Developing a Mobile Application for Managing Anaphylaxis: Discovering Critical Success Factors

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Developing a Mobile Application for Managing Anaphylaxis: Discovering Critical Success Factors

KOEN SMIT, JORIS MENES & MATTHIJS BERKHOUT

Abstract Anaphylaxis is a severe and potentially life-threatening allergic reaction that requires immediate treatment. A proposal for the development of a mobile application for supporting anaphylaxis patients was written by a team of allergists, after which this study was performed in order to identify critical success factors for the adoption of such an app. A mixed-method approach is used in order to gather data from a variety of sources, comprising a literature review, a domain expert interview, and a patient survey. One of the most valuable factors proved to be the validation of the medical information provided in the app. Besides this, patients are mostly concerned with the clarity of the presented information. While the proposed app does not fulfill all the identified factors, its development is overseen by medical professionals and endorsed by patient organizations. With a lack of such apps in the Dutch market and the demand indicated by survey respondents, this app has the potential to fill a gap in the support of anaphylaxis patients.

Keywords: • Allergens • Anaphylaxis • Apps • Healthcare • Mobile •
1 Introduction

In this paper, we study a mobile application (app) for supporting anaphylaxis patients. The app was proposed by a team from the department for allergology at the University Medical Center Utrecht (UMCU), a large academic teaching hospital in the Netherlands. The app will be developed in collaboration with physicians and patient groups supporting anaphylaxis patients. Anaphylaxis is a type of immediate allergic reaction categorized as type I hypersensitivity (Gell & Coombs, 1963), further defined as "... an acute, systemic reaction caused by mast cell–mediator release [which is] potentially life threatening" (Yocum et al., 1999). Anaphylaxis may be caused by a number of triggers, also called anaphylaxis agents, such as foods, medication, insect bites or contact with latex (Kemp & Lockey, 2002). Anaphylactic reactions cause symptoms which may be life-threatening and require an emergency response (Schwartz, 1994). The proposed app is intended to support anaphylaxis patients and their caregivers by providing step-by-step assistance in the case of an anaphylactic reaction.

Exposure to allergens that cause anaphylactic reactions may occur via ingestion, inhalation, injection or direct contact (WAO, 2012). Anaphylaxis manifests itself through symptoms such as flushing and itchiness of the skin, difficulty breathing, swelling of the mouth or eyes or an abnormal heart rate (Sampson et al., 2006). An anaphylactic reaction is usually treated by administering a dose of epinephrine (adrenaline) intramuscularly into the thigh using an auto-injector, after which the patient should be admitted to a hospital for further treatment and observation (Sampson, 2003).

The exact prevalence of anaphylaxis is difficult to establish, as people may develop sensitivities to allergens at different points in life, or may be unaware of sensitivities to allergens they have not yet been exposed to. Different studies indicate a 0.5% to 2% prevalence in the world's population (Simons, 2010), a 1.21% to 15.04% prevalence (Neugut, Ghatak, & Miller, 2001) and a 1.6% to 7.7% prevalence in the US population (Wood et al., 2014). Data provided in the app's proposal indicates the prevalence of diagnosed food allergy in The Netherlands at 1-2% in adults and 1-3% in children, with 90% carrying emergency medication. For insect bites, the prevalence is 1-3% among the Dutch population. The morbidity and mortality of anaphylaxis are believed to be underestimated due to limited data on its incidence (Brown, McKinnon, & Chu, 2001; Neugut et al., 2001). Evidence points towards an increase in anaphylaxis prevalence (Liew, Williamson, & Tang, 2009), which may be attributed to changes in diet and medicine use (Sheikh & Alves, 2000).

Besides the physical symptoms, anaphylaxis is shown to have a societal impact by leading to a decreased quality of life and limiting of social activities for children (Sicherer, Noone, & Munoz-Furlong, 2001), as well as proneness to school absence and decreased participation in the labour market for adolescents (Marklund, Ahlstedt, & Nordström, 2007). Several patient groups aim to support anaphylaxis patients by providing information on the internet. Examples are the National Foundation of Food Allergy (in
Dutch: Stichting Voedselallergie) and the Dutch Anaphylaxis Network (in Dutch: Nederlands Anafylaxie netwerk).

This study aims to determine the critical success factors for the adoption of the proposed anaphylaxis app. To achieve this, we conducted a mixed method approach, containing a literature review, a domain expert interview, and a patient survey. The research question addressed in this paper is defined as follows:

RQ: “What are critical success factors for user acceptance of an app to support patients suffering from severe allergic reactions?”

The remainder of this paper is organized as follows. First, we provide information with regards to the anaphylaxis app that will be developed by UMCU, analyze similar apps and identify (critical) success factors for the adoption of such apps in literature in the background and related work section. This is followed by the research method in section three. In section four, the results of the mixed method approach are presented. Lastly, in section five, we reflect on the results and applied research methods in the discussion, conclude upon our study, and propose possible directions for future research.

2 Background and related work

In this section, the anaphylaxis app will be presented and compared to existing applications. Additionally, the literature with regards to Critical Success Factors (CSFs) is explored and discussed upon.

2.1 The anaphylaxis app

The anaphylaxis app studied in this paper was proposed by a team at the department of allergy at the UMCU. The proposal entails a request for funding, which will be needed to start the development of the app for Android and iOS. Currently, no actual app or prototype exists. Development of the app will be performed by the Medical Apps Co-creation Center, also known as MAC³. MAC³ provides centralized services for the development, testing, and research of medical apps. The author of the proposal was interviewed in order to gather background information on the app.

The team at UMCU collaborates with the National Foundation for Food Allergy, the Dutch Anaphylaxis Network and the domain group for eczema, which is a part of the Dutch Society of Dermatology and Venereology. These contacts are used to establish requirements for the app and to foster its acceptance in the medical community.

The purpose of the app is to provide a better alternative compared to the leaflets that are usually given to patients by physicians, alongside anaphylaxis medication. Such leaflets provide information on emergency procedures but are not always carried by the patient. The app should improve the availability of this information by residing on the
smartphones of patients or caregivers. The information provided will be personalized depending on the type of reaction (caused by food or insect bites), the severity of the reaction and the medication the patient uses. Information on reactions caused by other, less common triggers is not explicitly included, but may be covered by the available information on treating reactions caused by food or insect bites.

Besides providing assistance in the case of an allergic reaction, the app will provide background information on allergic reactions to be consulted at any time. While similar apps already exist in countries such as the UK and Australia, an app geared towards the Dutch market that is endorsed by patient organizations and contains validated medical information and instructions is not yet available. Country-specific apps are also needed because of differences in medications available per country.

2.2 Related apps/games

The current offering of anaphylaxis-related apps was studied in order to explore similarities and differences compared to the proposed app. Apps were collected by performing the search query: ‘Anaphylaxis’ and ‘Allergy’ on the Google Play Store and the Apple App Store, including related apps for any identified app that resulted from our search. The apps and their characteristics, features, and ratings are compared in Table 1.
Table 1: Related app comparison

<table>
<thead>
<tr>
<th>Name</th>
<th>Anaphylaxis</th>
<th>Jext</th>
<th>Anaphylactic Shock</th>
<th>Anaphylaxis1 01</th>
<th>Anaphylaxis Allergy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developer</td>
<td>Coventry Univ.</td>
<td>ALK-Abelló</td>
<td>Small cog</td>
<td>Mylan</td>
<td>Phacia Inc.</td>
</tr>
<tr>
<td>Platform</td>
<td>iOS</td>
<td>iOS, Android</td>
<td>Android</td>
<td>iOS, Android</td>
<td>iOS</td>
</tr>
<tr>
<td>Price</td>
<td>Free</td>
<td>Free</td>
<td>€ 1.16</td>
<td>Free</td>
<td>$ 0.99</td>
</tr>
<tr>
<td>Install base</td>
<td>Unknown</td>
<td>100-500</td>
<td>10-50</td>
<td>100-500</td>
<td>Unknown</td>
</tr>
<tr>
<td>Target market</td>
<td>UK</td>
<td>UK</td>
<td>General</td>
<td>US</td>
<td>US</td>
</tr>
<tr>
<td>Vendor-specific</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>General information</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Personalized advice</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Emergency contacts</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Expiry reminders</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Facility Locator</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Most apps provide similar functionalities, some being more extensive than others. Such functionalities may include general information about anaphylaxis and allergies, instructions for emergency procedures and the use of auto-injectors, medication expiration reminders and interactive maps for finding nearby medical facilities. All apps found are aimed at anaphylaxis patients or caregivers. As evidenced by the available data on the number of installations, there does not appear to be one particularly popular anaphylaxis app. Install base data is only available on the Google Play Store and not on the Apple App Store. In terms of ratings and evaluations of the app, no information was found originating from independent sources.

Some of the compared apps are free to use, while others require a small fee. Apps such as the one made by Coventry University are intended for a more general audience of anaphylaxis patients, while the Jext app developed by ALK-Abelló is to be used specifically by patients using Jext-branded auto-injectors. The former app is also the only app found that is endorsed by a local patient organization, namely the UK Anaphylaxis Campaign.
2.3 Critical success factors

The current body of knowledge on critical success factors in the context of this study consists of research on both (mobile) allergy management in general and anaphylaxis management. The available literature, which consisted of nine relevant papers, is presented in three main categories; preventative information, providing assistance, and mobile healthcare.

2.3.1 Preventative information

Mobile technology is used in several ways to support patients suffering from allergies or anaphylaxis. One of these ways is providing preventative information by enabling patients to scan food items or medications through the use of barcode or NFC technology. A general study into smartphones and barcode scanning by Eichler & Luke (2009) describes a prototype developed by Deutsche Telekom Laboratories called 'Allergy Warner', which provides an alert message when scanning barcodes of food products in the supermarket. The app will contain a personalized allergy profile which looks for matching ingredients in the scanned products. Eicher & Luke argue that modern smartphones can quickly and easily scan and recognize multiple types of barcodes, making them suitable for this purpose.

A similar study by Gassner, Vollmer, Prehn, Fiedler, & Ssmoller (2005) concludes that reliable information about food products is difficult to obtain because of different interests of stakeholders in the food value chain. A mobile app that provides such information would fill a gap in the market. Ottenhof (2010) provides a proof of concept for a device-based solution (DBS) that allows customers in supermarkets to scan product packages for allergy information. However, Ottenhof concludes that a lack of information provided by manufacturers proves to be an obstacle. Stierman (2009) found that scanning product packages make it easier for patients to retrieve allergen information. Patients were more likely to buy products they were unfamiliar with thanks to a scanning solution.

A study by Möller, Diewald, Roalter, & Kranz (2012) evaluated an application called MobiMed, which allows users to scan medicines in different ways, either through text search, barcode scanning, visual search or Near Field Communication (NFC). This app could then be used to warn patients for medicines that would put them at risk of allergic reactions. Extracting information through NFC was found to be the fastest and most preferable method because the user does not need to search for and scan a barcode. However, the integration of NFC technology in smartphones and packaging is not yet widespread.

Ottenhof (2010) found that NFC (or similarly, RFID) technology provides the best matching capabilities because of its high storage capacity and the possibility to tag products on an item level rather than by product type. While this information is easily extracted by modern smartphones, the implementation of RFID/NFC on packaging is
relatively expensive. Scanning of standard EAN-13 barcodes is the cheapest in terms of implementation since products are already equipped with these barcodes. However, EAN-13 has a low storage capacity and can only identify products on a product level. A backend that provides additional information would be needed. Problems could occur when the composition of one type of product with the same barcode changes over time.

When looking at the current literature on providing preventative allergy information to patients, we can conclude that there are still some improvements that can be made to cater to patients. In terms of retrieving the information, a universal, fast and cost-effective method needs to be found to provide contextual information about physical products on a smartphone. Additionally, manufacturers of medicines and food products need to provide allergen information that is easily accessible for consumers.

### 2.3.2 Providing assistance

A series of works by Hernandez et al. describes a personal mobile health device and the associated app used to alert emergency services automatically when an auto-injector is administered to a patient (Hernandez Munoz & Woolley, 2009, 2010; Hernandez Munoz, Woolley, & Baber, 2008). The solution, called PervaLaxis, uses an accelerometer connected to an auto-injector to detect its usage, which is signaled wirelessly to a smartphone using Bluetooth. Emergency services can be contacted automatically through the phone.

In a later study, PervaLaxis was further validated by involving patients (Hernandez Munoz & Woolley, 2010). A pilot study was performed, after which the patient sample was increased over time. Use case diagrams were used to test usability and determine important success factors for the solution. These success factors are reported to be: adrenaline injectors expiry alerts, an emergency support button, and adrenaline injection sensing. Limitations identified for this solution were the reliability of the mobile phone transmission and the accuracy of the injection sensor.

Other works suggest that instructions for providing assistance to patients should be segmented towards different user groups. This may be done based on the age of the patient and the number of years of experience they have with their illness. Further personalization of the app could be of use here (Miles, Valovirta, & Frewer, 2006; Yu & Ramani, 2006).

### 2.3.3 Mobile healthcare

Obiodu (2012) studied the top 500 medical apps in the Android market and concluded that the majority of apps are designed for healthcare professionals, while it is plausible that most end-users are patients rather than healthcare professionals. One significant problem is that it is often unknown whether medical apps intended for patients provide information that is validated by medical professionals (Haffey, Brady, & Maxwell, 2013).
In practice, it is found that medical professionals are often not involved in the development process of medical apps, or that there is a lack of validated sources available in the app (Buijink, Visser, & Marshall, 2013; Rosser & Eccleston, 2011). Beyond this, there are no obvious signs to distinguish medically validated apps from apps that have not been validated, such as an international mark of quality. When an app does not offer a diagnosis, treatment or cure, it cannot be classed as a medical device and will not be subject to the thorough scrutiny of such medical devices. (McCartney, 2013) However, the general information or advice provided by such a medical app may still cause harm to the patient. An increasing number of apps published and the lack of an international safeguard for monitoring medical apps undermines patient safety (Cook & Nolan, 2011; McCartney, 2013; Visvanathan, Hamilton, & Brady, 2012).

2.3.4 Critical Success Factors

The literature contains 9 relevant contributions with regards to CSFs applicable in our study. The CSFs of the app can be defined as follows:

1. The information is context-aware through scanning of physical objects;
2. The information is easy to retrieve;
3. The information improves the user's understanding of the subject.

When looking at the ability of the app to provide assistance in the event of an allergic reaction and general characteristics of mobile healthcare, the following success factors were identified:

4. The app should provide advice that is validated by medical professionals;
5. The app should provide advice that is tailored to the user's medicines;
6. The app should provide advice that is tailored to the characteristics of the user, such as age or level of experience.

In Table 2, the critical success factors are linked to the papers from the literature review. In the header row, the six CSFs identified earlier are transformed into keywords.
Table 2: Meta-analysis regarding CFSs in the current body of knowledge

<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(Eichler &amp; Lüke, 2009)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>(Gassner et al., 2005)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Ottenhof, 2010)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>(Stierman, 2009)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>(Möller et al., 2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>(Hernandez Munoz et al., 2008)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Hernandez Munoz &amp; Woolley, 2010)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Hernandez Munoz &amp; Woolley, 2013)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>(Miles et al., 2006)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Yu &amp; Ramani, 2006)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

3 Research method

3.1 Interview

In this section, we describe the setup, deployment and the evaluation of the interview with a domain expert who is a representative and the founder of the Dutch Anaphylaxis Network, known as NAN in Dutch. The NAN informs and provides support to patients while also keeping in touch with stakeholders, such as food producers, on current issues surrounding allergies.

As the interview is semi-structured of nature, the following topics are discussed:

1. The current necessity of an app;
2. Existing knowledge on mobile applications concerning allergy or anaphylactic patients;
3. Critical success factors concerning user acceptance of an app;
4. Additional comments or advice.
With regards to CSFs, the domain expert was first invited to provide his own insight into possible CSFs and then asked to evaluate the CSFs identified during the literature review. This was done in order not to create a possible bias by first presenting our findings derived from literature.

3.2 Survey

Following the literature review and domain expert interview, a survey was conducted among a sample of patients in order to gather further data on CSFs. As described in section one, the proposed app is aimed at the Dutch market, with a prevalence of diagnosed food allergy at 1-2% in adults and 1-3% in children, with 90% carrying emergency medication. For insect bites, the prevalence is 1-3% among the Dutch population, as indicated by the proposal of the app. All patients in The Netherlands who may be at risk for anaphylactic shock are included in the scope of the survey.

The survey was designed to first establish basic information about the patient, such as their age and the number of years of experience they have with anaphylaxis. The patient was also asked if they are familiar with smartphones, including the total years of use and a self-assessed competency rating. A number of possible functionalities for the app were presented to the participants, for which they could indicate their desire for such a functionality in an anaphylaxis app on a Likert scale. These functionalities were adopted and where needed adapted from results of the literature review and domain expert interview. An open-ended question provided respondents the possibility to provide additional functionalities. The ratings given for the functionalities were then used to determine the most valuable functionalities and therefore CSFs for the adoption of the app. Another set of questions adopted from the System Usability Scale (SUS) and Technology Acceptance Model (TAM) determined which usability factors were deemed most important by patients, such as the clarity of the presented information and the interactivity of the app. Finally, the respondents were asked to rate the likeliness of using an anaphylaxis app on a scale of 1 to 10.

4 Results

In this section, the results of the interview and the patient survey are presented.

4.1 Domain expert interview

The domain expert was positive about the concept of an anaphylaxis app. There is a necessity for such a solution in the domain. With regard to replacing paper leaflets, an app may be useful, but only until the patient has familiarized himself with the information. After this, the app will need additional functionalities to engage and support the patient, such as training users to identify and avoid possible anaphylactic triggers.
The domain expert identified the following CSFs for the adoption of an anaphylaxis app:

1. The app should focus on including avoidance strategies for potential anaphylactic triggers.
2. The app should include gamification, such as a quiz used to test knowledge on allergens and emergency procedures, both for the patient, caregivers as well as friends or family.
3. The app should focus on different user groups since the information needs of each group can differ. Adolescents may more easily ignore food warnings, for example, making it necessary to address them in a different way.
4. The app should be interactive, rather than just providing static content.
5. The app should be free. Earlier research by the domain expert concluded that paid-for apps lead to low adoption rates among patients.

4.2 Patient Survey

Contacting patients directly through UMCU proved to be difficult and time-consuming due to the clearance procedures involved. The decision was therefore made to deploy the survey on the website of the NAN, with help of the domain expert interviewed earlier. The NAN receives about 500 unique visitors per day on their website. The survey was featured on the front page for a period of 6 days between from the 21st up until the 26th of June 2014. Patients could voluntarily and anonymously fill out the survey on the website.

276 respondents filled out the survey. The sample consists out of 16.7% male and 79.7% female respondents (3.6% unknown), with an average age of 40.96 years (s = 11.17). Our respondents have an average of 9.81 years of experience with anaphylaxis (s = 7.514). 93.1% of respondents indicate owning a smartphone. With a 46% percent share, Android is the most used mobile operating system, closely followed by iOS at 39.1%. The remaining share goes to other or unknown operating systems (13.8%) and Blackberry (1.1%). The average number of years respondents have been using a smartphone is 3.95 years (s = 2.511). They rate their own competency in the use of mobile phones with a 7.75 (s = 1.797) on a scale of 1 to 10.

The desirability of an app to support anaphylaxis patients is rated with an average of 8.34 on a scale of 1 to 10 (s = 1.787), while the probability of the respondents using such an app is rated with an 8.75 (s = 1.903). The three most compelling app features indicated by respondents are the clarity of the information, the medical validation of the information, and the availability of information regarding emergency procedures, with average scores of 6.68, 6.62 and 6.48 on a scale of 1 to 7, respectively. The aspect rated as least important are the presence of an element of play (gamification), a quiz to test allergy knowledge and interactivity of the app, with average scores of 2.66, 3.33 and 4.50, respectively. All CSFs are shown in table 3.
Table 3: Survey results

<table>
<thead>
<tr>
<th>Requirement</th>
<th>N</th>
<th>Missing</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The app must present the information in an organized manner</td>
<td>274</td>
<td>2</td>
<td>6.68</td>
<td>0.651</td>
</tr>
<tr>
<td>The app must have a medical validation of the provided information</td>
<td>275</td>
<td>1</td>
<td>6.62</td>
<td>0.799</td>
</tr>
<tr>
<td>The app must scan product barcodes for information</td>
<td>273</td>
<td>3</td>
<td>6.48</td>
<td>0.944</td>
</tr>
<tr>
<td>The app must give information about emergency procedures</td>
<td>274</td>
<td>2</td>
<td>6.48</td>
<td>0.999</td>
</tr>
<tr>
<td>The app must have a list of predefined emergency contacts</td>
<td>275</td>
<td>1</td>
<td>6.43</td>
<td>1.038</td>
</tr>
<tr>
<td>The app must give advice about allergy triggers</td>
<td>276</td>
<td>0</td>
<td>6.31</td>
<td>1.328</td>
</tr>
<tr>
<td>The app must give advice about the expiration date of the medicine</td>
<td>274</td>
<td>2</td>
<td>6.18</td>
<td>1.23</td>
</tr>
<tr>
<td>The app must give guidance for recognizing products with specific ingredients</td>
<td>275</td>
<td>1</td>
<td>6.11</td>
<td>1.35</td>
</tr>
<tr>
<td>The app must have guidance for recognizing specific ingredients</td>
<td>276</td>
<td>0</td>
<td>6.03</td>
<td>1.366</td>
</tr>
<tr>
<td>The app must give advice about the used medicine</td>
<td>276</td>
<td>0</td>
<td>6.03</td>
<td>1.373</td>
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<tr>
<td>The app must be free of charge</td>
<td>274</td>
<td>2</td>
<td>5.48</td>
<td>1.781</td>
</tr>
<tr>
<td>The app must be able to share my allergy information with my surroundings</td>
<td>276</td>
<td>0</td>
<td>5.34</td>
<td>1.799</td>
</tr>
<tr>
<td>The app must look attractive</td>
<td>276</td>
<td>0</td>
<td>5.03</td>
<td>1.523</td>
</tr>
<tr>
<td>The app must show basic information about allergies</td>
<td>273</td>
<td>3</td>
<td>4.73</td>
<td>1.953</td>
</tr>
<tr>
<td>The app must be interactive</td>
<td>274</td>
<td>2</td>
<td>4.5</td>
<td>1.895</td>
</tr>
<tr>
<td>A quiz to test the knowledge about allergies</td>
<td>273</td>
<td>3</td>
<td>3.33</td>
<td>1.827</td>
</tr>
<tr>
<td>The app needs a challenging game element (gamification)</td>
<td>274</td>
<td>2</td>
<td>2.66</td>
<td>1.694</td>
</tr>
</tbody>
</table>

The open-ended question in the survey asking patients for other desirable functionalities yielded many results. The functionalities provided were categorized by similarity. 22 respondents indicated the desire for a functionality that helps to translate allergens and emergency instructions into another language for when the patient is traveling. 12 respondents wish for an alarm button that can quickly contact emergency services and other predefined contacts, and another 12 respondents wish for a newsfeed containing updates on medication or treatments.

5 Conclusion & Discussion

The research questions addressed in this paper was defined as follows: What are the critical success factors for user acceptance of an app to support patients suffering from allergies? To answer this research question, we looked at the results of the analysis of the
current body of knowledge, the domain expert interview and the patient survey that were performed during this study. The various factors gathered from different sources indicate that a broad range of features is possible in an app that supports anaphylaxis patients. However, different features may appeal to different subgroups of patients depending on the severity of their symptoms, their age, and experience with their illness, among other factors.

In literature, a number of studies were found concerning food allergies in general and specific measures for anaphylaxis. The studies on food allergies noted the possibility to scan food packaging as a critical success factor for user adoption in their specific context. The studies related specifically to anaphylaxis, such as the study concerned with automatically detecting the activation of an adrenaline injector through a Bluetooth accelerometer, were more concerned with the validity of the information provided by the accompanying app. However, the UMCU has already indicated that such features will not be included in the app at this time. The factors that remain, based on literature, are that the app should contain medically validated information, be easy to use and improve the user’s understanding of the subject, and be sensitive to different user groups. The proposed app will adhere to these factors.

The domain expert indicated a number of new factors mainly relating to the interactivity of the app and having certain quiz or gamification elements that test the knowledge and train them to avoid allergens. Another factor mentioned was that the app should be free in order to boost user adoption. Patients surveyed agreed with this, although they did not appear to be very enthusiastic about gamification or quizzes. Once more, new factors were introduced after the patient survey such as the ability to translate allergens and procedure information, providing a newsfeed and a list of predefined emergency contacts. The factors for the medical validation of the information and the availability of clear emergency procedures were also rated highly by patients. Another interesting factor is that patients indicated they would overall be very likely to use such an app.

In relation to all of the features that were established in this study, the proposed anaphylaxis app appears to be relatively limited in features. However, the team at UMCU has indicated that the proposed app should be simple and straightforward to use. The decision was made not to include features such as scanning of objects or giving extensive information on types of food that contain allergens. Even though the app does not contain all functionalities that may be seen as critical success factors, the app may still prove to be of added value for patients when its functionalities are fit for purpose. The simplicity of the app will also contribute to the clarity of the information, which was another success factor.

An effectiveness study will have to reveal the actual usefulness of the app for patients. The current body of knowledge related specifically to anaphylaxis apps is rather small and anaphylaxis apps are a relative niche market within the medical app landscape, making it difficult to predict the effects the CSFs will have on actual user adoption.
Beyond this, we recommend the team at UMCU looks into the possible expansion of the app in the future, in order to include some of the features that were indicated as being desirable for patients. Moreover, our results also indicate a selection of lower rated functionalities for the app. For example, the functionality that was rated lowest in our results was the functionality regarding the addition of a challenging game element (gamification). While we believe that our survey was conducted with the aim to gather data from the appropriate user groups, some of the respondents indicated to be a parent or caregiver. This is usually the case with younger children. There could be a difference between how a sample drawn solely from patient groups versus our sample rate the functionalities presented in a survey. Currently, our results are difficult to link with the existing body of knowledge as no uniform opinion exists on the importance of CSFs and related functionalities.

Besides the methods used in this study, further validation should be performed using other patient organizations, medical professionals, domain experts, and patients. In this study, we were only able to contact one medical professional (the author of the proposal for the development of the app) and one representative of a patient organization (the domain expert). Therefore, the results of the survey could be affected by the input from the results of the interview, which were derived from one subject-matter expert. The generalizability of our results could be improved by involving more subject-matter experts from different perspectives (i.e. medical specialties, medical informatics, and academics). In addition to the Dutch market, the development team could also get into contact with other international organizations who have previously developed similar apps in order to find out more about their lessons learned.

All in all, we believe that the current potential success of the app lies in the fact that it is being developed by medical professionals in collaboration with patient organizations, which is a highly regarded success factor. In addition, the app will be available for free and is targeted towards the Dutch market, where no such app currently exists. The information given about emergency procedures may indeed prove to be a useful replacement to paper leaflets, once doctors start prescribing the app alongside anaphylaxis medications. From a theoretical perspective, our study provides an overview of CSFs and the importance of those CSFs in the context of a substantial Dutch sample geared towards the development of an app to manage anaphylaxis. From a practical perspective, our results provide direct evidence and directions for development and help in the prioritization of the development of functionalities in similar apps.

References


