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MOBILE APPLICATION TO GENERATE NUTRITION PLANS FOR DIABETICS AND OVERWEIGHT PEOPLE

Introduction

Currently, together with an increasing number of people with serious chronic diseases, autoimmunological diseases, food allergies and other civilization diseases, there is a growing group of people who take care of their health in order to improve longevity and the quality of life. Apart from physical activity and sports, healthy and balanced diet is of significant importance in the achievement of their goal.

The article presents operations aiming at the development of an Android-based mobile application to support the users to maintain an adequate diet through the generation of medically sound nutrition plans. The Android system provides the opportunity to program applications that can be used on the devices of different manufacturers and in a wide price range, which makes it possible to reach a significant group of customers.

1. Application objective

The aim of the application is to make everyday life easier and to organize or to change completely the eating habits of its user. The program is dedicated mainly to diabetics or people who have problems with obesity. The strength of the software is that it generates nutrition plans in a dynamic way, which means that they are developed on the basis of data that is continually collected, up-dated and concerns the needs of a particular organism. This is important as certain illnesses require permanent monitoring and the adjustment of the nutrition plan to the current health condition. There are also other cases when a diet user needs some change but still wishes to eat healthy and nutritious food. The application is helpful in all such cases. However, it should be emphasized that no software that supports decision making can replace a doctor.

The additional objective of the application for a dynamic generation of nutrition plans is to increase the self-awareness of the user and to support him/her in the efforts to have a balanced diet. The software indicates what quantities of the recommended products should be eaten, what products should be reduced or completely avoided. It should be remembered that

there are cases where the attitude to the diet should be extremely rigorous and where one should take into consideration the levels of blood sugar, especially of simple sugars, of blood carbohydrates as well as the harmful effects of dairy products or food allergies.

The application is a good solution for people who have problems with type 1 or type 2 diabetes or for obese persons but it also may be helpful for sportspeople. People with different illnesses and diseases need a diversified approach as regards the choice of products, meal routines and the amount of particular nutrients. An adequately adjusted nutrition plan may result in a better comfort of life of a diabetic; an obese person will lose the weight without starving and a sportsperson will improve sport results.

According to statistics, there are approximately 415 million diabetics in the world, which constitutes 8.8% of all adult (20 – 79 years old) inhabitants of our planet[1]. Moreover, as many as 1.9 billion adult people (over18 years) are overweight, which includes 650 million obese people. Overweight people make 39% of the adult population and almost all of them come from highly and moderately developed countries[2].

As the aim is to reach the highest possible number of users in different age groups and backgrounds, the choice of Android to implement the application seems most sensible. This is due to the fact that the Android platform has an 80% share on the market of smartphones which currently amounts to approximately 1.43 billion devices[3]. Nowadays almost everybody has a mobile phone and smartphones prevail; the Android system is available on the devices of various manufacturers and consequently it reaches a numerous group of users.

The modeling area includes the generation of a nutrition plan template on the basis of information collected in a form. The information is helpful in the adequate adjustment of the number of desired calories and the distribution of microelements in particular meals and, finally, in the development of a nutrition plan. The application has the option to add new products to the local database and to browse it.

The target user of the application is a person who wishes to analyze his/her diet, to organize it or to change completely the eating habits. In fact, the application can be used by anybody who has or wants to take care of his/her health through a balanced diet. What is more, as the application is intuitive, it can be used by users in any age group.

[1] International Diabetes Federation, IDF Diabetes Atlas, 7th edition, 2015, www.idf.org/e-library/epidemiology-research/diabetes-atlas.html [Accessed 2.11.2017]
[2] World Health Organization, www.who.int/mediacentre/factsheets/fs311/en/ [Accessed: 2.11.2017]
[3] The Wall Street Journal, blogs.wsj.com/digits/2015/12/03/china-hangs-up-global-smartphone-growth [Accessed: 6.01.2016]

2. Review of the existing applications for the development of nutrition plans

The review of the available applications was conducted with regard to the following assessment criteria: price, intuitiveness, layout, the language used by the application and - the crucial ones - the innovativeness of the solutions and the methods of arranging the nutrition plan.

The analysis concerned the following common applications: MyFitnessPal[4], Calory counter – Lifesum[5], Dieta PL[6], Kcalmar[7], Dr Barbara[8].

When looking through the selected applications, one can easily notice that most of them include an excessive number of optional solutions and neglect their basic function, i.e. a precise calculation of how much and what the user should eat.

Kcalmar and Dr Barbara are the closest to the objectives of the application in question. They are the best among the above listed applications but their drawback is that they do not calculate precisely the nutritional value and they focus on the diversification of the menu to which other criteria such as caloric requirements or carbohydrate are adjusted. Moreover, both applications lower daily caloric requirement, which is probably due to the fear that the user may not achieve a satisfying effect promptly enough. They offer "starvation" diets and the amount of food they suggest is actually insufficient.

The most useful additional options in the applications under investigation are: the possibility to develop a nutrition plan in the form of a diary, where the user can check the meals eaten previously or the ones that are going to be eaten in subsequent days, a shopping list and a presentation of the average cost of every meal.

Having analyzed all the aspects that were considered in the assessment of the applications available on the market, one can easily notice a trend that more significance is attached to the features that attract potential users rather than to the basic functionality, i.e. an adequate calculation of values necessary for balancing the diet in a correct way for people who really need it. What is more, due to the variety of options as regards the choice of the menu, the user is constantly hungry because of the small volume of meals.

[4] MyFitnessPal, play.google.com/store/apps/details?id=com.myfitnesspal.android&hl=pl. [Accessed: 16.02.2016]
[5] Licznik kalorii – Lifesun, play.google.com/store/apps/details?id=com.sillens.shapeupclub. [Accessed: 18.02.2016]
[6] Dieta PL, play.Google.com/store/apps/details?id=pl.mobiem.android.dieta&hl=pl. [Accessed: 24.02.2016]
[7] Kcalmar, https://play.google.com/store/apps/details?id=com.kcalmar&hl=pl. [Accessed: 10.03.2016]
[8] Dr Barbara, https://play.google.com/store/apps/details?id=pl.drbarbara&hl=pl. [Accessed: 12.02.2016]

Thus, the most important requirement for the application under development is to calculate precisely the requirements and to follow the restrictions that are imposed by particular diseases. Moreover, it is significant that the users should be approached individually and the lowering of the daily caloric requirement to achieve spectacular losses of weight should be avoided.

3. Functional analysis of the system

The purpose of the functional analysis of the system is to show what functions are included in the application, how the application reacts to the introduction of data and how it operates in particular situations. The system data flow diagram (Fig.1) illustrates the possibilities to generate a nutrition plan for a user, to operate on the database with the products and to monitor the user, i.e. to check whether his/her data remain unchanged.

The operation of the application requires the completion of a diet questionnaire; the information will help design the nutrition plan. After the nutrition plan generator (process 1) completes the necessary calculations, it sends the information directly to the user database and the nutrition plan database. Then, the nutrition plan is generated for the user.

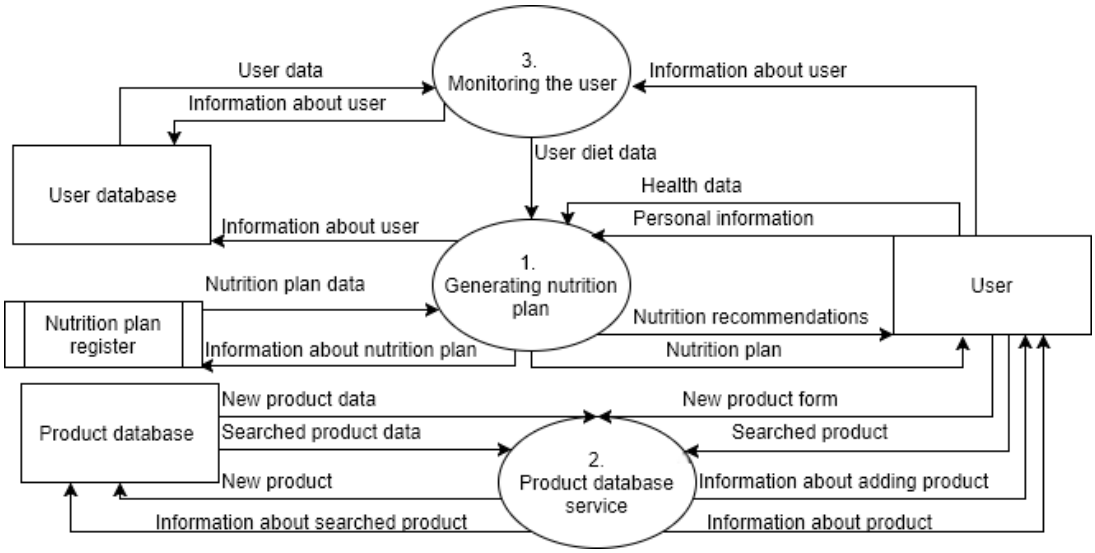
In the case of any changes to the data, the user initiates process 3 which modifies the data in the database and sends the information to the user.

The database service operations start when the user browses through the product by downloading subsequent records from the product database. Process 2 also adds new products to the product database.

Figure 2 illustrates the user service. When logging to the system, the user is automatically verified in process 1.1. The verification process sends the information about the user to the user database. User data are downloaded for the generation of the nutrition plan in order to be presented to the user.

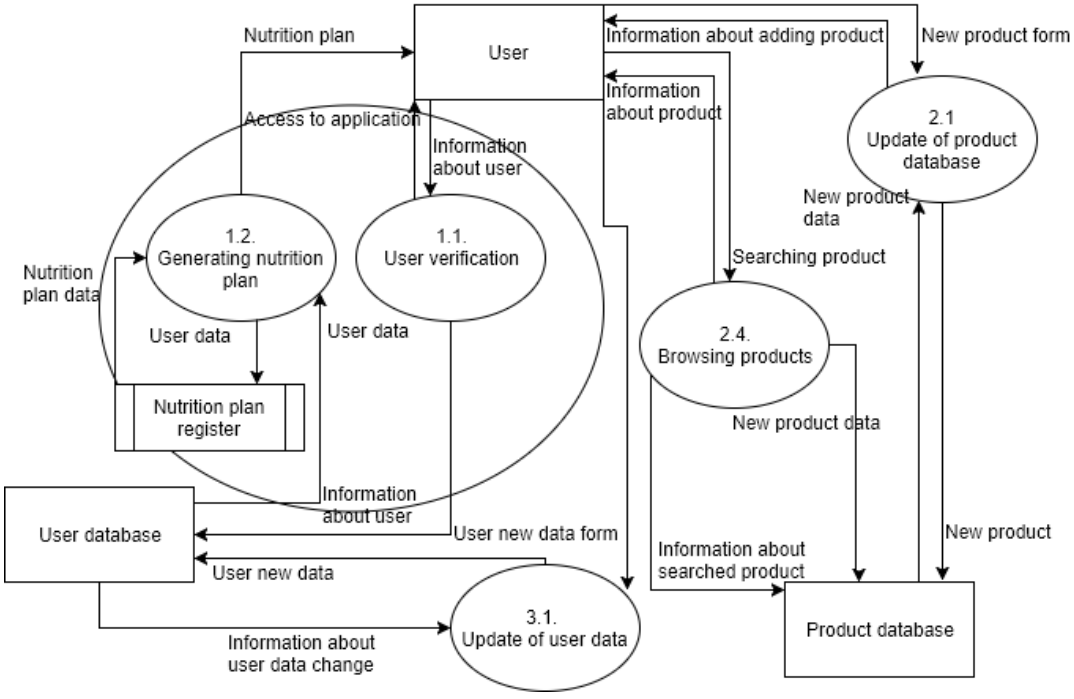
The browsing of products and adding new products is conducted within the product database. To add a product, process 2.1 is applied. When adding a new record, process 2.4 (browsing products) is responsible for downloading the records from the database and presenting them to the user. Diagrams which illustrate the remaining key services offered by the application are given in [8].

Figure 1. System of a model for generating nutrition plans



Source: Authors' research.

Figure 2. User service model



Source: Authors' research.

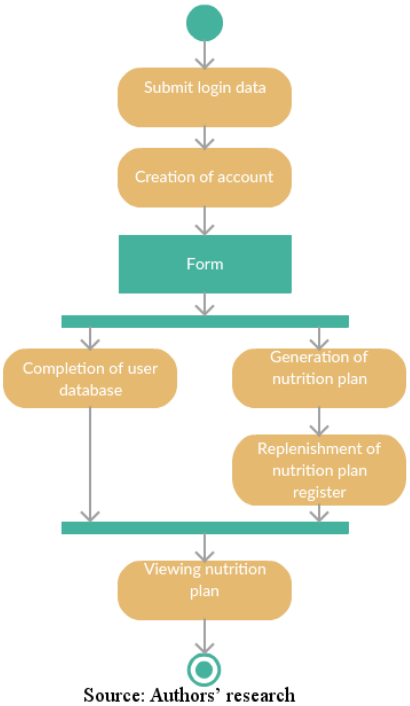
4. System behaviour in time

The most important issues concerning the behavior of the system in time are presented by UML – activity diagrams. For example, Figure 3 gives an activity diagram that represents a sequence of activities when the application is started for the first time in order to develop

one's own nutrition plan. The user can see a welcome screen, then gives his/her personal data and the data necessary to generate a nutrition plan. Consequently, a user account is created and a nutrition plan is presented.

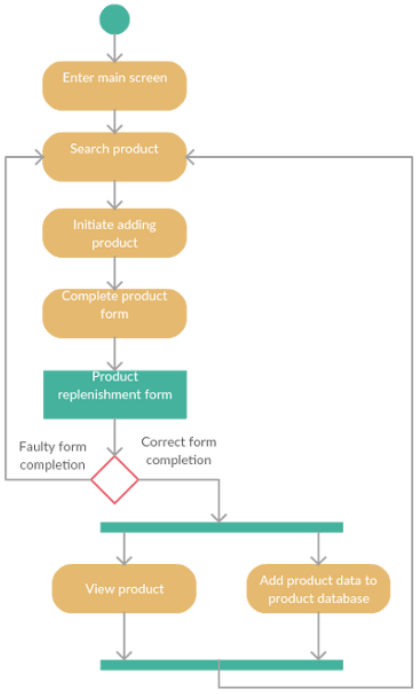
The addition of a new product which is illustrated by an activity diagram (Fig.4) starts with the activation of the application. Next, the user chooses the search product option. In order to add a product, an adequate form has to be completed and then the connection to the network is checked. When the connection works properly, the form is sent for acceptance. If the product does not exist in the database, the product is added; otherwise the database remains unchanged. The activity diagrams for other operations that are conducted by the application and their detailed descriptions can be found in [8].

Figure 3. Developing nutrition plan



Source: Authors' research

Figure 4. Adding new product



Source: Authors' research

5. Graphic interface

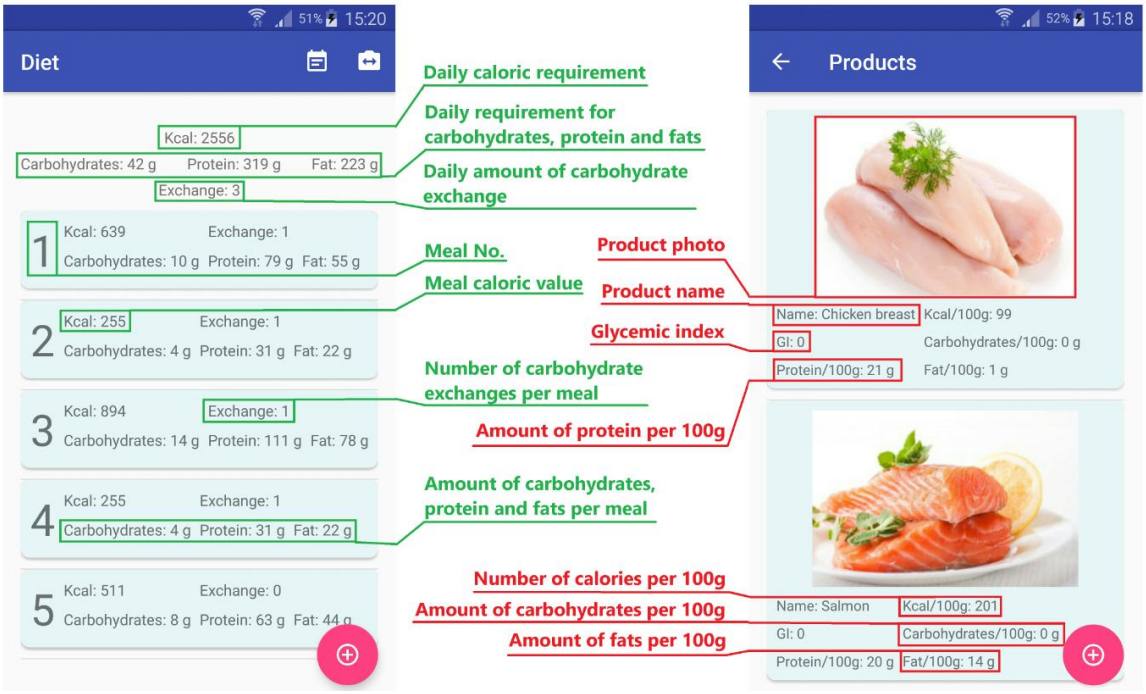
When designing an Android-based graphic interface, one should take into consideration user experience (UX), i.e. the feeling experienced by the user when using an interactive product, so that the interaction involves positive emotions on the part of the user. The application should look attractive and useful; it should provide users with pleasure and satisfaction. The Android-based graphic interface is defined with XML.

The application uses *Material Design* by applying icons in the form of vector graphics and the recommended selection of colours[9]. The application for generating nutrition plans lays emphasis on the functionality rather than innovative solutions of the graphic interface. The structure of the graphic interface is diversified in order to meet the need for the development of separate solutions for the information collection form, the presentation of data in databases and the remaining section where statistical data is presented.

The layout of graphics in the forms used for entering the data in order to develop an account, generating nutrition plans, presenting the plans, adding new products to the database, etc. is very simple and fairly uniform. It consists of separate activities with their own layouts.

Figure 5 gives a graphic layout of the presentation of nutrition values for a daily diet plan with the division by meals and includes a screen view presenting the contents of the food product database together with the description of the products. The graphic layout scheme (on the right) includes an element of hierarchization, which enables a return to the application's main activity, i.e. the generation of nutrition plans (cf. the left column in Fig. 5). The activity also plays the role both of the initiation function of generating nutrition plans and the menu of the whole application.

Figure 5. Presentation of a nutrition plan for subsequent meals (1-5) in one day and a view of a product list

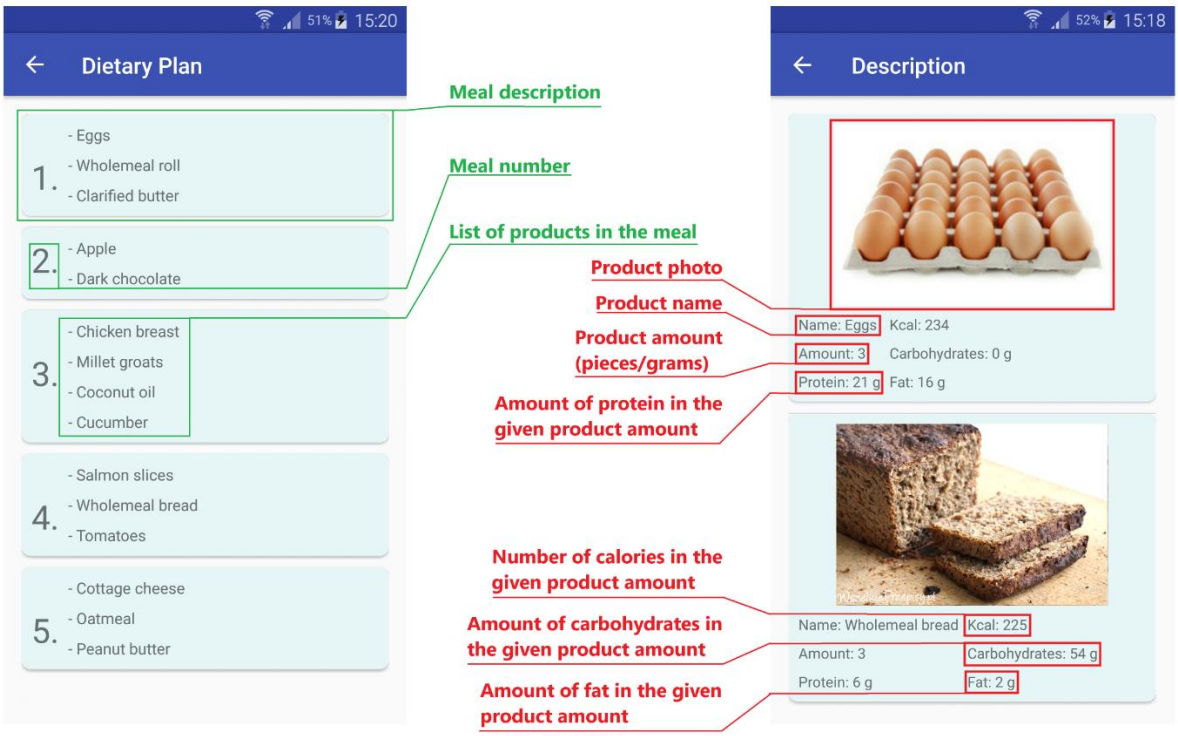


Source: Authors' research

[9] Introduction, material.google.com/. [Accessed: 10.07.2016]

In its left column Figure 6 presents a graphic layout of a list of food products that form particular meals suggested on the basis of a previously calculated daily diet plan (cf. Fig.5). Detailed quantity data of these products can be obtained after the selection of a given meal – the information will appear in the right column of Fig.6.

Figure 6. Presentation of food products that form meals included in a daily diet plan



Source: Authors' research

6. Implementation description

The main function of the implementation is to dynamically generate a nutrition plan with regard to the individual needs of the user. Its priorities include a provision of a convenient and intuitive tool to develop a nutrition plan, an accomplishment of the expectations of users with health problems as well as healthy users who expect to be offered a suitable diet, the possibility to add new products to the database and to browse through a product list with their description.

The application includes such functionalities as collecting and storing information about users (particularly their health data that are necessary to determine the type of nutrition plan and adequate ratios of dietary components), generating adequate nutrition plans (the application defines a suitable type of the diet and its adequate nutrients) adding new products (the application users can add the necessary new products to the database).

Below, the authors present two qualitatively different examples for the calculations of a daily calorific requirement that were conducted by the application in order to determine adequate ratios [8] of macro-components (carbohydrates, protein and fats), cf. Fig 6. The calculations take into consideration the characteristics of the individual (gender, age, weight, height), the activity level and the condition of the organism.

1. *A male with diabetes and obesity*

Age: 54 years, weight 115 kg, height: 180 cm (1.8m).

Description: an individual with type 1diabetes, with low physical activity.

Calculations:

1) *BMI (Body Mass Index) = body weight / (height)^2*
   BMI = 115 / 1.80^2 = 35.49
   35,0 - 40,0 – obesity degree 2
   BMI-based indicator: 30
2) *Physical activity.*
   Low physical activity, sedentary lifestyle.
   Physical activity indicator: 30
3) *Average of BMI and activity indicators.*
   (BMI-based indicator + physical activity indicator) / 2 = 30
4) *Calculation of TDEE (Total Daily Energy Expenditure).*
   *TDEE = body weight * average of BMI and activity indicators*
   *TDEE = 115 * 30 = 3450 kcal*
5) *Calculation of TDEE at the recommended weight reduction diet*
   *TDEE _weight reduction diet = TDEE * 0.75 = 2587 kcal*

2. A female with overweight, without diabetes.

Age: 43 years, weight: 86 kg, height: 161 cm

Description: A woman with overweight, no sport activities, sedentary lifestyle.

Calculations:

1) *BMR (Basal Metabolic Rate) requirement.*
   *BMR = 665.09 + (9.56 * body weight) + (1.85 * height) – (4.67 * age)*
   *BMR = 665.09 + (9.56 * 86) + (1.85 * 161) – (4.67 * 43) = 1584.29*
2) *TTEF (Thermic Effect of Food).*
   *TEF = BMR * 0.1 = 1584.29 * 0.1 = 158.429*
3) *TEA (Thermic Effect of Activity).*
   *TEA = BMR * 0.3 = 1584.29 * 0.3 = 475.287*
4) *NEAT (Non-Exercise Activity Thermogenesis).*
   NEAT = 300
5) *TDEE (Total Daily Energy Expenditure).*
   TDEE = BMR + TEF + TEA + NEAT
   TDEE = 1584.29 + 158.429 + 475.287 + 300 = ~2518

As a result, on the basis of the value of energy expenditure the user obtains a list with selected products; the choice of a particular meal results in receiving a precise ratio of the products used.

The implementation tools are divided into two groups. The first one is the hardware. For correct functioning, the application requires the Android platform. The authors did not take into consideration such Android-based devices as smartwatches with modified and limited Wear version or smart TV. The application was tested on Samsung Galaxy Note 4.

The other group concerns the software. The whole project uses the Android Studio environment. The IDE was developed by Google to create applications for Android. In the application, the devices can be emulated by AVD Manager. The technologies that it uses are: JAVA[10], XML[11] and SQLite[12]. SQLite does not use the server but it reads and saves data directly in files. Moreover, it has a quality that is significant for Android when it does not work, it does not take the time of the processor.

Conclusions

The aim of the work presented in the article was to develop an application that would meet the demand of diabetics and people with overweight for a simple and user-friendly mobile tool to support them in arranging adequate diets. The use of the application facilitates the control over the selection of products that form a daily menu in line with the requirements of a balanced and varied diet. The important feature of the application is that it makes it possible to calculate nutrition plans that meet the needs of particular users. The article presents the justification of the need for the development of such application and it shows the process of its development with the use of free tools. It also describes the mode of action of the application that works in line with the above assumptions and is based on the methods that were taken from established sources.

It must be emphasized that in the long term the application of this type has a great development potential as regards the cooperation with such peripherals as electronic scales for weighing products whose weight could be transferred by the application into adequate amounts macro- and micro-elements and calories; consequently the composition of meals

[10] H. Schildt „Java. Kompendium programisty Wydanie VIII" wyd. HELLION 2012, ISBN: 978-83-246-3767-6
[11] Jacek Kobusiński XML w przykładach, www.cs.put.poznan.pl/jkobusinski/xml.html. [Accessed: 4.11.2016]
[12] Vogella, www.vogella.com/tutorials/AndroidSQLite/article.html#sqlite-and-android. [Accessed: 4.11.2016]

would be almost unrestricted. Moreover, the application would be highly effective and helpful for diabetics: the data from blood sugar meters could be sent to the application which would then provide dietary solutions with the consideration of the current sugar level in blood. One more device that seems to be useful are Android-based watches or sports wristbands that read users' daily activities, which could be applied in a more precise calculation of nutrition plans.

Bibliography

[1] American Diabetes Association, www.diabetes.org/diabetes-basics/statistics
[2] Android Developers, developer.android.com/design/material/index.html
[3] Centers for Disease Control and Prevention, https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf
[4] Czuba M., Zydek M., Gołaś A., Zając A., Poprzęcki S. „Żywienie i suplementacja w sporcie rekreacji i stanach chorobowych. " AWF Katowice, 2014
[5] Dr Barbara, https://play.google.com/store/apps/details?id=pl.drbarbara&hl=pl.
[6] International Diabetes Federation, IDF Diabetes Atlas, 7th edition, 2015, www.idf.org/e-library/epidemiology-research/diabetes-atlas.html
[7] Kcalmar, https://play.google.com/store/apps/details?id=com.kcalmar&hl=pl.
[8] Kuchciak M. „Aplikacja generująca plany żywieniowe", diploma work, Wyższa Szkoła Zarządzania i Bankowości, Kraków 2017
[9] Stanowisko Polskiego Towarzystwa Diabetologicznego, „Zalecenia kliniczne dotyczące postępowania u chorych na cukrzycę", 2016, www.metabol.wl.uj.edu.pl/documents/20028879/9d8590c5-392c-421d-8e4f-e031123b5843
[10] World Health Organization, www.who.int/mediacentre/factsheets/fs311/en/
[11] Żabińska-Rakoczy M. „Systemy informacyjne", lectures published by e-learning system SAKE, sake.wszib.edu.pl, Wyższa Szkoła Zarządzania i Bankowości w Krakowie

Abstract

At present, there is a significant demand for the development of diets that suit the needs of diabetics, obese people and the ones who care about their weight. The article presents the justification for the need to develop a cheap and user-friendly mobile application to generate a nutrition plan for a particular diet. It also presents the way how to design such an application, the principles on which the algorithms are based, the elements of the project and the functioning of the created program.