

Optimization of Blood Donation Activity Supporting a Smart City

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Abstract

The reported research aimed to decrease the distance between a person and the healthcare system regarding blood donation. The result is a web application developed for the healthcare system, in order to optimize blood donation process. There is an acute need of blood in transfusion centers. The first question is: “Why?”. Some answers could refer to the lack of education in volunteering or the lack of awareness, the fear of needles or of infections caused by needles, the difficulties of the donation process. These answers generate another question: “What can be done?”. A statistical analysis has been performed in order to evaluate participants’ attitude towards blood donation. It shows that there are many fellow citizens who want to help, but are not informed about this aspect, or they do not know how to do this. The application presented here can be of real help in encouraging people to donate.

Keywords: Blood donation; Web application; Statistics

Introduction

The paper is written in the context of smart cities. A smart city can be defined by its smart people, who understand the requirements of the smart community they belong to and who need smart tools in order to do smart things. The purpose of this paper is to present a smart tool that can be used to improve the blood donation process.

The development of such a tool was encouraged by the results of a blood donation campaign organized in a state university [1] and meant to inform students (and not only) about the necessity of a blood supply in hospitals. This was a very good idea, because the benefits of these types of campaigns are priceless. But it is worth to analyze some data associated to this campaign:

- the campaign took place over an entire week (13-17 November 2017) [1];
- the institution that organized the event has about [2]: 13,500 students, 700 teaching staff, 500 administrative and additional staff;
- total number of donors in this campaign: over 120 persons (50 liters of blood) [1].

Therefore, 120 donors out of about 14,700 people. Is this enough? Of course, this is more than nothing, but it is obvious that the desired smart community has a long way to go in order to improve the attitude towards mutual help.

The problem with blood donation, and other volunteering activities, is that the people are neither aware nor educated to do such things. Thus, the lack of education in volunteering is one aspect and

it can be connected to the fact that people don't care about someone else's problems. Then, even if someone wants to help and he/she has good intentions and decides to be involved in the community's problems, sometimes the blood donation process is difficult, being a test of patience (because there is a long distance between the good intentions and their achievement).

A statistical study, described in the following section, emphasizes that, generally, people are concerned about blood donation and they want to help, but they are not informed. Then follows a section that presents the proposed solution: a simple web application that makes this process easier and encourages blood donation. Some results, future work, discussions and conclusions are emphasized at the end of the paper.

The Context

The work presented here can be introduced by a recent circumstance: a blood donation campaign. Once the effects of the campaign have been published [1], the authors of this paper made a statistical analysis, which proves that better results can be obtained. A questionnaire form [3] was created and filled in by 115 participants: students, teachers and additional staff belonging to the institution that organized the blood donation campaign and other persons, outside this institution (because the campaign was addressed to anybody wanted to donate). The results are presented in table 1 and they explain the arguments of the application that was developed.

Table 1. Results regarding the attitude towards blood donation

Identification		Are you able to donate blood (according to the donation requirements and to eligibility and exclusion criteria [4, 5])?	
Student – 61.7% Teaching staff – 16.5% Additional staff – 2.6% Other – 19.1%		Yes – 60.9% I suppose I am – 27% No – 12.2%	
Would you like to donate blood?		Would you donate for a very close person?	
Yes – 73% No, because I do not agree blood donation – 1.7% No, because I am afraid – 12.2% No, for other reasons – 13%		Yes – 97.4% No – 2.6%	
Would you donate for an unknown person?		Did you know about the donation campaign from November 13-17, 2017	
Yes – 88.7% No – 11.3%		Yes – 29.6% No – 70.4%	

The identification question proves that the statistical population follows the proportions of the persons from the organizing institution (described in the introduction section). As can be seen in Table 1, the percentage of those participants who are able and who want to donate blood is considerable. Unfortunately, many of them didn't know about the donation campaign.

There are some participants who are afraid to donate. They should know (or should be informed) that this is not a painful process and that it is a safe one (there is no risk to catch an infection).

Few of those who answered the questionnaire declared that they would donate for a very close person only. Thus, there is a chance here and this way of thinking can be improved in order to convince them to donate for anybody.

There is another category of participants who do not wait for a blood donation campaign. They are trying to do this by their own forces, looking for a transfusion center, finding out why and how they should do this. Some of them succeed; some not, because the system is not always helping them. This is another point that needs some improvements.

The Method

A Web Application

A solution can be a simple web application that makes the donation process easier and encourages blood donation. It looks like a Google Map, in fact it starts from such a map, but it is adapted to the current context, providing specific visual elements that emphasize the donation centers and that give additional information regarding the status of each blood type available in a blood donation center (Figure 1). This way, the potentially donors can select the closest center or the center with the higher need of his/her blood type.

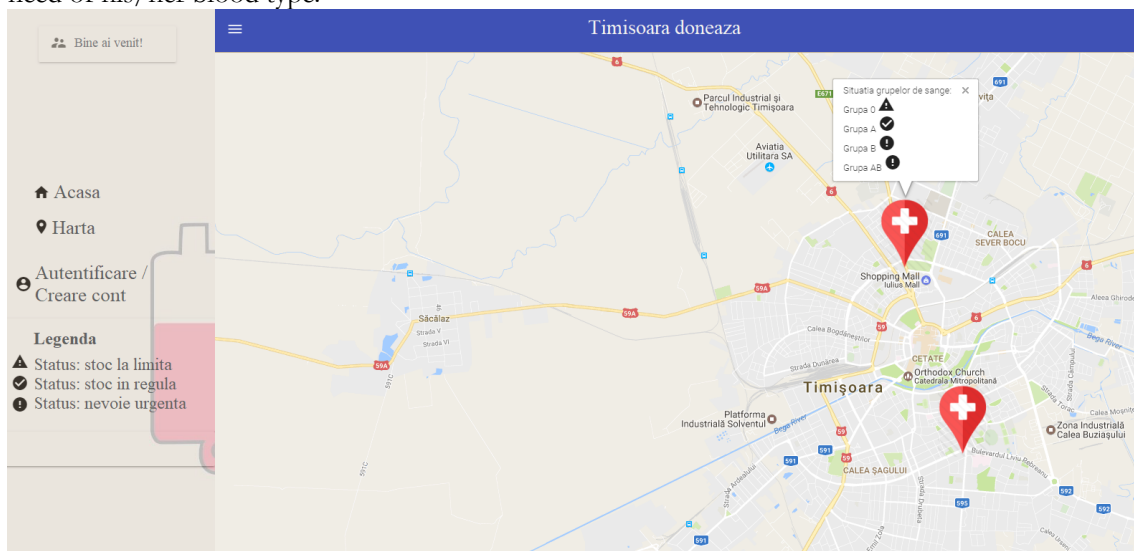


Figure 1. The map shows the donation centers and the blood types status for each center.

The graphical user interface described by Figure 1 contains two parts. The central part is represented by the map, which emphasizes, with a specific sign, the donation centers. When the user selects a certain center, some details regarding the blood types status are presented. A legend of the possible statuses for the blood stock (at the limit, all right, urgent need) is placed in the left-down side of the interface. Besides the legend, there are three button-links on the left side, which allow the user to load the home page, the map, and to authenticate (or to create a new account).

The application has five access levels. The graphical user interface (Figure 2) is adapting according to the user type. Initially, its left side contains the button-links that lead the user to the home page, to the map or to the authentication form. The central part of the interface displays a welcome message and provides general information regarding the blood donation process (the requested documents and the recommendations that have to be accomplished before donation). Then, according to the user type, the web application provides several different interfaces:

- The map is the only thing a visitor (a guest) can see. If he wants a greater interaction with the blood donation centers, he can create an account, becoming an authenticated user.

- A user has several more actions, one of them being that he is able to set notifications. What are these useful for? Maybe someone doesn't have any intention to donate today or this week, but if he/she receives a notification which informs him/her about an acute need of his blood type, maybe he/she can decide to donate right now.
- Another level is dedicated to the employees; they can add users or can search for a user.
- The admin of a center can add employees or users.
- The admin of a county (the highest level of the application) can add centers or users.



Figure 2. The home page allows the access on five levels.

The application was implemented for Timisoara and its resident citizens. For this reason, the interface is provided in Romanian. If necessary, it can be translated.

Technical Information

The authors decided to implement this system as a web application and not as a mobile one for several reasons:

- the user actions are not difficult because it is not necessary to download and install an application (especially that it is not permanently used, the interval between two donations being at least 8 weeks [4]);
- it uses only a browser (of smartphone or computer);
- it is available at any moment, everybody having a smartphone with internet access.

From technical point of view, the application is implemented using quite new technologies. AngularJS [6] is a framework used to display information in browser. It provides reusable components (this way, with minimum code, more functionality can be achieved). Regarding the language that is used, this is TypeScript [7], one of the newest models provided for development of the visual part of an application. NodeJS [8] was used to insert and process data and to answer to the user's actions. The language was JavaScript. Data storage was made with a NoSQL database called MongoDB [9]. It is a document-oriented database, it doesn't have a fixed storage form and it is suitable for storing large amounts of data.

A necessary step in software development is the testing phase. The correctness of a system is verified by interactions with that system or with parts of it. These interactions aim to check whether the implementation follows the specifications or not [10].

This application was tested during its development and when it was completed. Two types of testing have been used: modular testing (performed by the developer) and overall testing (mainly performed by the donors). The main objectives of these tests were to prevent the malfunctions of the applications' entities, to detect the possible failures and to ensure that the tested elements are providing the expected results.

Each module of the application was tested by the developer during the software implementation and all the arisen problems have been solved at that level. Once a functional version of the application was available, it was tested by the donors and by the supervisor of this work. This overall testing aimed to verify if the entire system met the requirements. It also included usability testing, which is a fundamental stage, emphasizing aspects regarding the way real users interact with the tool. Some adjustments have been applied, as a result of these tests, in order to improve specific features. A final testing was performed by a special committee organized to validate this product.

The application was not yet tested by medical staff, but their opinion is valuable and there are essential points where medical staff can provide feedback. The following versions will include more specific aspects, connected to medical issues.

Results and Discussion

The answers to the questionnaire show that a significant number of persons who belong to the institution that organized the blood donation campaign and who would like to donate did not know about this event (73% of the participants would like to donate blood, 70.4% of the participants didn't know about the blood donation campaign). The web application presented here can be used to promote such actions (and not only). The county administrator of this tool adds a temporary transfusion center into the system. This way, it will be quickly identified by those persons who are interested in blood donation. More than this, the authenticated users who have activated notifications in their application will be automatically informed about the campaign.

The results of the testing phase were encouraging. Besides some ordinary technical aspects that had to be corrected during the implementation, the development of each module didn't generate notable difficulties. The potential donors that tested this application have been satisfied by its user interface and by the provided functionalities. One attractive (even if not essential) suggestion was to rotate (with 180 degrees) the graphical element that indicates a transfusion center on the map, making it look like a drop of blood.

The application is going to be tested by employees of the medical units, too. They are the beneficiaries of the consequences produced by the use of this tool. In fact, the final beneficiaries are the patients, but they have nothing to do with this application in that terrible moment when their life depends of a certain blood supply.

Even if the application is functional, it can be permanently improved. For instance, some limitations of this tool can be considered as future work; this may include:

- more specific information available on the map (for instance, about the blood subtypes: Rh negative, Rh positive);
- statistics in order to have a general image of this process and to make predictions;
- development at national level (with medical staff involved in specifications and testing);
- appointments for a better management (of time and of blood), with the possibility to see the appointments already booked by other donors.

According to these results, two main ideas can be mentioned. On the one hand, this tool was a necessity in the field of medical informatics. On the other hand, there are essential aspects to be added in order to make it really influential.

It is known that the blood supplies are insufficient. This statement is valid for many countries, not only for Romania, and it is supported by recent research articles. As the results of a statistical analysis show [11], even if there is an acute need of blood products, only a small part of eligible persons choose to help and be active donors. The lack of motivation in blood donation has several specific reasons, also emphasized by the current paper: carelessness, ignorance, fear, difficulty. The statistical study described in the first part of this paper (section "The Context") shows that the fellow citizens would have good intentions regarding blood donation activity, but the actions, and obviously, the results are missing. This fact can be improved by education and awareness. And one thing is for sure: it is about need rather than altruism [11].

A solid help in this field can be provided by tools that make the blood donation process easier. The current paper presents an innovative solution, easy to be used for everybody having internet access. It is not the single one available globally. There are some research articles that describe other web or mobile applications developed to encourage and to improve blood donation, but none of them in Romania and none of them with this innovative concept based on a map of blood necessity.

An example of such a tool is a web application created by a group of researchers in order to manage the blood donation and transfusion processes [12]. The proposed solution tries to gather and to organize data from blood banks and from blood donation campaigns, this way improving the difficult problem of obtaining a proper blood group. That paper [12] also emphasizes the lack of awareness in this domain.

There are also mobile applications developed due to a strong need for actions in this domain in order to supply the blood demand [13]. The mHealth (mobile health) concept is suitable also for blood donation, this complex process that consumes time and energy to find a donor whose blood type is compatible with the patient's one [14]. Several analyses of existing mobile applications for blood donation have been performed and described in research papers [15, 16]. Their main conclusion is that there are essential improvements that should be added to these tools, especially for identifying potential donors and also for recruiting non-willing persons [15]. The results of these analyses also show that there is a need for better applications in this domain (of blood donation optimization) in order to increase the number of volunteer donors [16].

Therefore, this is a field with a high development potential and the applications that have already been created are welcomed and necessary. Of course, there is enough space for improvements and new ideas. The web application described by the current paper brings several benefits emphasized in the previous paragraphs. It has some limitations, too, and there are new features that can be added (also enumerated earlier, in this paper) in order to make it more useful, efficient and reliable.

One significant aspect that is worth to be considered when a new version will be developed, could make this web application an intelligent tool. It has access to the data that describes the donation activity and also the blood demand. It is not difficult to use some mechanism from the domain of artificial intelligence in order to make predictions regarding the trends in the near future. The expected need of certain blood types or even subtypes can be accomplished by specific blood donation campaigns. It is also possible to make long term predictions [17] that can be used by government agencies or other organizations that are responsible for this domain to ensure the blood supply.

Conclusions

The application described into this paper is the result of authors' experience in the process of blood donation, followed by discussions with people from the medical domain, but also with simple (potentially) donors. Their conclusion was that a similar solution is not available. The aspects presented in this paper showed that this web application could be of real help. This is one of the reasons this tool has been developed: the need of optimization in this crucial volunteering action, which, in fact, comes from the need of blood that can save lives.

Finally, it cannot be stated that blood donation is a really difficult process or not. After all, if somebody wants to help, she/he will do everything she/he can. But the goal is to improve things in this smart society that everybody desire.

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