Designing Interaction of Food Allergy Information Application Using User-Centered Design Approach: Gojek Case Study

A T Sutrisno¹, L P Yulianti² and Harlili³

¹, ², ³ School of Electrical Engineering and Informatics, Institut Teknologi Bandung, Bandung, 40132, Indonesia

Email: ariesthska@gmail.com¹

Abstract. Food allergy and anaphylaxis are known to keep increasing in prevalence for over the years. Various efforts have been made to provide the solutions but they have not been proven very effective while on the other hand technological solution has not yet been much involved to support them. The main problem with food allergy is that people find it hard to access the information of complete ingredients, food-making process, and shared equipment that might be used in the process. The information is regularly needed by people with food allergy to determine whether the food is safe to consume or not. This paper will explain how the problems are solved by designing a food allergy information application using user-centered design (UCD) approach to facilitate the user needs with Gojek application as the study case. The outcome of this research is a high-fidelity prototype of the application. Usability testing is conducted for the prototype by using parameters such as completion rate, System Usability Scale (SUS) questionnaire, and User Engagement Scale-Short Form (UES-SF) questionnaire with corresponding results of 100% completion rate, 85.4 SUS score, and 4.23 UES-SF score which shows that effectivity and engaging as usability and user experience goals are fulfilled to answer the user needs.

1. Introduction
Approximately 240-550 million people around the world suffer from food allergy [1]. Until today, food allergy cannot be cured thus avoiding ingredients that may contain food allergens is still the best therapy for food allergy. With the prevalence of food allergy and anaphylaxis—fatal allergic reaction—keep increasing quite significantly in most part of the world [2], this issue is becoming a serious matter as various solutions regarding food allergy mainly focusing on food labelling have not yet been proven very effective.

Development of technological solution in health industry on the other hand has recently been gaining public attention. The adaptation of digital health technology has been well facilitated as the technological disruption in health system has also started to rise to the surface [3]. In Indonesia, the trend is also supported by the fact that more than half of internet usage is dedicated for accessing health information needs where at the same time the national internet usage penetration was able to reach up to 64,8% population in 2018 and will likely to keep increasing each year [4][5]. This opportunity in digital health system will also open new possibilities for solving many other health problems including food allergy.

Some applications designed for food allergy are available for public use. Despite that, the adaptation of those applications by people with food allergy still seems low. Usability testing conducted for few examples of those applications, for example Allergy Life app and Infood, shows
that the users still find difficulties in using those kind of applications for their needs. The result further proves that the designed features are less effective and the user experience of using the applications gives not yet good impact for the users. Therefore, an application that could provide better usability and user experience is needed to support people with food allergy hence their needs are facilitated.

In this study, we will discuss several things associated to food allergy, related works about food allergy, the process to acquire information about the food allergy problems from the potential users’ perspective, and how the solution to the food allergy problem will be implemented.

2. Literature Review

In this chapter, certain topics will be explained based on the review that has been done on several works from the literature. The materials reviewed from the literature includes the information about food allergy, user-centered design, usability testing, and previous related works regarding solution for food allergy problems.

2.1. Food Allergy
Food allergy is a medical condition that triggers abnormal immune reaction occurring on exposure of certain given food [6]. Sensitization occurs when immune system attacks protein that comes with certain food ingredients therefore food-specific antibody is produced that leads to release of histamine and leukotriene. Food allergy is then said to happen when sensitization occurs and the symptoms appear [7]. Basically any kind of food ingredients can cause food allergy. However, as identified by FAO technical consultation in 1995, several ingredients are classified as the most common cause of food allergy. Those ingredients are milk, eggs, peanuts, tree nuts, wheat, soy, fish, and shellfish whom more popularly known as the big eight allergens [8].

2.2. User-Centered Design
User-centered design (UCD), is a design process that ensures the fulfillment of user needs so that a product is made usable for the users to accomplish their goals and is able to deliver delightful experience for them [9]. By using UCD, designer focuses on the users and their needs when designing a product. Therefore, users are involved throughout the entire design process from the research, design, until testing phase. According to ISO 9241-210:2010 [10], there are several activities that must be present in a human-centric design for interactive systems that can also be applied in UCD: 1) understanding and specifying the context of use, 2) specifying the user requirements, 3) producing design solutions to meet user requirements, and 4) evaluating designs against requirements.

2.3. Usability Testing
Usability testing is one of evaluation methods for measuring the usability of a system by doing certain tasks and giving feedback for the next improvement [11]. It is usually conducted in a small sample of users to represent the whole population. According to Nielsen [12], five respondents are enough to bring the optimum result for usability testing.

In usability testing, certain methods like post-test questionnaire and interview are usually featured to generate user feedback. There are also several metrics that can be used for scoring the performance of the system based on the designed usability goals and user experience goals for example:

- Completion Rate
  Completion rate is a fundamental usability metric that measures the completion of a task in either pass or fail. The concept relies on the principle that if a user cannot complete the required task then not much else matters about usability or user experience [13].

- System Usability Scale (SUS)
  SUS is a survey to evaluate the usability of a system or a product in a quick and simple manner [14]. It’s a 10-item questionnaire with a Likert scale response in basis of 1 to 5 originally created by John Brooke. The score of the questionnaire will then be converted ranging from 0 to 100 and can be interpreted using several measures by Jeff Sauro as shown in Figure 1 [15].
Figure 1. Five ways to interpret SUS scores [15]

- **User Engagement Scale (UES)**
  UES is a research tool that is developed by O’Brien and Toms to measure user engagement in various digital domain. It is originally a 31-item questionnaire with a Likert scale response in basis of 1 to 5. UES Short Form (UES-SF) on the other hand, is a simplified version of UES (or also known as UES-LF) that consists of 12-item with the same Likert scale response. The questions are arranged randomly and the score will be the sum of all responses with exception that several statements which are PU-S1, PU-S2, and PU-S3 getting reverse-coded [16].

2.4. **Related Works**

There are several topics that are related to the study of food allergy problems and the solutions that involve technological innovations. Many of them include software-related solutions covering from the software engineering perspective until the algorithm implementation perspective while there are also technological innovations that focus on creating devices and tools.

Numerous applications on the store that are designed to solve food allergy problems generally provide functionalities to help people with food allergy choose the best option out of many that are available to buy. It usually includes barcode-scanning functionality to display ingredients or ingredients filter to sort foods that may or may not contain certain allergens. Those applications available in Indonesia are for example Allergy Life and Infood. Another example, as mentioned by Grifantini (2016) in her paper, is ipiit, an application launched by San Francisco-based cofounders that help the users search for any potential allergens in the products they are about to buy and suggest alternative products based on their personal preferences [20].

Software-based solution in form of information system was also proposed by Kayo Iizuka et. al (2011). They suggest that the problem could be solved with a web-based information system that supply supplementary information for people with allergy to help them buy products or foods when they go out shopping or eating out at restaurants. The information system consists of three main functions: helping the users buy the desired products based on their preferences including price, location, availability, and safety; helping the users look for desirable restaurants nearby or choosing the safe menu based on preferences; and building social networking service to help people with food allergy share information about food allergy [21]. Based on the explanation on the paper, there may have been only the first two solutions implemented in the web-based information system.

3. **User Research and Analysis**

This chapter will discuss the user research methods and process in understanding the users’ problems. The result of the user research is presented in the form of user problems and user needs. After analyzing the user needs, the feature analysis will be presented as the base of the proposed solution along with the usability goals and user experience goals to accommodate the better usability and user experience for the design implementation.

3.1. **Research Methods**

Several researches were conducted using different methods both qualitative and quantitative including preliminary usability testing for several food allergy applications, questionnaire, and interview to
identify the context of use which consists user problems and user needs. Proposed features are then identified based on the user requirements to become the basis of implementation.

Target users are people with food allergy from 13 to 60 years old. The age 13 is the minimum age for a person allowed to have gadgets recommended by Indonesian ministry KemenPPPA [17]. Meanwhile, the age 60 is considered the maximum age of mainstream users defined by NNGroup [18]. Target audiences for the research is similar with the target users. The preliminary usability testing and the interview are conducted with 5 participants where the questionnaire is filled in by 108 respondents.

3.2. User Requirements

The result of the research is then analyzed to identify the context of use. Result of the questionnaire provides overview about the users such as user profiles, user habits, user knowledge and experience in using food allergy application, and user preferences. Besides, preliminary usability testing gives insight about the usage of food allergy applications regarding user behavior and the improvement that can be made from the existing applications. The interview on the other hand shows supporting facts and ideas that provide helpful hints for the analysis. Based on the analysis result, the user problems are identified in Table 1 as follows.

| No. | User Problems |
|-----|---------------|
| 1   | Complete food ingredients is hard to access |
| 2   | Food-making process and the tools used for making the food that may contain allergens are unknown |
| 3   | The available information about food ingredients is doubtful |
| 4   | The available information about food-making process and the tools used for making the food is uncertain |

After identifying the user problems, user needs are mapped to sort out the user needs that will be used in determining the proposed features. User behaviours are also taken into consideration in identifying the user needs including the kind of places the users usually buy the food from. User needs are identified in Table 2 as follows.

| No. | User Needs |
|-----|------------|
| 1   | See the complete restaurant’s food ingredients list |
| 2   | Know if there are any other possible substances that might be contained throughout the food-making process in the restaurant |
| 3   | See the complete packaged food ingredients list |
| 4   | See the complete street food ingredients list |
| 5   | Know if there are any other possible substances that might be contained throughout the food-making process in the street vendor |
| 6   | Find recommendation of allergy-free foods |

3.3. Feature Analysis

Based on the user requirements identified on previous section, the features for the food allergy information application are analyzed to provide basis for producing the design solutions. The idea is to give a notion that user needs are fulfilled if these features are implemented in the design solution. However, the design should also consider the usability goals and user experience goals in addition to the implementation of these features. Besides, the insights from preliminary usability testing are also taken into consideration in formulating the features. The proposed features and the description of the features are identified in Table 3 as follows.
### Table 3. Proposed Features

| No. | Feature Name                | Description                                                                 |
|-----|----------------------------|-----------------------------------------------------------------------------|
| 1   | Allergen input             | To organize the list of user’s food allergens                               |
| 2   | Merchant overview          | To display overview of the safety of foods provided by the merchant         |
| 3   | Food overview              | To display overview of the safety of the food                               |
| 4   | Food review                | To display detailed information of the safety of the food including other users’ reviews |
| 5   | Review input               | To facilitate user review for purchased food                                |
| 6   | Packaged food overview     | To display overview of the safety of the packaged food                      |
| 7   | Packaged food details      | To display detailed information of the safety of the packaged food          |
| 8   | Allergy-safe recommendation| To sort allergy-free foods easily                                          |

3.4. Usability Goals and User Experience Goals

Usability goals and user experience goals should be designed to solve the main usability and user experience issues as shown in existing applications. The usability goals and user experience goals will also decide the prioritized aspects of the design implementation. The evaluation of the design implementation later considers the usability goals and user experience goals to arrange the testing plan and choice of the metrics for scoring the performance.

According to McCurdie et al. [19], effectivity is an important factor that should be achieved by a mobile health application as it provides the basic parameter that shows if the application successfully intervenes user behavioral change towards healthier behavior. On the other hand, the mobile health application should also provide an engaging experience for the users because only if the users regularly use the application could they achieve the intended goals. Therefore, the usability goals of the application should be effective to use and the user experience goals should be engaging. The designed usability goals and user experience goals are also validated by the result of the questionnaire that is filled in by the target users previously.

### 4. Implementation and Testing

In this chapter, we will discuss the proposed solution and the design implementation for the proposed solution. The discussion will also include the decision-making process and the comparison of the proposed solution to the related works. This chapter will cover the design solution consideration, design implementation, usability testing scenario for the design, and usability testing results with the corresponding analysis.

4.1. Design Solution

Based on the feature analysis as explained on Table 3, generally there comes up two solutions for the architectural design of the solution. The first one is to create a whole new application from scratch that covers all features mentioned previously, for example the supplementary information system proposed by Iizuka and Iizuka that we reviewed earlier on related works. Meanwhile, the second one is to develop current running application that are already used widely. There are certain criteria that need to be considered in choosing the desired architecture while both proposed architectures have their own advantages and disadvantages to be applied such as the flexibility of the development, integration capability, design system, and user experience.

However, taking into consideration of those criteria, developing a widely-used existing application is a more preferable choice for this study with the opportunity of growing on-demand applications in Indonesia. The decision is mainly supported by the fact that lately there has been an increasing popularity in the usage of on-demand applications where a person’s needs in many fields are fulfilled in a single application including food delivery service and health service where both fields
are the main scope of this research. On the other hand, those popular on-demand applications in Indonesia such as Gojek and Grab provide comprehensive integration capability in their products while also offer a quite mature design system that deliver a good user experience for the customer. In this case, Gojek will be the platform where the solution of this research will be implemented because the availability of its published design system. Nevertheless, regardless of the platform, any architectural design and the platform of implementation might also be implemented in future research.

4.2. Implementation

Gojek is an on-demand application that features various services for its users including food delivery, health, transport, payments, logistics, and many more. The scope of the application that will be covered in the design implementation will include only 3 products which are GoMed, GoFood, and GoMart. GoMed will be redesigned to facilitate the allergens management system while GoFood and GoMart will facilitate the purchase of safe foods and safe packaged foods respectively.

There are some aspects that differentiate this proposed solution compared to Iizuka’s supplementary information system. This proposed solution mainly focuses on integrating the proposed features into the current design of Gojek application. Integration will provide more usability in terms of simplicity in ordering food compared to using two different systems for achieving the goal of getting food ordered. The integration to Gojek application will also be supported by a proven abstraction of shopping and eating out in restaurants (two main functions in Iizuka’s supplementary information system) which are implemented in GoFood and GoMart. Besides that, the SNS concept that was also proposed for the supplementary information system will be fully implemented in this proposed solution in the form of food reviews by other users that have ordered the same food.

On the design aspects, Gojek’s design system called Asphalt will also be implemented in the prototype along with some new components. Design implementation is done in two iterations, low-fidelity prototyping and high-fidelity prototyping, for the design prototype has already reached the desired result on the second iteration. The complete details of design implementation will be explained further as follows:

- **GoMed**

  In GoMed, the allergen input feature is implemented under the name GoAllergy (see Figure 2). GoAllergy basically provides a way for the user to input their allergens either by searching for the allergens or by browsing complete list of allergens by categories. An allergen is classified as a mild one or a severe one to be calculated and labeled later for the other features such as food overview and food review. The allergen classification is designed to help users decide if any food is safe by looking at the displayed labels.

- **GoFood**

  In GoFood, some features are implemented that consist of merchant overview, food overview, food review, review input, and allergy-safe recommendation. The journey a user normally takes until they get their food ordered includes choosing a restaurant (merchant), choosing food items, payment, and giving reviews for the food. Taking into account that scenario, all the features implemented in GoFood are designed to assist the users in ordering safe foods in the entire phases.

  Merchant overview displays information that is needed by the user to choose the most suitable merchant to order safe foods from, such as the user’s order history from that merchant, the amount of safe foods provided by the merchant, and the amount of foods reviewed by the user (see Figure 3). The information is initially hidden until the user swipes the carousel right on the merchant list to incorporate the old design where the general merchant information (price range, distance, etc.) is considered more important. Aside from the choosing merchant page, if the user wants to look for certain foods or merchants by search, the allergy-safe recommendation feature provides an additional ‘Allergy-safe’ filter to sort the search results from the safest merchant or the safest food first (see Figure 3). Then, after the user chooses the desired merchant from the list, they will typically choose the foods they want to order. To help them choose the safe foods, food overview feature comes in handy.
Food overview displays information whether a food is safe with two labels: the food’s recipe and the tools used in the food-making process (see Figure 4). The label shows if they are safe, might contain mild allergens, or might contain severe allergens. The goal is to have the user decide if any food is safe simply by looking at the labels because usually the food list consists of many items to choose from. If the user needs more information regarding the allergens, it will be facilitated in the food review page where more detailed information is given including food rating, list of possible allergens contained in the recipe and the tools provided by the merchants, and reviews from other users who previously ordered the food (see Figure 4). Finally, when the user has successfully ordered the food they can fill in a review for the food. The review input page is redesigned so that it can facilitate the user to mention if they feel like any allergen is contained in the food after consuming it. The user is able to choose as many allergens from their list of allergens they put in the GoAllergy.

- GoMart

In GoMart, there are three features implemented which are packaged food overview, packaged food details, and allergy-safe recommendation (see Figure 5). Compared with GoFood, the journey the user takes until the order is complete is basically similar. It makes the implementation of packaged food overview and packaged food details also follow the same design aspects as food overview and food review except for the review part. Packaged food does not necessarily need to be reviewed as it is usually manufactured in a large-scale production and is usually less custom unlike the foods provided by restaurants.

The allergy-safe recommendation is also implemented with the same pattern like the one implemented in GoFood (see Figure 6). The difference is only where in GoMart user does not have to choose merchants as it is automatically assigned by the system so that the allergy-safe recommendation implementation is made only on products filter. An additional ‘Allergy-safe’ filter is added for the existing sort feature which will sort out the products in the list from the safest ones first.

4.3. Usability Testing Scenario

The design prototype as explained on previous section is then evaluated using usability testing method to measure the usability and user experience of the solution. Usability testing for low-fidelity prototype is conducted with 5 participants while high-fidelity prototype is conducted with an additional participant making it 6 participants in total. The usability testing is moderated, done remotely via conference for two participants and in-person for the rest of the participants. The participants are assigned several tasks to complete and they are also given time to adapt to the design prototype. The tasks assigned to the participants are listed as follows:

- User fills in list of allergens
- User decides which restaurants to order food from
- User looks at the food menu and decides which food to order
- User looks at detailed information about the food and decides if the food is safe
- User gives review about the ordered food
- User looks at the packaged foods list and decides which product to order
- User looks at detailed information about the packaged food and decides if the food is safe
- User searches for a certain merchant or food and decides which one to choose from

Usability goals and user experience goals are measured in the usability testing using several metrics for each goal. The metrics will then be interpreted to score the performance of the design prototype. The usability goal ‘effective to use’ is measured using two metrics; completion rate and SUS questionnaire while the user experience goal ‘engaging’ is measured using UES-SF questionnaire. Completion rate is calculated by directly observing participant’s capability in completing the assigned tasks with SUS and UES-SF questionnaire are given together with the post-test questionnaire.
4.4. Testing Result and Analysis
Based on the usability testing conducted on the design prototype as explained previously, result shows that only certain tasks are completed in low-fidelity prototype testing with 65% completion rate in
percentage while all participants are able to complete all the assigned tasks for the high-fidelity prototype testing giving the completion rate of 100% in percentage. With the maximum completion rate achieved, it means that the design prototype is usable and effective to use for the users. Improvements are also seen from the low-fidelity to high-fidelity prototype according to changes made from the user feedback and the refined fidelity of the prototype.

Looking at the other metrics, the low-fidelity prototype is scored 76.5 for the SUS questionnaire and the high-fidelity prototype is scored 85.4. Interpretation of SUS questionnaire classifies the low-fidelity prototype in grade B with good acceptability and Net Promoter Score (NPS) class—users’ likelihood to recommend—being passive. However, the high-fidelity prototype is upgrading to be classified in grade A+, good acceptability, and recommenders for the NPS. Thus, the SUS score also tells similar result as completion rate that the design prototype is generally usable and effective to use.

UES-SF as the metrics to measure engagement, on the other hand, shows the average score of 4.23 for the high-fidelity prototype. UES-SF metrics is only measured on second iteration or high-fidelity prototype usability testing as lower fidelity prototype might still generate biases for the users’ engagement having the visual aspects not yet fully designed. A study about generalizability of UES in exploratory search by O’Brien & Toms in 2013 is used as benchmark for this metrics and shows that the UES-SF result for the design prototype scores higher with 4.23 than the average UES score of 2.81 by comparison in 5-scale Likert. The benchmark gives an insight that the design prototype gives a good engagement having the UES-SF score stand quite above the exploratory search UES average score. Therefore, the design prototype gives an engaging user experience for the users.

5. Conclusion and Future Work
Effectivity and engagement are seen as the suitable usability goals and user experience goals for food allergy information application. Besides that, designing an interaction that assists people with food allergy to purchase safe foods throughout the entire purchasing process also helps to solve their problem. By using the design prototype, people with food allergy can safely purchase foods without having to worry about any allergens being contained their food hence the quality of life can be improved.

Based on the testing result, it shows that the design prototype has 100% completion rate, average SUS score of 85.4, and average UES-SF score of 4.23. The result indicates that the testing participants agree that the design prototype is effective to use and engaging for the users.

As for the future work, the development of interaction design regarding food customization that is able to exclude certain food ingredients will be a great addition to the current result. Besides that, exploring various ways of food ordering, food delivery, and food-making mechanism will also enrich the scope of the research concerning food allergy problems.

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