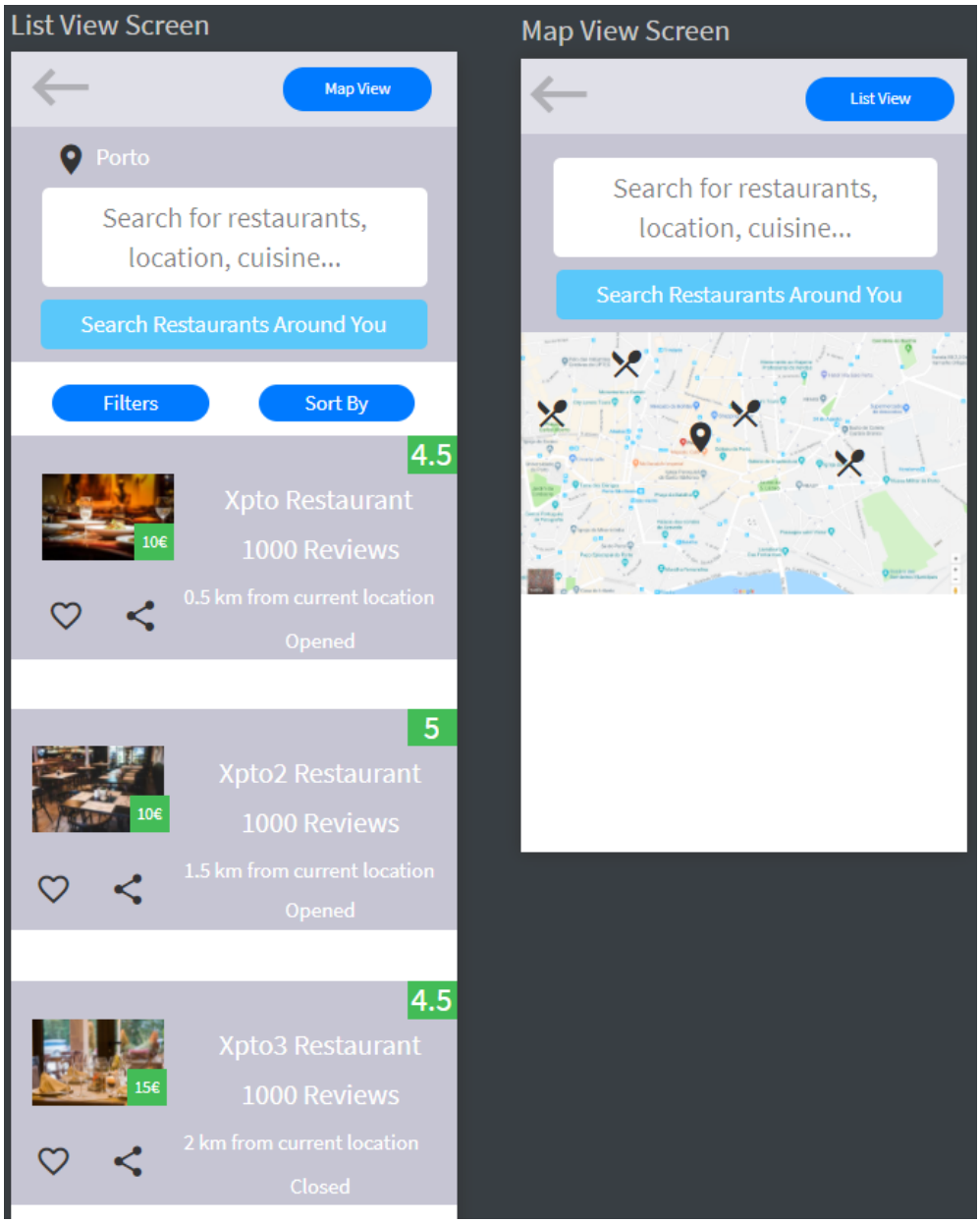


Figure 5.3: Restaurant search results views: list view and map view

5.1.3 See restaurant information

In order to perform a safe choice, analyzing information about the restaurant is essential. Choosing a restaurant is not an easy task for people living with food allergies, as seen in sections 4.1.2, 4.1.3, 4.1.4. In the restaurant landing page (Figure 5.4a), the screen displays all the information needed to make easier to them a restaurant choice. All the information presented and reviews structure is the result of the in-depth analysis carried out during the interview phase. The first information presented in the restaurant landing page (Figure 5.4a) is similar to the one displayed

in the restaurant result list(Figure 5.3): a restaurant picture, name, rating, overall price, number of reviews, schedule and if is opened or closed, and a brief description.

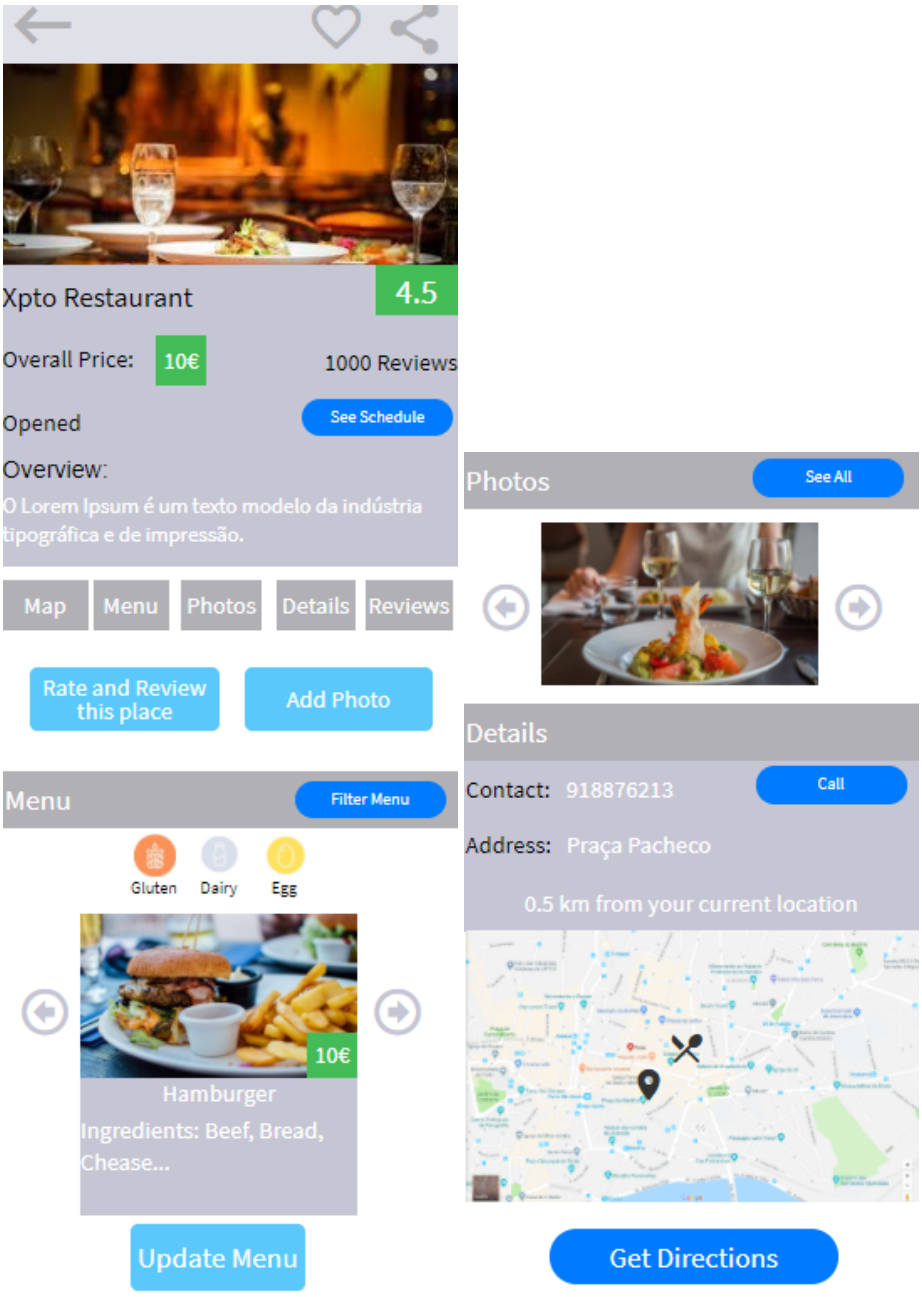
After that, the restaurant menu is shown since is the first thing that people want to see to understand if the restaurant allergy-friendly menu items for them. Having the menu up to date is pretty hard and also having the specific ingredients of the menu is difficult, so this is the biggest challenge of the platform. If the users noticed that the app menu is outdated, they could upload a menu picture by clicking in the "Update Menu" button in Figure 5.4a that would be analyzed by the system administrator to update the restaurant menu later. Having detailed menu and the associated ingredients is crucial to have a functional restaurant recommendation platform. In the menu section of the platform, it's possible to observe the allergens of the menu since, as previously seen in section 4.1.2, food allergic-people love and trust when the restaurant provides an allergen list to each plate. Also, the platform provides a filter on the menu section to filter by price or to filter for a customized menu, a menu that displays allergy-friendly meals according to the allergens that user has selected. This feature was approached by the participants of the interactive interviews and is a way to see what they can consume.

Then the photos of the restaurant are displayed (Figure 5.4b), the images are provided by the restaurant by the users, as seen in section 4.1.4 having pictures is something that people like and need because sometimes they can draw conclusions about allergens by looking at the image. Also, it makes the overall platform design better.

After that, the application presents details of the restaurant (Figure 5.4b). As seen in section 4.1.4, sometimes people with food allergies tend to call before going to a restaurant to clarify some doubts. That's why in the details about the restaurant the platform has the contact and offers the option to call. To perceive the restaurant location, the platform presents its address, the distance from the place to the user current location and a "Get Direction" button to show the fastest route to the restaurant. IP24 pointed out that the "get directions" button is to redirect the platform to Google Maps page so the user can see the best and fast option to get to the place by foot, by public transportation or by car.

Using the top navigation bar (Figure 5.4a) the user can follow the restaurant and also share the restaurant to a friend using external sources like Facebook Messenger[2]. These two features were approached during the interactive interviews as features that bring value to the application even though it is not the core and most important of the application.

[2]Facebook Messenger is a messaging application and platform [Wika].



(a) (b)

Figure 5.4: Restaurant Landing page.

5.1.4 See restaurant detailed reviews

In the restaurant landing page, the reviews section is presented (Figure 5.5). The reviews system, alongside with the menu is the most important thing to people living with food allergies. As seen in part 4.1.4, the participant search on the reviews by the employees' knowledge or quality-price rating, among other things. They also confessed that usually, the reviews system they read are not as detailed as they want them to be. In the same section, they mentioned that they value an opinion

of another person with food allergies, and knowing the allergy and level is essential to understand if the restaurant is a possibility for them. Therefore, building and designing a review system with all this information is crucial for a review to be meaningful. The participants confessed, in section 4.1.4, that they don't know a lot of people with food allergies to ask for advice, so having a review system created and populated by people with this health condition will help them to get more honest and trustworthy opinions about a place. So based on the exploratory interviews analysis, the users want to see five topics on the review of the restaurant: Allergy Support, Food, Service, Quality-Price, and Atmosphere. In particular, they want to know the reviewer allergy and its severity. During interactive interviews, it became clear that recommendations from others were not hassle-free. For instance how they can trust in the person that did a review, and ensure the credibility of the reviewer a system of following people was created. So by the number of reviews and the number of followers, the user can see if the user is legit or not. Also, by following a person that is interesting for the user, for instance a person with the same allergy is useful because as the participants of the interactive interviews mentioned seeing more reviews or the favorites restaurants can increase their options to eat out. Having a photo of what the person ate brings value to a review in the participants perspective because one thing is the restaurant photo, and another one is the guest's photo. During the exploratory interviews some participants mentioned that they don't like to read useless reviews, so a like/dislike system was created and with this, the user can sort reviews by the most liked reviews. This idea was validated during the interactive interviews.

Figure 5.5: Review section

5.1.5 See the profile of the persons who wrote reviews

The system of following a person was initially created to give credibility to the user who did a review. During the interactive interviews the participants agreed with the suggestion and pointed out that having access some information about the user is valuable. So, when seeing a person profile (Figure 5.6) the user has four accesses: he can look at the allergies, to the favorite restaurants, reviews and ratings and the followers. All this accesses were validated during the interactive interviews, and for the participants, these are the essential information that they want to access when looking for other users profile.

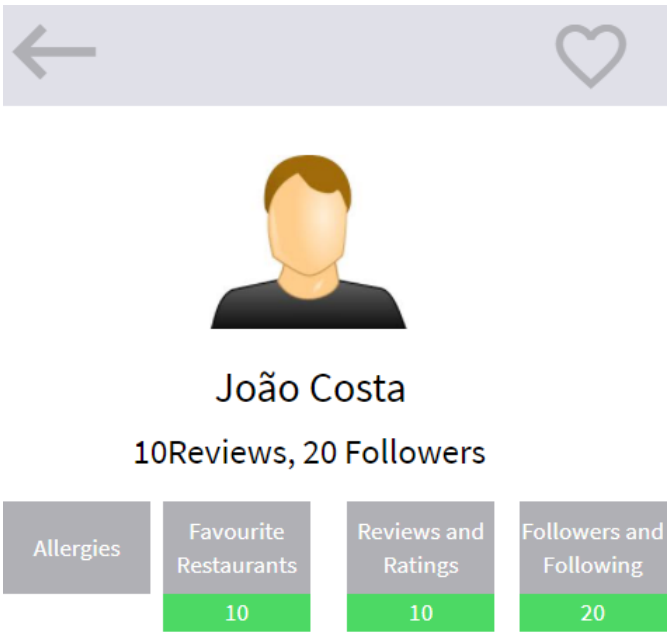


Figure 5.6: Profile of a person that made a review

5.2 Summary

This chapter presented how the platform was designed and why it contains specific information about the restaurants. All the prototype was built on top of the interviews analysis to create a system that food allergic people feel comfortable to use and to easier choose a restaurant to dine out, which made it possible to design a platform that is different from the current ones. The list of allergens on the menu, the five topics approached in a review, the level and allergy of a user that performed a review, the possibility to follow a user, the nearby and specific restaurant search and the personalized profile makes this platform unique. Thus, it contains the information and features needed to people with food allergies select a restaurant safely.

Chapter 6

Evaluation

Having presented the result of the interviews and proposed a solution for recommending restaurants, the following chapter concerns the evaluation of the solution proposal. This chapter discusses the usability test procedure is explained as well as the results obtained.

6.1 Usability Testing

As mentioned in 3.2.1.3 the prototype was evaluated with 8 participants using concurrent think aloud and retrospective probing techniques.

The task scenarios (see appendix C) created to evaluate the prototype were based on the interviews analysis. In section 4.1.4, the participants explained the situations when they would use the platform: in a planned scenario and an unplanned scenario. With this information, I could understand the most critical activities for the user accomplish in the platform.

Only a subset of the prototype was evaluated because the task scenarios (see appendix C) created were to evaluate the most important activities to the user accomplish in the platform. In section 3.2.1.3, I detailed those activities. I only focused on a prototype subset because this is the first usability test and also to perform a test that isn't too time-consuming.

The objective of the test was to see if the user can accomplish the most critical activities on the prototype intuitively. Users were free to experiment with the system, and when had difficulties or issues, I tried to understand why and discuss possible solutions to the problem found with them using the moderate technique retrospective probing. The most of the test was qualitative were data related to observations about pathways participants took, problems experienced, comments/recommendations, answers to open-ended questions using the moderating technique concurrent think aloud [usaa]. All this data was recorded with a video camera to record both audio and image. At the end of the section, after asking about the difficulties felt, we talked about the information presented on the prototype and also others features, like the profile page (see appendix C).

6.1.1 Users

Since the prototype is a restaurant recommendation platform for food allergic all the participants used had food allergies. In this usability test was used 8 participants, with ages between 20 and 33 years old. All of the participants were master or Ph.D. students from FEUP. All participants were accustomed to using technology and had several applications installed on their smartphone, even though some of them were not used to the Android system or a Samsung Galaxy s7 Edge device. Five of the eight participants participated in the two interview phases, while three participated only in the exploratory phase. The sample collected represents the end users of the application. In section 3.2.1.3 the Table 3.4 summarizes the characteristics of the participants.

6.1.2 Context of the test

The usability test was conducted in a meeting room at Fraunhofer AICOS. Since the previous interviews were done in the same way, people already felt comfortable in a place they have been before. The meeting room is a calm and silent place which causes the test to be done in a relaxed environment. In the meeting room, only the participant and I were present.

This application in a normal context of use can be used anywhere, at home, on the street, at school. If people living with food allergies want to have a meal at the restaurant, they will use the application to find the best option So doing in a meeting room don't differ too much from the usual context because it's a place that people felt comfortable.

Since all the participants felt relaxed and comfortable in the meeting room, there were not any circumstances that could affect the results with the environment. The only thing that could make the task take a little longer or not successful is the fact of some users were not accustomed to using the Android system.

6.1.3 Task Scenarios

Since all the users knew the project, I only made a summary of the test and the objectives. Then I explained in what consists the usability test that the person would perform. I often use the word "activities" instead of task scenarios to make the participant more comfortable. I emphasized the fact that people are not being tested, only the prototype was. If they didn't understand something, there was a fault in the prototype.

From the data collected in the interviews 8 scenarios were created (see appendix C):

1. Create a profile: The profile is vital to understand what type of person has done the review of some restaurant and also to do a review you must be logged in. Since the activity is used to create a profile, and also the same design is used to edit the allergies in the profile, because allergies can change throughout life, it's crucial to understand how easy, intuitive and fast is to create a profile on the prototype.

2. Find a list of restaurants nearby that suits your allergy constraints: This scenario is related to the unplanned situation of being in the street and wanting to find an appropriate restaurant,

is one of the core features on the platform. Thus understanding how intuitive and fast it is to find a restaurant nearby that suits the allergy in an unplanned situation is essential.

3. Make a phone call to the restaurant to clear some doubts: This scenario is related to both the unplanned and a planned restaurant searching scenarios. From the interviews, it became clear that sometimes food-allergic people call restaurants to know what are the ingredients that they use to prepare the meals (see section 4.1.4). Also to make a reservation, a phone call was their preferred method.

4. Leave a like on a review or follow a person: From the interviews, people living with food allergies confessed that they don't like to spend the time reading reviews without meaning. By leaving a like in a meaningful review, they can sort the reviews by the most liked ones to avoid reading an unmeaningful text. This scenario is to see whether leaving a like in the review was meaningful to them. A follow system was also created to give credibility to a reviewer, and so this scenario is also to see if the user is willing to follow the person who does a review.

5. Get directions to the restaurant: This scenario is to analyze if the directions of the restaurant are easy to get and to understand if the Google Maps approach to see the fastest way to get there is the best option.

6. Rate and Review a restaurant: This scenario is relevant because the review and rating system is one of the most essential features of the platform. Was explicitly designed for food allergic people to understand how easy and intuitive it is to rate and review a restaurant is crucial to encourage users to do reviews to help others.

7. Help to improve outdated menus: This scenario is a way to try to fix the problem with outdated menus. I tried to analyze if the user understands the purpose of the scenario.

8. Find a restaurant in a specific location: This scenario is related to the planned situation, is one of the core features on the platform. So understanding how intuitive and fast is to find a restaurant in a specific location that suits the allergy is essential.

6.1.4 Usability metrics

In a usability test, it's possible to test the following metrics: effectiveness, efficiency, and satisfaction. These three metrics were carefully described in section 3.2.1.3. To assess the effectiveness, I analyzed the percentage of participants who entirely and correctly achieve each task goal (unassisted task), and the percentage of participants who cannot proceed on a task but, with some help, they ended up completing it (assisted task). The efficiency is usually assessed by the mean time take to achieve the task. Since the moderating technique concurrent think aloud was used the tasks and the section was not time-limited and so measure time was not calculated. The satisfaction was

tested openly, by asking the user the overall experience and not with questionnaires like SUMI[1] or SUS[2].

6.2 Results

6.2.1 Performance Results

In Table 6.1, is presented the usability test results for each task. When a participant performs a complete a task without help is represented with the word "Success", when the task is performed and completed with help is represented with the word "Success with help" and when the participant cannot complete the task is represented with "-".

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8
IP1	Success	Success	Success	Success	Success	Success	Success	Success
IP2	Success with help	-	Success	Success with help	Success	Success	Success	-
IP3	Success	-	Success with help	Success	Success	Success	Success	Success
IP4	Success	-	Success	Success	Success	Success	Success	Success with help
IP5	Success	Success	Success	Success	Success	Success	Success	Success
IP6	Success	-	Success	Success	Success	Success	Success	Success with help
IP7	Success	-	Success	Success	Success	Success	Success	Success
IP8	Success with help	Success	Success	Success	Success	Success	Success	Success

Table 6.1: Tasks Results.

The performance results related to the effectiveness in presented in Table 6.2

[1]The Software Usability Measurement Inventory (SUMI) is a questionnaire to measure the user satisfaction related to software by analyzing products or prototypes concerning usability and quality of use [SAP].

[2]The System Usability Scale (SUS) is a 10 item questionnaire for measuring the usability. The respondents can answer from Strongly agree to Strongly disagree [usac].

	Task 1	Task 2	Task3	Task 4	Task 5	Task 6	Task 7	Task 8
Numbers of Unassisted Task	6	3	7	7	8	8	8	5
Numbers of Assisted Task	2	0	1	1	0	0	0	2
Number of Errors	0	5	0	0	0	0	0	1
Percentage of Unassisted Task	6/8	3/8	7/8	7/8	8/8	8/8	8/8	5/8
Percentage of Assisted Task	2/8	0/8	1/8	1/8	0/8	0/8	0/8	2/8
Percentage of Errors	0/8	5/8	0/8	0/8	0/8	0/8	0/8	1/8

Table 6.2: Summary of the tasks results.

6.2.2 Data analysis

In order to understand why the user needed help to complete a task, why the participant succeeded when performing a task or why they hesitated in some parts of the scenario I observed their pathways, got feedback about their thoughts and difficulties using concurrent think aloud and with the retrospective probing I could understand the reason for the problems and ask for improvements.

To explain the result obtained for each task the Tables 6.1 and 6.2 will be used.

In task 1, all the users completed the task (6/8 unassisted and 2/8 assisted). It was possible to observe that when selecting the level of the allergy to create a profile, most users hesitated because the current design forces the user to double-click the level (Figure 6.1). They explained that the prototype should have an "OK" button, so they only have to click once on the level and then on the "OK" button, or instead of having a spinner to display the allergy levels a three buttons option to each allergy level would be better, but still with the "OK" button.

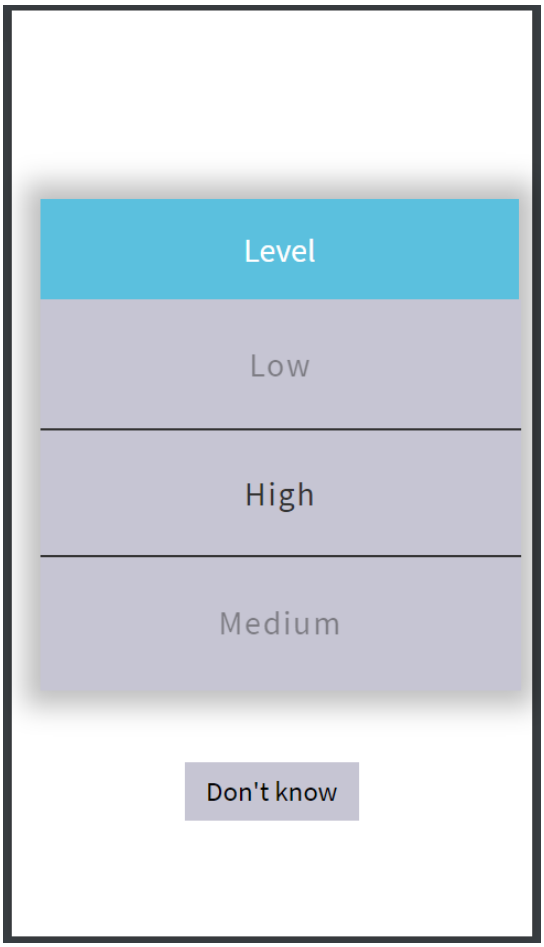


Figure 6.1: Allergy Level screen

They also mentioned that after choosing the allergy and the level they should get some feedback referring that they perform they choice right, for instance having the allergen button in a different color. IP2 and IP8 completed the scenario with help because both of them started by login in the system and did not understand that they needed to Sign Up first. With some clues, they easily performed the task. IP2 referred that he didn't see the "Sign Up" button because the smartphone keyboard covered it, and he wasn't used to that operation system, so he didn't know how to hide the keyboard. IP8 confessed that he was distracted and that was the reason for not seeing the "Sign Up" button.

In task 2, finding a restaurant nearby that suits their allergies was the task where the participant failed more (5/8 errors). It's crucial to understand why because this is one of the essential features. In appendix C, it's possible to observe the criteria to complete the task successfully. All the users failed in the same place, right on the first step: Press "Your Own" button (Figure 6.2). Since they already are logged in, currently the flow to search the restaurant nearby is to press "Your Own" button and then the "Search restaurants around you" button. All the participants pressed the "Search restaurants around you" button, so to them since they already had a profile the button

should retrieve the restaurants based on the profile allergies, and the "Your Own" button should not exist. Also, IP5 and IP6 pointed out that maybe the structure of the Figure 6.2 should be inverted, first appears the allergies and the search buttons.

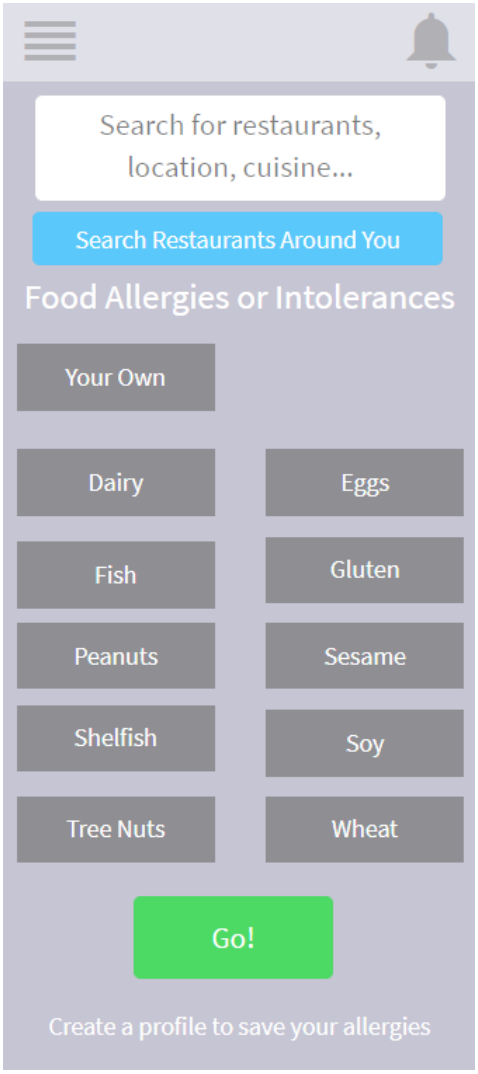


Figure 6.2: Main screen of the platform to perform the restaurant searches

In task 3, make a phone call to the restaurant all the participants completed with success the task (7/8 unassisted and 1/8 assisted). Only IP3 needed a clue because she didn't understand that had already read all the restaurant information, such as menu and reviews.

In task 4, leave a like on a review or follow a person most of the users correctly completed the task (7/8 unassisted and 1/8 assisted). Only IP2 performed this task with help because he wouldn't leave a like right away. To do that he needed to analyze everything carefully.

In task 5, get restaurant directions, task 6, rate and review the restaurant and task 7, helping improve outdated menus all the users completed the activities without any assistance (8/8 unassisted). Even though they easily accomplish the goal, they mentioned insights to improve the way

how the information is presented to clear any doubts that can exist. For instance, the "Rate and Review this place" button (Figure 5.4a) should also appear in the reviews section (Figure 5.5). When performing a review (flow to write a review Figure 6.3), they would like to see all the ratings to each topic (allergy support, food, service, quality-price, and atmosphere) on the first screen and then the text box to justify the rating and not a text box to each topic. With this design change, doing a review would be less boring.

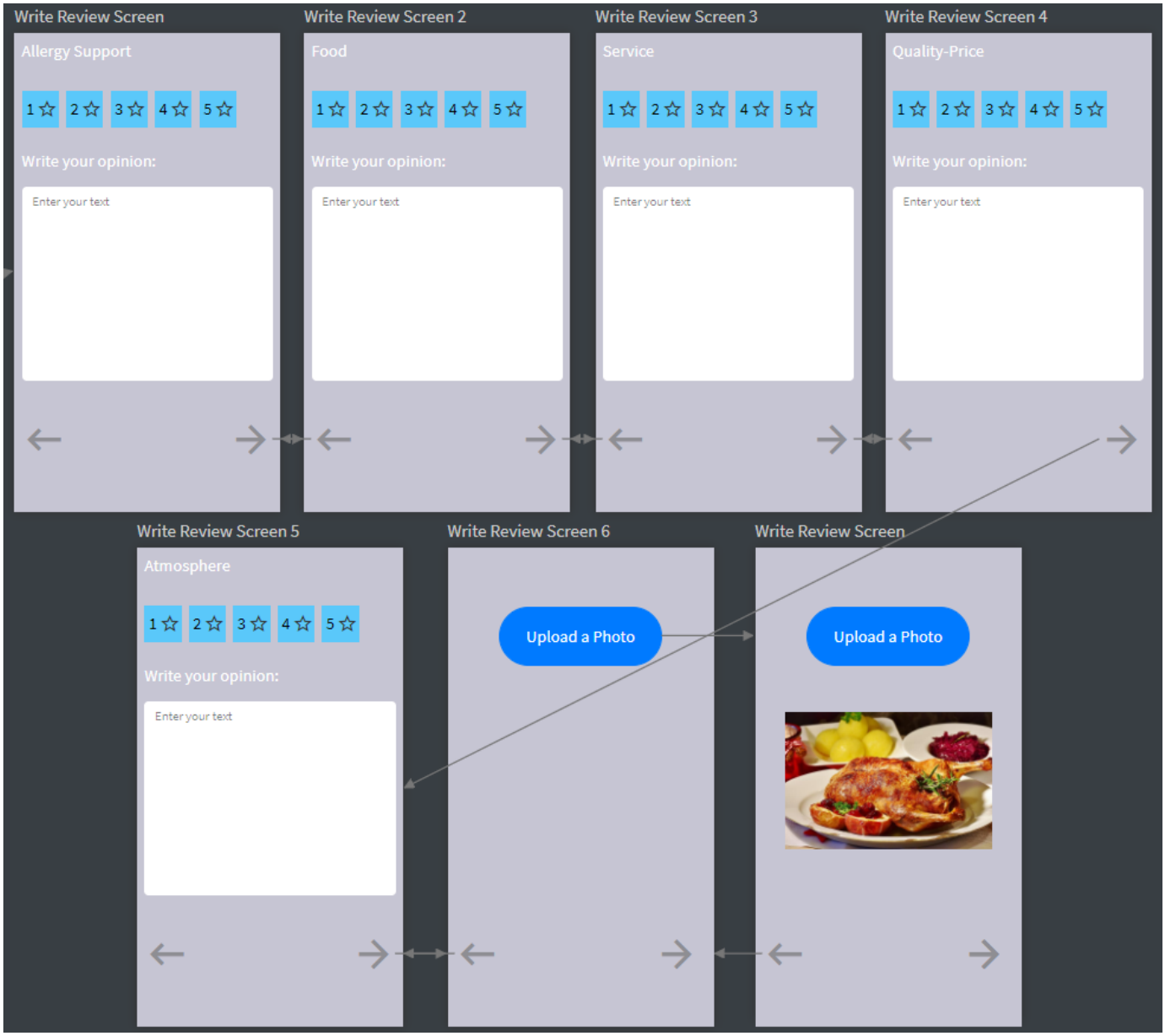


Figure 6.3: Flow to write a review

To them was very useful the redirect to the Google Maps because they can see the fastest way to get to the restaurant with different methods (walking, public transportation, driving). In the

update menu task, IP4 mention that should be more specific like asking a question to the user "The application menu did not correspond to the restaurant menu?" and then next to it the button "Update Menu". Also, this should be smaller because this it draws the most attention on the menu section and it shouldn't (Figure 5.4a).

In task 8 (5/8 unassisted, 2/8 assisted and 1/8 failed), finding a restaurant in a specific location most of the users completed the task. Only the IP4 and IP6 needed help, and IP2 failed. The goal was to press "Your Own" button, write "Lisboa" in the search bar and then press "Go" button (Figure 6.2). A curious fact was that in this task all the users pressed the "Your Own" button, they learn this when I explained the purpose of the button. All the participants made the same error. They clicked on "Search restaurants around you" button instead of the "GO" button. They mentioned that the "Go" button was hiding and they didn't see it. They prefer to see the button right next to it the search box. If they can see the two search buttons right away, they quickly realize that one is for the current location search and the other is for a specific search.

In the end, after approaching the problems and difficulties felt some topic were discussed (see appendix C). The users pointed out that the information presented is enough to perform a safe decision when choosing a restaurant. The information in the reviews section is handy and the reviewer information displayed is vital, with the number of reviews and followers they can see if the user is credible. The following system is a great idea, from their perspective because not only gives credibility to the reviewer but can also encourage users to do reviews to get more followers. The profile screen and accesses are excellent and useful. To IP4 this prototype is excellent because having a profile is not necessary, but the way the prototype is designed encourages you to create one to have a custom service. There are some things to improve, for instance, they would like to see the menu section (Figure 5.4a) with list design, to right way see the all menu and specify the allergens in this section is also need, like having a text saying "This menu contains following allergens:" and the present the icons and names of the allergens. A button to access the main page easily from any page can improve the navigation. To IP7 the restaurant landing page 5.4 is too long, maybe have a button named "Overview" with the all page and then having buttons to the menu, photos, details and reviews section is crucial. This buttons should work like tabs and not jump in the restaurant landing page. Another information that could be helpful pointed out by IP8 is the possibility to have a rating by the allergy to each restaurant. For example, if two users with peanuts allergy rate a restaurant with 4 stars and 5 stars, respectively, that restaurant should be rated 4.5 stars for peanuts. This type of rating is valuable information that complements the detailed reviews system of the platform.

6.3 Summary

This chapter presented the how the prototype was evaluated. Firstly, it's shown the objectives of the test and the techniques used. Secondly, the users that participate and the context where the tests were performed, the task scenarios that they had to accomplish and the metrics to evaluate them and thirdly, the results obtained.

Chapter 7

Discussion

In this chapter, we discuss the results achieved in this work. First, an overview of the research process, followed by a more in-depth reflection on the interviews phase and usability testing. After that, is presented some platform characteristics and the lessons learned.

7.1 The Research Process

Designing a restaurant recommendation platform for people with food allergies was challenging. The participatory design methodology was crucial to understanding the everyday practices and challenges that they face when there is a need to eat out. The literature review gave some insights of the impacts that this health condition has on the person and how the quality of life is affected, but the interviews phase with food allergic people helped to gain a better understanding of their daily problems, more specifically when eating out.

Performing two interviews phases, exploratory and interactive allowed a discussion about possible solution during the analysis before start prototyping regarding the information to be presented or how certain sections such as reviews should be constructed taking into account the specific target of the platform people with food allergies. Although there were a large number of interviews, 25 and all of them were analyzed using the thematic analysis method, the result of the coding to search for themes proved to be a crucial and valuable way to obtain the overall picture of the platform. Most of the participants were recruited in the same way, through an email to the Faculty of Engineering of the University of Porto but they had different allergies and different backgrounds which results in a heterogeneous group, and so diverse perspective of living with the allergy, challenges and everyday practices of eating out or avoid cross-contamination were collected. Recruiting the participants was not an easy task as well engaging them to cooperate throughout different stages of the project, and managing the interviews when it touched on more personal matters was also challenging.

Based on the knowledge acquired from the interviews, a clickable low-fidelity prototype was developed. The Quant-UX prototyping tool proved to be an appropriate choice to design the prototype since it supports usability testing at an early stage. The prototype was initially evaluated with 8 participants where the objective was to analyze if the user could accomplish the most critical activities on the prototype comfortably and intuitively. The usability test came from the need to have the result evaluated by possible end-users. Due to time constraints and since the interviews phase was time-consuming, the usability testing only had one iteration. The test allowed to test the performance of the prototype, more specifically the effectiveness, the satisfaction and a qualitative analysis through observations, pathways of the participant helped to understand why the user failed or hesitated in some task scenario. The results of the test were positive, and they will help to perform improvements on the design, navigation, and features in the future. However, the platform requires iterations and further evaluations.

Involving the user in the all process, giving them the opportunity to express their ideas proved to be the right way to design the platform, they raised problems and at the same time proposed solutions for them, which means that in the end the number of issues with the platform will be lower, and so the result was positive. This increase the probability of the potential end-users of the platform to accept the information contained and design.

There are several topics within this work that meet some topics covered in the literature. The literature review allowed to perceive the negative impact on the QoL of the patient and the caregiver [CNMFS04] [SSS+10b], for instance, Mackenzie et al. [MRVLD10] studied how food allergy affects teenagers and concluded that they missed some parties due to their health condition. During the interviews, IP8 also mentioned that she lost some anniversaries when she was young. A study, in the Netherlands, concluded that people with food allergies have a higher school absence, maybe because of the higher health condition burden [CRB+02] [CRB+06]. Throughout the interview, IP10 confessed that in childhood she was ashamed to go to school due to their food allergy. To most of the participants, there is a lack of knowledge in the restaurant's staff and a study in São Paulo concluded that all the managers agreed that food handlers don't have training in food allergies [ACF+10]. One of the most affected activities in people with food allergies life is eating out [HV12] and this research complement this literature review topic since a more in-depth investigation into this problem was performed. It was explored the eating out challenges faced by people with food allergies, their practices to find a restaurant that suits their allergy and their practices to avoid cross-contamination at restaurants. A solution to this problem, inspired by the fieldwork investigation which makes it possible to have a platform distinct from the ones that exist like AllergyEats or AllergyBot, was proposed. This platform has detailed reviews designed with and for people with food allergies, detailed menus with the respective allergens to each dish and a system of following other users. This characteristics makes this platform unique and allows the users to perform a safe restaurant choice.

7.2 Lessons Learned

There are many interesting findings from work conducted within the scope of this dissertation:

- How food-allergic people learned to live with food allergies:

  After the diagnosis of the food allergy, people with this health-condition had to learn several things to avoid an allergic reaction. They have to understand how to avoid the allergen since this is present in many foods and sauces in a hidden way. A rigid diet is crucial, searching for substitutes for the allergen is vital to have a diverse and varied diet. They need to be always aware and cautious about everything they eat. They need to learn to read labels as a routine in their shopping groceries. Using a list with the food that they can or cannot eat is beneficial and learning how to act in case of having an allergic reaction is crucial to avoid tragic accidents. For instance, recognize the first symptoms is essential to take medicine immediately. IP15 mentioned that she once didn't realize the early signs and even after taking EpiPen she had to go to the hospital and be intubated.

- Challenges faced by people living with food allergies when eating out:

  The literature review, section 2.1.4 showed that eating out is a problem faced by people with this health condition. During the interviews this topic has been deepened, indoors home they have full control about what they eat but outdoors the most challenge thing is that lack of knowledge of the restaurant staff which makes food-allergic people avoid places that they usually went before the diagnose. Extra caution is mandatory because allergic-reactions occur due to lack of knowledge. Restaurants with a allergens list are more trustable to people with food allergies because it suggests that the restaurant is informed about the problem. The number of restaurants they know to go to lunch out is small, which evidences the need for our tool.

- Practices of food-allergic people to avoid cross-contamination:

  Cross-contamination is a tremendous problem, mostly at restaurants, and to prevent it people living with food allergies rely on adapting their meals or they eat previously at home, or they pack the lunch to eat at the restaurant. If they have to eat in the restaurant, they first try to understand the restaurant concerns about this problem, the hygiene and the ingredients used in their meals.

- Practices of people living with food allergies to find a restaurant:

  To have a safe meal, food-allergic people tend to go to familiar places, restaurants that they already trust. When the restaurant is new, these people tend to do a previous online search on the menu, reviews, ratings, and details that help to know if the restaurant uses the allergen. Sometimes they call to the place before going there to clear possible doubts about the allergen and cross-contamination.

- How should be designed and what is the essential information in a restaurant recommendation platform for food-allergic people:

  For food-allergic people, there are some information and details crucial to choose a restaurant for lunch safely. Having detailed menu with the allergens makes their search a lot easier. The opinion of other people with the food allergies is helpful for them, and so a review system based on people with this health-condition is vital for them. Knowing the allergy and the severity brings value when looking for a review as well as understanding the allergy support, food, service, quality-price and atmosphere opinions.

7.3 Platform Characteristics

The primary concern was to learn the challenges and practices of food-allergic people to develop a platform that holds the needed characteristics for providing a pleasant experience for them when searching for a restaurant to minimize the problems felt by them when they have to go eat out. The overall specification and design of the platform was described in section 5. But there are some features extracted from the interviews phase and usability testing that I considered vital that summarize the several aspects in which the developed platform is suitable for food allergic people:

1. Multi-platform: The platform should work in every device, computer, tablet and smartphone so it can be used everywhere anytime.

2. Customization: The platform offers a customized profile to each user and customized menus based on their allergies.

3. Nearby restaurants search: The possibility to find a restaurant around the current location of the user location is one the most valuable features on the system, as seen during the interviews.

4. Specific restaurants, location, cuisine search: To complement the nearby search, the platform, to a more planned restaurant search, allows this type of particular search.

5. Unique reviews interface: The platform reviews section was built with food-allergic people for food-allergic people. The existing information and design is detailed to the maximum so that a review can be meaningful for a people living with food allergies.

6. Social interaction: The platform promote following system the gives credibility to the users and encourages them to review restaurants in order to increase the number of followers. Also, it offers the possibility to share a restaurant with others using external sources like Facebook Messenger.

Not all these characteristics were evaluated and validated, but it would be interesting to judge their influence on the overall allergy-friendly restaurant search.

7.4 Summary

This chapter documented the research process performed throughout the project, its challenges, and advantages. Then is discussed the interesting facts and life experiences of food-allergic people that turns out to be helpful to design a solution for finding a restaurant. In the end, is described some platform characteristics in order to build a solution valid and meaningful for people with food allergies.

Discussion

Chapter 8

Conclusions and Future Work

Allergic diseases are growing worldwide, and food allergies are not left out of this picture. The impact of this health condition on the quality of life of the patient and caregiver is negative. It's undeniable that the use of technology can substantially increase the QoL of food allergic people, during the literature review (section 2.2) it was possible to observe a categorization of existing technologies to help people with this problem. Tools that allow people with food allergies to avoid buying food that contains allergens, tools that enable people with food allergies to testing food, medicine reminders, recipes recommendations and restaurants recommendations platforms.

One of the most affected aspects, in the daily life of people with food allergies, is eating out (section 2.1.4). Technology can be used to improve and work around this obstacle, therefore designing a restaurant recommendation platform that meets the needs of people with allergies, considering their problems, challenges, practices, likes, and dislikes can potential help them to eat out safely.

This dissertation had the main goal to analyze, design and evaluate a restaurant recommendation platform for people with food allergies. And so, to accomplish this a deep understanding of the target users was required to propose a solution that the end-users felt that have the characteristics and information for providing a safe way to choose a restaurant considering their specific allergies intuitively. Performing to interviews phases, exploratory and interactive showed to be a benefit to get the right picture of the overall design, structure, and information of the platform.

The research questions raised in the early stage were successfully answered as follows:

RQ1: It was possible to gain through the exploratory and interactive interviews, an in-depth knowledge on how the people live with the allergies they daily life, how they learned to live with their health condition, their eating out challenges, their everyday practices to avoid cross-contamination in restaurants and daily habits to find restaurants that suit their allergy was reached.

RQ2: With the knowledge acquired in the section 4 a design of a restaurant recommendation platform for people with food allergies was created, were the users can choose a restaurant safely

due to the detailed information about the restaurant and meticulous review system specifically designed with and for people with food allergies (section 5).

Building upon this research, a base for future studies and work arises. It's important to understand that an in-depth analysis of people with food allergies was performed, and has provided the information necessary for these people to make a restaurant choice safely. The interviews were time-consuming, and so only one usability test was performed. Therefore future work to evaluate and validate the usability of the platform is required as well implementing the solutions for the founded problems in this first usability test. At this point, an iterative and incremental prototyping approach, using low-fidelity prototyping, is the best way to achieve excellent results of usability since it's possible to obtain relevant information and feedback from the end-users.

After exploring the usability tests, a high-fidelity prototype running on mobile and desktop should be developed iteratively and incrementally to take advantage of the participatory design method. The priority requirements, established in the low-fidelity prototype phase, should be the first ones to be developed.

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Appendix A

Exploratory Interviews Script

This appendix contains the interview scrip used during the exploratory interviews.

A.1 Introduction

Hi, my name is João Almeida, I'm 22 years old, I'm from Póvoa de Varzim, and I'm currently studying Informatics Engineering at FEUP. I am in the 5th year of the course, and I find myself doing my thesis at Fraunhofer Portugal. The goal of this project is to design a solution that will improve the problems that people with food allergies have when it comes to having lunch or dinner out. This solution will be developed based on the experiences and ideas of people with food allergies since this project is aimed at these people. Your input is essential to design a solution that meets the needs of the users. I would like to thank you in advance for your time and willingness to help with this study. Before we start, we would like to read and sign these papers of consensus and confidentiality about the data from this interview. Is there anything you want to know about this study before we start the interview? I'd like to ask your permission to record the conversation to make it easier for me to analyze the data later.

A.2 Privacy Policy

Your cooperation is voluntary, there is no monetary compensation to any part involved. You can leave this study at any time without any consequences.

A.3 Questions

A.3.1 Interview start

1. What is your name?
2. Tell me a little about yourself. Name, Age, Profession, Education, Personality, Interests
3. Do you live alone?

A.3.2 Treatment

1. Tell me about your allergy?
    (a) What is the food that you are allergic?
    (b) What precautions do you have to take?
    (c) What can happen to you if you have an allergic reaction?
    (d) What do you have to do if a reaction happens?
    (e) Are you allergic to more than one food?

A.3.3 Diagnosis

1. Are you followed in medical terms?
2. How did you find out you had food allergies?
3. When did you get the first signs?
4. When was he diagnosed?
5. How did you feel?
6. What has changed in your life?

A.3.4 Learning

1. How did you learn to live with allergy?
2. Did someone give you advice? Who? What type of advice?
3. Advice for someone who has food allergies?

A.3.5 Food allergies and the Person

1. What is a food allergy to you?
2. What is for you to live with food allergies?
3. What bothers you the most?
4. Can you give a level to your allergy?
5. Can you explain the impact of the food allergy on your life?

A.3.6 Living with food allergies

1. What change in your life due to food allergies? Examples
2. What are the biggest difficulties you feel because of this problem? Examples
3. Can you tell me your last experience when you went out to lunch?
   (a) Where did you go? Do you tend to vary from restaurants?
4. Have you ever had any bad experiences due to your food allergies? And in restaurants?

A.3.7 Technology

1. Do you use any technology / application because of allergy?
2. When do you need to go lunch out what information you are looking for? Who do you advise?
   (a) What information should this advice have to become good and significant?
   (b) What information does the advice contain to see if the restaurant is suitable for you?
   (c) Ask for advice from people with similar allergies? How do you know that this person has a similar allergy?

Is there anything else you would like to share? (turning off the recorder may lead to a different response)

Ask about willingness to participate throughout the project

Do you know anyone with allergies who can help and contribute to the study?

Taking notes, check if the recorder is always operational.

Thank you again !!

Appendix B

Thematic Analysis Mind Map

The appendix contains the Mind Map used for the organize the codes and themes when performing the thematic analysis method.

B.1 Mind Map

Figure B.1: Mind Map used to help the organization of codes and themes when performing the thematic analysis method.

Appendix C

Usability Testing Script

The appendix contains the script used for the usability testing.

C.1 Introduction

Hi, my name is João Almeida, I'm 22 years old, I'm from Póvoa de Varzim, and I'm currently studying Informatics Engineering at FEUP. I am in the 5th year of the course, and I find myself doing my thesis at Fraunhofer Portugal. The goal of this project is to design a solution that will improve the problems that people with food allergies have when it comes to having lunch or dinner out. This solution was developed based on the experiences and ideas of people with food allergies since this project is aimed at these people. Your input is essential to create a solution that meets the needs of the users. I would like to thank you in advance for your time and willingness to help with this study. It is effortless, I will give 8 activities and you using that prototype will try to do these activities. Any questions you have, please ask because if this happens, it is because the prototype has something wrong. I'm here to test the prototype and not you. Thank you very much for participating in this project.

C.2 Privacy Policy

Your cooperation is voluntary, there is no monetary compensation to any part involved. You can leave this study at any time without any consequences.

C.3 Task Scenarios

C.3.1 Scenario 1: Create a profile

Imagine that you want to take advantage of all the features of the system, assuming you have moderate peanut allergies create a profile for you.

Importance of the scenario: The profile is vital to understand what type of person has done the review of some restaurant and also to do a review you must be logged in.

The criteria to successfully complete the task is the following (see Figure 5.1 to understand the flow):

- Press “Sign Up” button
- Fill the box for the “First Name”, “Last Name”, “Email”, “Password” and then press “Create Account” button
- Press “Medium” Option
- Press “Done” button

C.3.2 Scenario 2: Find a list of restaurants nearby that suits the allergy

Imagine that you are starving, considering your allergy to peanuts, look for a list of restaurants near you that does not exceed € 10 a meal and is currently open.

Importance of the scenario: This scenario is one of the reasons for people to use the application.

The criteria to successfully complete the task is the following (see Figures 5.2 and 5.3 to understand the flow):

- Press “Your Own” button
- Press “Search Restaurants Around You” button
- Press “Filter” button
- Press “0€ to 10€” checkbox
- Press “Open Places” checkbox
- Press “Apply Filter” button

C.3.3 Scenario 3: Make a phone call to the restaurant to clear some doubts

Choose a restaurant from the list and imagine that when you look at the information, you have about the restaurant you like the restaurant but you have some doubts if they are ready to cook for you because of your allergy. What would you do to get more details about it?

Importance of the scenario: Understand if people would call the restaurant to get more information.

The criteria to successfully complete the task is the following (see Figure 5.4b to understand the flow):

- Press “Call” button

C.3.4 Scenario 4: Leave a like on a review or Follow a person

Imagine that you are reading the experience of another person about the restaurant, if the experience of the person was significant to you and helped you a lot what you would do about it?

Importance of the scenario: Understand if people would leave a like if the review were meaningful to them, or if the would follow a person to see more reviews of that person or his favorite restaurants.

The criteria to successfully complete the task is the following (see Figure 5.5 to understand the flow):

- Press “Like” button or Press “Follow” button

C.3.5 Scenario 5: Get directions to the restaurant

Imagine that you want to go to this restaurant for lunch because it is perfect for you, how do you to get there?

Importance of the scenario: Understand if people the option get directions to understand how to get the restaurant.

The criteria to successfully complete the task is the following (see Figure 5.4b to understand the flow):

- Press “Get Directions” button
- Press “Done” button

C.3.6 Scenario 6: Rate and Review a restaurant

Imagine that you went to lunch at this restaurant, I would like that you write your opinion about the place.

Importance of the scenario: Understand how easy and intuitive is to rate and review a restaurant.

The criteria to successfully complete the task is the following (see Figures 5.4a and 6.3 to understand the flow):

- Press “Rate and Review this place” button
- Press the button to rate, like “4 stars” button
- Write something about it (not mandatory)
- Repeat the second and third step four more times
- Press “Upload a Photo” button (not mandatory)
- Press “->” Option

C.3.7 Scenario 7: Help improving outdated menus

Imagine that you went to lunch at this restaurant and the menu on the app is outdated compared to the menu at the restaurant. Help the application to have an up to date menu.

Importance of the scenario: This scenario is one way to fix the main problem of the app outdated menus.

The criteria to successfully complete the task is the following (see Figure 5.4a to understand the flow):

- Press “Update Menu” button
- Press “Upload a Photo” button
- Press “->” Option

C.3.8 Scenario 8: Find a restaurant in a specific location

Imagine that you went to lunch at this restaurant and the menu on the app is outdated compared to the menu at the restaurant. Help the application to have an up to date menu.

Importance of the scenario: This scenario is one way to fix the application outdated menus problem.

The criteria to successfully complete the task is the following (see Figures 5.2 and 5.3 to understand the flow):

- Press “Your Own” button
- Write “Lisboa” in the search bar
- Press “Go” button
- Press “Filter” button
- Press “0€ to 10€” checkbox
- Press “10€ to 20€” checkbox
- Press “Italian” option in the spinner
- Change distance (not mandatory)
- Press “Apply Filter” button

C.4 Topics to approach in the end of the test

- Find out if the information currently on the restaurant page makes it possible to choose a restaurant safely, if there is too much information or if there is a lack of information.

- Carefully analyze the structure of a review.
- Show functionality in the profile, explain why they exist and request missing information feedback.
- Find out if the choice of allergens is good and well structured because it is used to create the profile and to change allergies if necessary.