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ORIGINAL ARTICLE

Rule-Based Technique for Food Ingredient Aware Mobile Application

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Abstract

Food additives may come from natural and chemical sources. In some countries, this ingredient is coded into e-numbering system. E-Number identifies the additive substance, and it can be used to determine its possible sources hence the halal status and its value for health. However the use of scientific name or the coded number is confusing to consumers. This article presents an android-based mobile application that provides a database access to the detailed information about the additives. Information retrieval is done based on rule-based technique. The application also offers customer profiling services whereby upon user registration and sharing current health conditions, the consumer will be provided with extra information on the possible consequences of consuming the food. The system prototype system was analysed for the usability in terms of user satisfactions using System Usability Scale (SUS). The user satisfaction is rated from good to excellent according to SUS score in the range of 70%-80%. The application is expected to increase consumers' awareness of choosing the right food that is halal and healthy.

Keywords: Food additives; halal food; E-Number; rule-based technique; user satisfaction.

Introduction

Food intake is related to the development of human wellness and behavior. Foods that are freshly available from the market are considered as the best choice (Chamhuri and Batt, 2013). Such food can easily be identified by its sources and therefore religious and healthiness judgments can precisely be made at once. However, there are foods that normally do not come with simply information about its source such as imported and canned foods. In fact, the use of food additives in this type of products is not uncommon.

Food additives may come from natural sources as well as chemical source (Li et al., 2014) In some countries, the additive is coded into e-numbering system. E-Number identifies the additive substance, and it can be used to determine the source of it. Some consumers are very sensitive to certain ingredients due to their belief as well as their health (Newcombe, 2013; Pandey and Upadhyay, 2012). Therefore, these sources of ingredients need to be made known to the public so that consumers can properly decide which food to consume.

In Malaysia, consumers can get halal food by identifying the Malaysian Halal logo that is recognized by the Department of Islamic Development Malaysia (JAKIM) on the food label. However, other products that come without halal certificate have been a major concern for many Muslims of where these come from. Many of consumers know that, most of the on-the-shelf food contains additive ingredients. In addition to halal status, some additive is not safe for consumption especially those with health problems. The use of food additives has caused many diseases such as inflammatory, metabolic syndrome and cancer (Rood, 2015).

This article proposed a mobile-based application that provides information about the halal status (Halal, Haram and Makruh) and health information (safe, allergic and etc.) of the ingredients based on E-Numbers as user guidelines. The application used the concept of rule-based technique for searching the list of allergies and risks for a particular individual based on the E-Numbers which is followed by a reporting on the user's screen. The development methodology of this system relies on user center design (UCD). Developed system also considers the elements of Human Computer Interaction (HCI) namely usability that consist of effectiveness, efficiency and satisfaction of the system. The system is tested by the users for measuring the usability, namely user satisfaction and are geared as a catalyst to help users use the system based on their criteria for anytime and anywhere.

This paper is organized as follows. In second section namely Background Studies, we investigate the concept of halal and healthy food. In Proposed Application section, we introduce the design and the development of the proposed application, followed by user acceptance test for evaluating the degree of usability of our application. Result and Discussion section shows some results from this application and finally we conclude this work in the Conclusion section.

Background Studies

Food additive is a substance added to food to enhance its flavor or appearance or to preserve it. E-Numbers are codes for food additives that typically found on food labels throughout the European Union. Each additive is assigned with a unique number, and the numbering pattern follows that of the International Numbering System (INS) as determined by the Codex Alimentarius committee (Vesley, 1999). EU law requires most additives used in foods to be labeled clearly in the list of ingredients, either by name or by an E-Number. The e-numbering is used to regulate the additives and as a platform that informs consumers about food additive. In whole, each food additive has to be named or numbered. The E-Number can be classified as antimicrobial agents, antioxidants, artificial colors, artificial flavors and flavor enhancers, chelating agents and thickening and stabilizing agents (Güngörmüş and Kılıç, 2012).

There are many concerns about e-numbered ingredients. Two most important concerns are related to religious belief and healthy consumption (English). Muslims belief in the purity of the sources as well as the treatment during the preparation. According to Quranic term, the halal (lawful) status was given to the ingredients which are obtained from 100% halal raw materials without use of alcohol. Such sources are normally that of plant and chemical based material. On the other hand, haram (unlawful) ingredients are those obtained from animal source (such as pork) or use of alcohol. Halal animal but unslaughtered according to Islamic law by-products were also considered as Haram. Mushbooh (doubtful) is a term given to a grey area between Halal and Haram. It happens when the source of raw material was not known, it could be from plant source or animal source and also lack of information of use of alcohol with based ingredients. A practicing Muslim prevents himself from consuming doubtful things. Muslims are obligatory to consume halal food and forbidden to consume haram food.

Foods, amongst other things (cosmetics & medications), is a main source of these toxins (Dolan et al., 2010). A small percentage of people are sensitive to some food additives due to its containment of toxins. Food toxication is a main source of disease, although in some cases it may not be immediate, it may happen in the long run due to constant exposure. Immediate effects may include headaches, loss of concentration, and lower immunity to some disease. Whereas, long-term effects may increase your risk of cancer, cardiovascular disease and other

degenerative conditions. Begin by avoiding the most questionable additives. Proceed by cutting down consumption and slowly end it up especially those that are proved to be harmful.

The second part is the usability, emphasizing on user satisfaction of the system that has been developed. The usability is defined as the extent to which product can be easily used by specified users to achieve certain goals with effectiveness, efficiency and satisfaction (Harati, et al., 2016). The importance of rigorous studies to validate usability evaluation methods was first claimed by Gray and Salzman, (1998). The authors reviewed several experimental studies performed on usability evaluation methods and concluded that most applications suffer from the lack of meticulousness in proving the statistical validity of the achieved results. Similar claims were later discussed in Hartson et al., (2001), the authors also addressed the lack of standard criteria and a clear understanding of the factors being measured as major problems when comparing different usability evaluation methods.

The success of the software application strongly depends on the usability of its interface (Cassino et al., 2015). An empirical method was chosen for usability testing because this method involves the direct usage to evaluate the system (Cassino et al., 2015). It as an irreplaceable usability practice because it gives direct input on how real users use the system (Fernandez et al., 2013). There are other related models and theories such as The System Usability Scale (SUS) which was proposed mainly for the evaluation of web applications for two aspects; the learnability and usability. The SUS is well-researched and widely used questionnaires/statements for assessing the usability of most web applications (Kortum and Bangor, 2013; Bangor et al., 2009).

Propososed Application

This application is developed to assist users in getting ingredient related information from e-numbers that represent food additives that are widely used nowadays. User only needs to enter the ingredient name or E-Number, in return this system will notify the user on the halal status. Moreover, this system also provides information regarding to the risk that may affect ones' health by consuming the respective ingredients. Users of the system can be categorized into two: registered and non-registered.

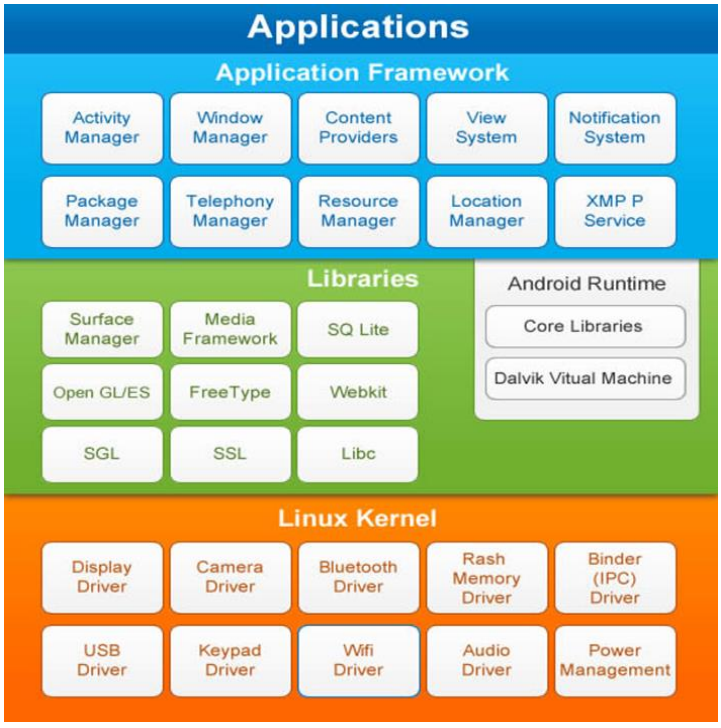

Figure 1. Mobile apps framework (Android Architecture)

User can choose to be a member via a simple registration procedure where among others, they have to key in their personal detail and health information (English). Either way, a user is able to check the information about the ingredient by entering the ingredient name or the E-Number. For registered user, the application will tally with their current health condition. This system will automatically highlight the food additive that they cannot use based on their current health. The development of the mobile application is based on the Android Architecture as illustrated in Fig. 1.

Rule-based Technique Implementation

Rule-based technique (Caron et al., 2013, Brill, 1992) consists of if-then rules, a bunch of facts, and an interpreter that control the statement. The if-then rule statements used to select the conditional statements that comprise the complete knowledge base. A single if-then rule assumes that the simplest form of conditional statements such as '*if x is A then y is B*' where the if-part of the rule '*x is A*' is called the antecedent or premise , while the then-part of the rule '*y is B*' is called the consequent or conclusion (Fig. 2).

Rule 1: *If A and C then Y*
Rule 2: *If A and X then Z*
Rule 3: *If B then X*
Rule 4: *If Z then D*

Figure 2. Rule Based Technique

In this project we proposed the rule-based technique to search for the list of allergies and risks for a particular individual based on the E-Numbers. The E-Numbers will be as an antecedent the description of the allergies and risks will be the conclusion.

Design and Modelling

The analysis and design of the system is based on the Structured Analysis and Design Methodology (Valacich, 2015). The conceptual model and logical model are generated from the software requirement. The conceptual design is depicted by the Context and Data Flow Diagram as illustrated in Fig. 3 and Fig. 4. Whereas the logical and data modeling is represented in Entity Relationship Diagram as in Fig. 5.

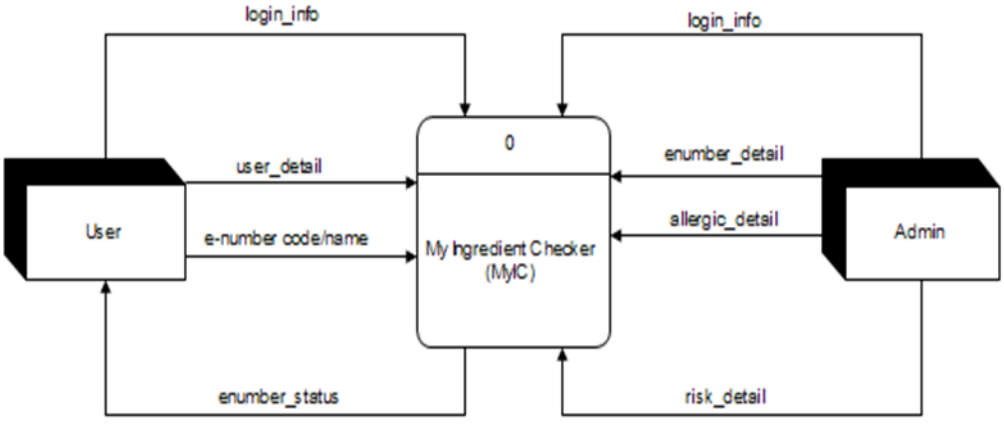

Figure 3. Context Diagram

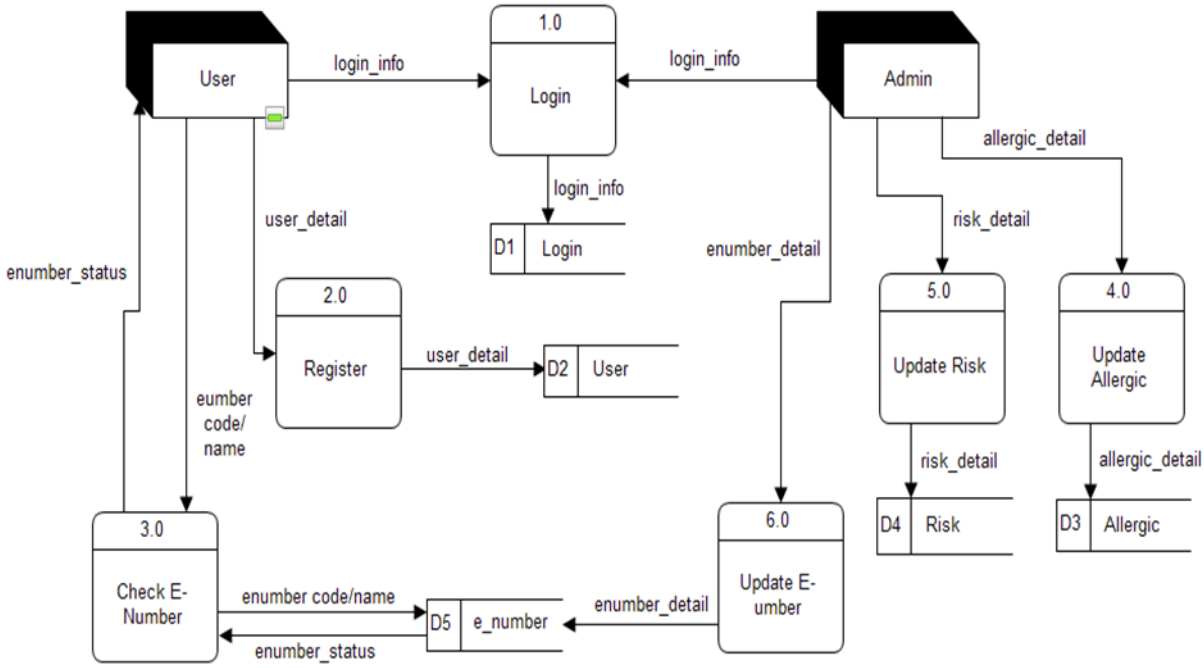

Figure 4. Data Flow Diagram

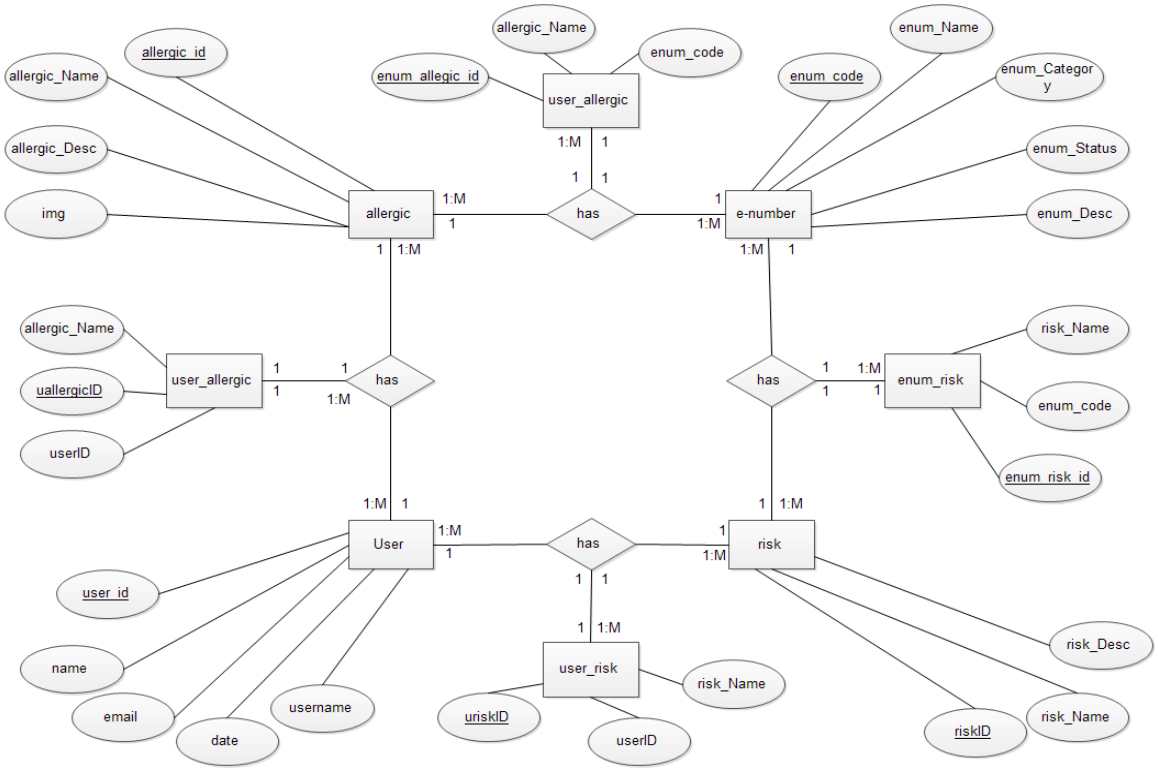

Figure 5. Entity Relationship Diagram

Usability Test (User Satisfaction)

This sub-section explains the process to test user satisfaction of the prototype system. To obtain the results of the empirical study, the usability (satisfaction) testing was conducted involving of 10 participants. The participants consisted of lecturers in the field of Human Computer Interaction (HCI) and other fields. The metric of usability of the user satisfaction is referring to Bevan, (2001). In detail, Bevan used standard ISO 9241-11 to test the usability. From the four (4) categories, two (2) categories are implemented during development of the software while the remainder are emphasising on user satisfaction. A System Usability Scale (SUS) was implemented to test the user usability of the user satisfaction (Brooke, 1996).

System Usability Scale (SUS)

The SUS technique is a reliable, low-cost usability scale that can be used for global assessments of system usability (Kortum and Bangor, 2013; Bangor et al., (2009); Brooke, 1996) and this scale based on the Likert scale. It is often assumed that a Likert scale is simply one based on forced-choice questions, where a statement is made and the respondent then indicates the degree of agreement or disagreement with the statement on a 5 (five) point scale. The statements in the SUS actually cover a variety of aspects of system usability, such as the need for support, training, and complexity, and thus have a high level of face validity for measuring the usability of a system. Based on Bangor et al., (2009) and Bangor et al., (2008), it is found that if the SUS score is over 85 the system/product is highly usable, over 70 to 85 it is characterized from good to excellent, a value from about 50 to about 70 shows that the system is acceptable but it has some usability problems and needs improvement, and finally a system with a SUS score below 50 is considered unusable and unacceptable.

Results and Discussion

In this section we show the finished product in respect to the functionalities that we have discussed earlier. The product has been tested on a wide area network. Next discussion centers on the communication between two parties, namely client (consumer with a mobile phone) and server (administrator). The administrator is initially needed to register himself. Upon successful login, one can start creating and the database and tables.

On the client side, users are given the ability to register themselves to enjoy extra features as shown in Fig. 6(a) and 6(b). However, without registration, the user can still request for ingredient information. A registered user can log into the application and fill up an update their personal information. Fig. 7(a) shows how a user can enter a number to obtain the information about the source of additive. Likewise, Fig. 7(b) has also requested for the same information but with different input, that is the ingredient name. Meanwhile, Fig. 8(a) and 8(b) shows the results of queries executed as shown in Fig. 7(a) and 7(b) respectively. The SUS form that has been returned by the user is evaluated for usability of user satisfaction as in Table 1.

(a) (b)

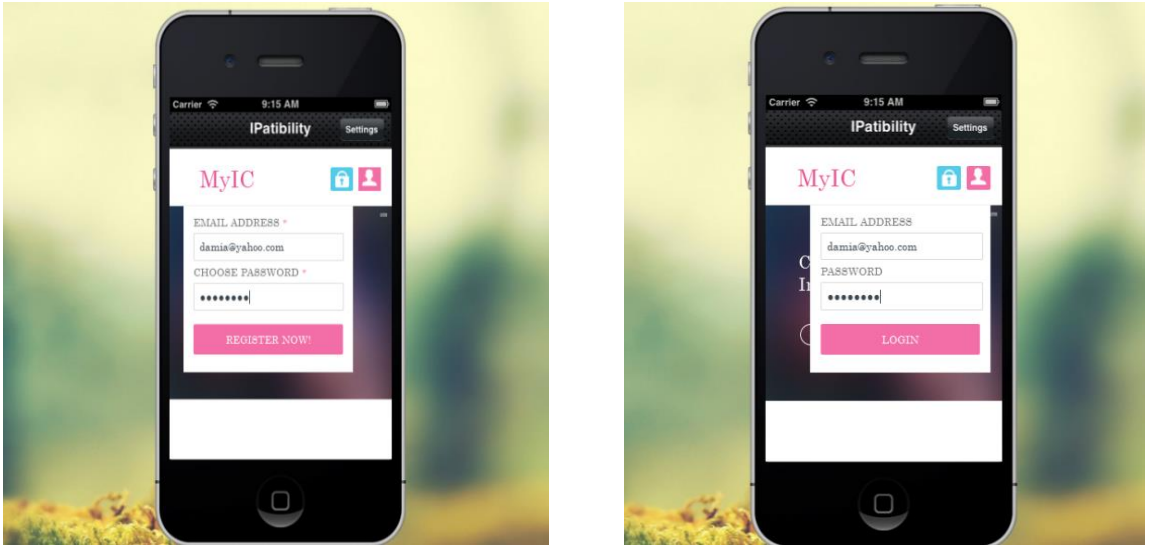

Figure 6. a) User Register b) User Login

(a) (b)

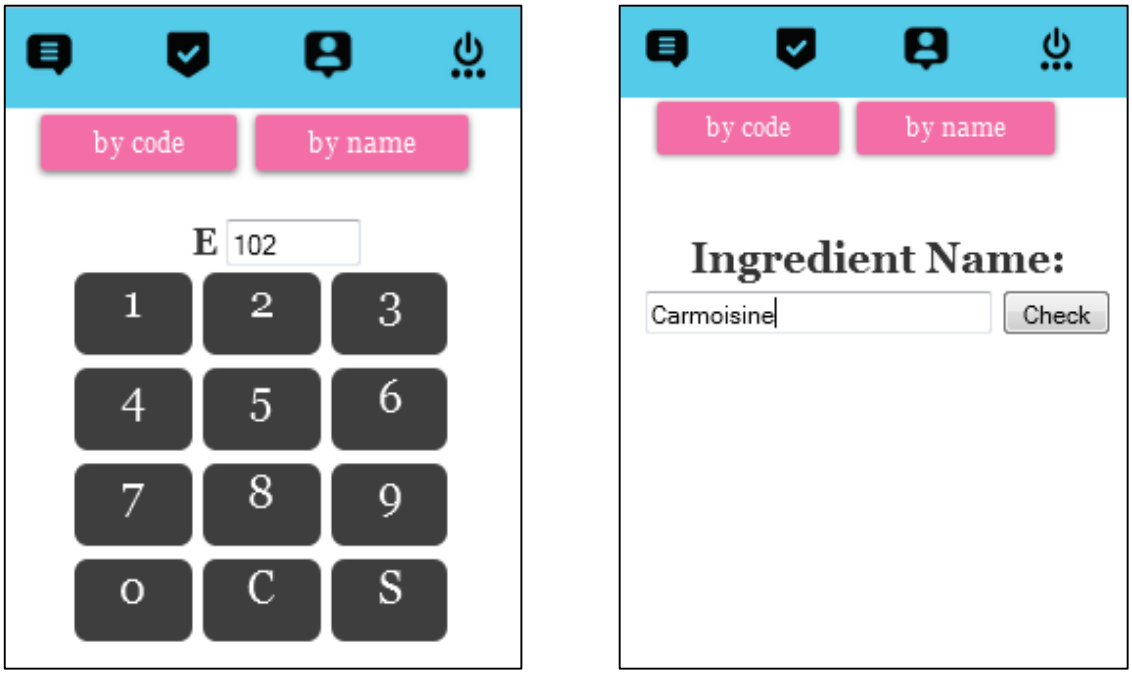

Figure 7. a) Ingredient by number, b) Ingredient by name

(a) (b)

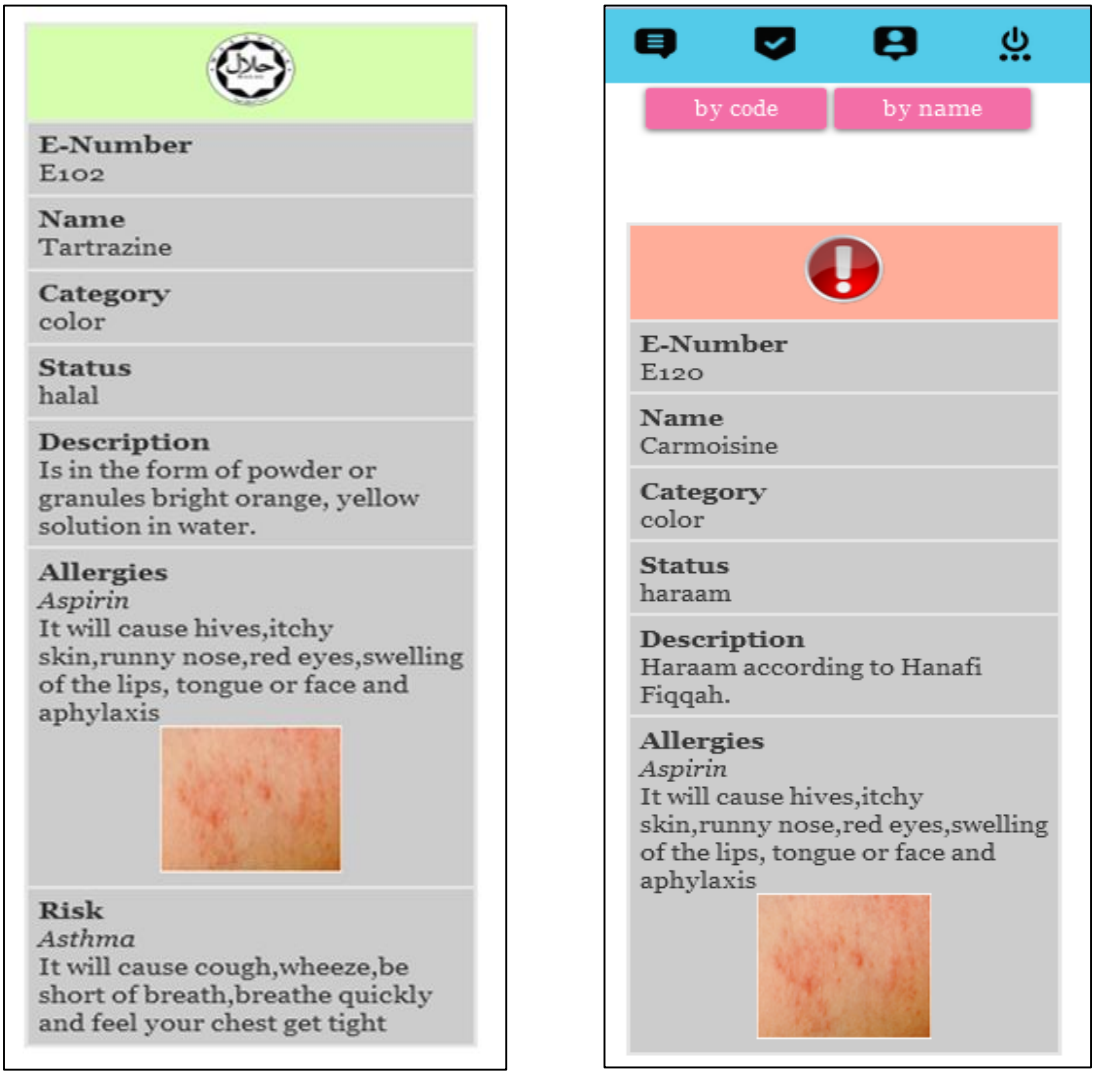

Figure 8. a) Detail E-Number (By Code) b) Detail E-Number (By Name)

Table 1. SUS scores

Participants	1	2	3	4	5	6	7	8	9	10	Average
SUS Scores (Max = 100)	77.5	75.0	72.5	75.0	77.5	75.0	77.5	75	75	80	76

Conclusion

The best choice would be foods that are not packaged and processed such as fresh fruits, vegetables, grains, beans, nuts and seeds. Look for foods that resemble what they looked like when they were originally grown. The article presents the development of an Andriod based halal and healthy ingredient checker to assist consumers in deciding the suitability of a food product for consumption with respect to halal and healthy status. This application is made available online, consumers can just download the pack, install on their phone and access the services at will.

In the future, we could accommodate the use of this application with a camera such that, instead of needing to manually insert the code, an algorithm can be used to recognized the input from camera and directly send it to the server for a description. From a development system view, the system is good to excellent of usable of user satisfaction. This can be seen in terms of SUS score of in the range of 70-80. For the future, the number of participants will be added as well as and testing for efficiency and effectiveness needs to be done..

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