Bilkent University

Department of Computer Engineering

Senior Design Project

HelpingHands

Final Report

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1. Introduction

As mankind progressed through the ages, the technology we possessed and our understanding of science progressed alongside us. Medicine was one of the fields that saw the most progression. Many medical conditions that may have resulted in fatalities in the past have simple solutions to them today. One big development that proved crucial to the field of medicine was blood transfusions. The first human-to-human blood transfusion was performed in 1795. [1] Since then, blood transfusions have saved countless lives, but the number of daily blood donations is still very little. Blood transfusions are used for many medical conditions, such as anemia or cancer, but more importantly, they are crucial for blood loss resulting from accidents. [2] As donated blood can only be stored for 42 days, and with only a few percent of the population donating their blood[3], a steady supply of blood donations is needed every day. This can be further proven by the fact that Bilkent University periodically sends requests for emergency blood donations. If our community consisting of 14.000 people needs to send this many requests, it is easy to grasp the grimness of the situation when we enlarge the scale to the whole population of Turkey.

This is where we, as HelpingHands, want to come in. We want to provide a mobile-based solution for connecting recipients and donors. We want to provide a platform where people in need, or hospitals, can put requests for types of blood donations, and donors fitting the provided criteria can be alerted by notifications, so that they can contact the recipients easily.

2. Requirements Details

2.1 Functional Requirements

2.1.1 System Functionality

The system should:

- Ask users (clients and hospitals) to register themselves with their identities for security.
- Have a login system for users.
- Ask for/Have clients' information such as their address, phone number, blood type, and address.
- Allow donee to announce their need for blood.
- Allow users to change their profile information in case changed.
- Find blood banks near the user's location.
- Display the blood types available at the blood bank.
- Notify donors if blood is needed at a blood bank near them.
- Provide a badge allocation for donors.
- Allow donors and recipients to chat in the case extra information is needed
- Allow users to view their blood donation cards.
- Allow users to check their blood donation and reservation history in order to keep track of their blood donation periods.
- Allow users to view their blood journey from donation, to processing, to storage, and finally donating it to other people.

2.1.2 User Functionality

The user should:

- Be able to register themselves with their identification details.
- Provide the information required to fill in during registering.
- Log in to the system.
- Change profile information.
- View near blood banks near his/her area that requires their blood type.
- Be able to post requests for blood donations via his/her nearby blood banks.
- View his/her badges to be able to know his/her rankings.
- Cancel or modify blood donation requests.
- View blood donation and reservation history.
- Be able to contact other users who requested blood in the case for extra information.
- View blood journey.

2.2 Nonfunctional Requirements

2.2.1 Extensibility

- Be easily maintainable
- Be available on other platforms such as a web application if the need arises for integration with hospitals.

2.2.2 Reliability

The system should:

- Ensure that each user’s data remains confidential and protected.
- Ensure that the location of nearby blood banks and donors is correct since any delay may be detrimental to a recipient's state.

2.2.3 Usability

The system should:

- Be user-friendly.
- Have options with themes and app layout, especially a dark theme for night-time viewing.
- Provide correct locations to users and remind users if device calibration is not correct.

2.2.4 Accessibility

The system should:

- Be downloadable from the Google Play Store.
- Be downloadable from the project's official website via the apk file provided there.

2.2.5 Portability

The system should:

- Be able to run on most Android phones running on popular operating systems.

2.2.6 Efficiency

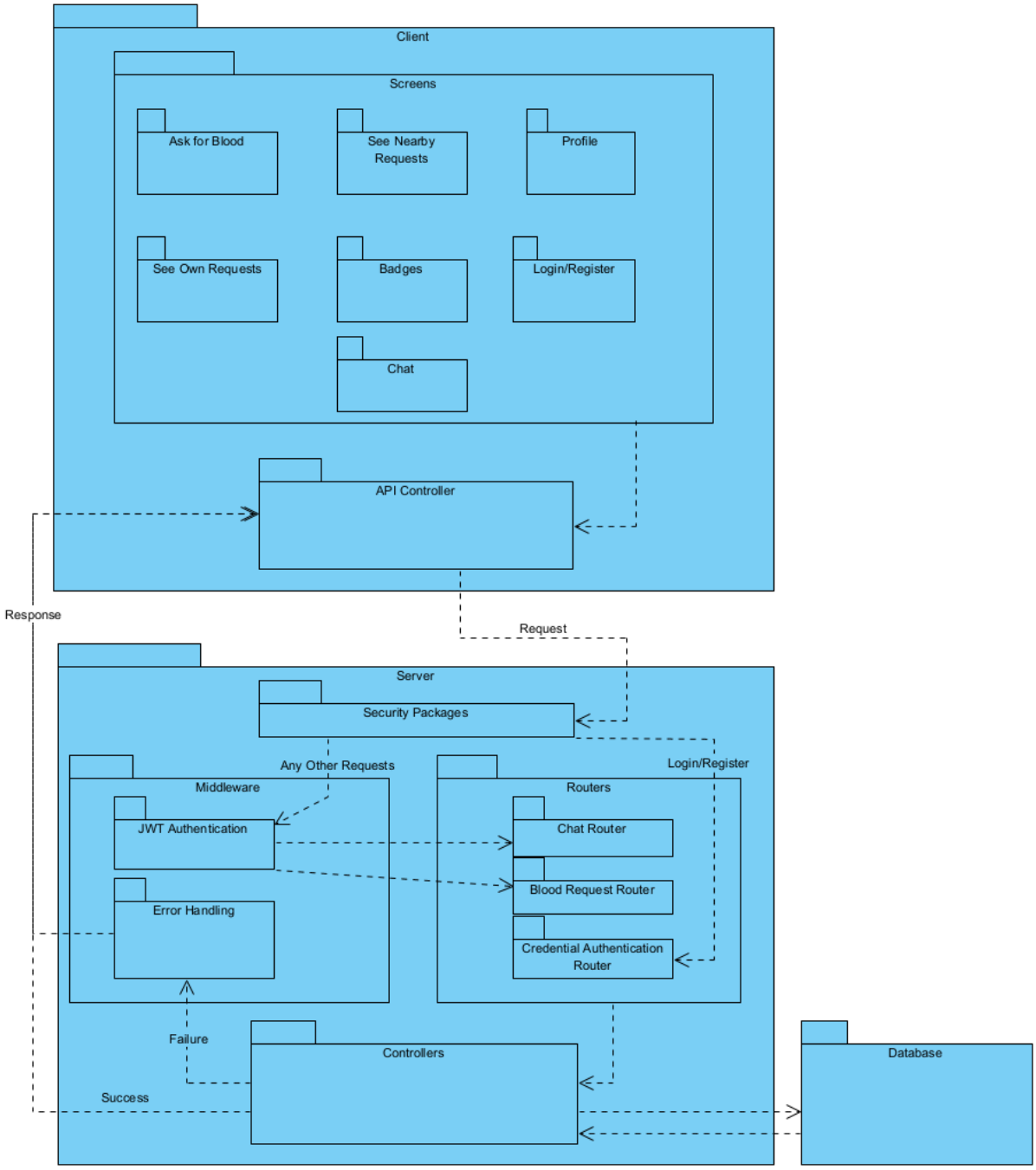
The system should:

- Be lightweight and not consume space since it is targeted as a health-critical application.
- Remain responsive and not lag even if there are multiple donors/recipients in a locale.

3. Final Architecture and Design Details

3.1 Subsystem Decomposition

We are using a Client-Server Architecture in HelpingHands. The decomposition diagram can be found below.



3.2 Client-Side

The Client-side is developed using React Native framework on the NodeJs environment. The application consists of Screens, which are basically Views, which are made up of imported react

components and custom-created components. CSS was used to style the elements present in the screens and responsive design was achieved using the Flex-box properties available via CSS.

All screens in react native has a self-contained state which is exclusive to those screens and are updated throughout the application lifecycle. A state management library such as Redux was not used since it did not merit the overhead for a lightweight application like this and instead useState hooks were utilized which are provided by react-native. In addition, for initial rendering, the useEffect hook was utilized to run functions at the initial loading of each page.

3.3 Server Side

The server of HelpingHands is a RESTful API that is hosted on the cloud service provider Heroku. The server serves HTTP requests: GET, POST, PATCH, and DELETE in particular, made by the client. The server is written in Node.js, and almost entirely utilizes the Express.js framework to aid in serving requests.

Our database of choice for HelpingHands is MongoDB. MongoDB, along with the Node.js framework Mongoose, allows for extremely simple data retrieval and alteration. As the client and server communicate using JSON Objects in HTTP bodies, MongoDB's document model allows the server to store the data directly without resorting to complex queries.

The layered system of routing, controlling, and error-handling both eases maintenance and allows new features to be added seamlessly.

4. Development/Implementation Details

4.1 Authentication and Security

When an HTTP request arrives at the server, it first undergoes inspection by third-party security packages. These packages are

Helmet.js: Secures HTTP header vulnerabilities and prevents attacks such as Cross-Site-Scripting (XSS) or clickjacking.

CORS.js: This allows the server to accept requests that do not fit in Cross-Origin Resource Sharing policy, in other words, allows the server to accept requests from external clients.

RateLimiter.js: Limits the number of requests that can be made from the same origin in a time window.

After security inspection, there are two possibilities. If the request is made to the /auth endpoint, which means it is a login or register request, the request is directly passed to Credential Authentication Router. After processing, the client is sent a JSON Web Token, along with necessary data.

Any requests apart from login and register require this same JWT to be sent in the Authorization header of the request. This token is used to ensure that the request is coming from a HelpingHands mobile client, and contains the userID of the logged-in user, which allows the

server to easily identify the caller. The JWT secret, which is used to sign and verify these tokens, is kept secure on the Heroku servers.

The last security feature implemented on the server is password hashing, which is done by the package **Bcrypt.js**. Passwords are not stored in plain text on the database.

4.2 Google API's and Location

Nearby hospitals were used as points of the transaction between the donor and the requestor. The user's location was necessary to show nearby requests and nearby hospitals as well. Therefore the following API's and modules were utilized to achieve this:

- **React-Native-Maps(Integrated Google Maps):** This was used in our application during the requesting process to show nearby hospitals and the user's location and the route between them, visualized on a map.
- **Google Distance-Matrix API:** This API was used to calculate the distance between the user and the hospital's location and the time it will take to travel there. Several modes were available for travel, and the mode used was traveled by car since usually that is the mode for traveling.
- **Expo-Location**: Since our project was initialized with Expo, consistently Expo-Location was used to get the user's current coordinates whenever it was necessary.
- **Google Places API:** Google's Places API was used to find the coordinates of nearby hospitals relative to the users' position and all their details such as name, nearby place, etc.

4.3 Text Messaging

Text messaging is handled by the server via storing the sender, receiver, blood request, and message body on the database. When queried by the client, the server sends every message associated with the client and target user. The client makes requests at set intervals to refresh the message history.

5. Testing Details

5.1 Code Review and Continuous Integration

Code review and continuous integration are crucial for designing and implementing applications larger than small scale. Since larger-scale applications can only be achieved by working in teams, these concepts are crucial. We utilized GitHub to share, review, merge and track our codebase. Tools provided by GitHub, along with periodic team meetings proved sufficient for collaboration in making an app of the scale of HelpingHands.

5.2 Frontend Testing

A test-driven development approach was used in creating the UI of the application and the functionality therein. Several test cases were made for the login/registration screen and then according to those cases, the application was developed. Sequentially, test cases for other pages were made, and then those pages were implemented as well. After their creation, the pages were tested using Appium to make sure those test cases were satisfied.

In addition, since Expo was used, the project was exported to Expo's own website and through the expo app it could be run from any android device. Therefore, the app was exported and the link given to many friends and family members to provide instant feedback and report any bugs associated with the frontend functionality. This also ensured users from different locations were able to use the application since the application relies heavily on the users' location being correct and the correct information of nearby hospitals being shown to the user.

5.3 Backend Testing

The two tools we used in backend testing were MongoDB Atlas and Postman. MongoDB Atlas is a web interface where users can see their collections of data sorted and presented in a meaningful way. Using this tool, we were able to instantaneously see any changes the server made to the database.

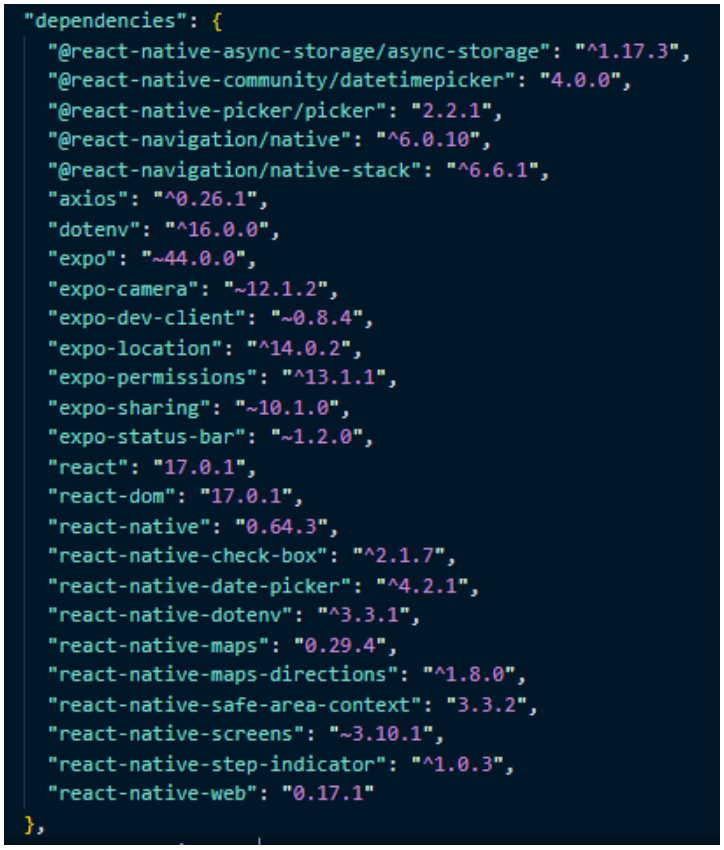
Postman is a tool that provides a simple way to make HTTP requests to any URL. Since web browsers can only make GET requests without writing JavaScript code, and because our frontend was in simultaneous development with the backend, Postman provided the necessary tools to test each endpoint and security feature of our backend.

6. Maintenance Plan and Details

Helping-Hands does not use any remote servers for storing user data so maintenance wise it is easier since the core functionalities work on the user's Android device. Helping-Hands uses Google APIs to keep track of nearby locations and API calls are free up to a certain limit per day.

If there is a substantial increase in user base then depending on the number of calls made, the price will vary and will need to be paid per month.

Currently, Helping-Hands is implemented using react native version 0..64.4. There are constant updates in the packages that the app uses and it is possible that some packages may lose support from the creators and might need to be changed with some other package. For now, though, the following packages work perfectly and are being supported by their creators.



7. Other Project Elements

7.1. Consideration of Various Factors in Engineering Design

7.1.1 Public Health

Perhaps the most important factor to consider, we do not think that HelpingHands will be constrained by public health. While it is true that our project aims to provide a solution to a health problem, in all aspects it is a supplementary application. It is more of a social media app aimed to connect donors and recipients, it holds absolutely no authority in any medical domain. When a donor and recipient are connected, any medical operations deemed necessary will be performed by hospitals or blood banks, so we do not foresee any negative health effects caused by our application and we do not foresee any negative effects caused on our project by such concerns.

Level of Effect: 2/10

7.1.2 Public Safety

Public safety is an important factor for our project, as we aim to have individuals meet up in real life. Upon confirmation from the user, their name, contact information, and location will be shared with a complete stranger. While we will hold the two parties' information, we cannot verify if this information is completely correct. We will try to combat these problems in two ways: First, we will share a person's desired amount of information upon their request, and we will not share live location data, as in we will only share the target hospital/blood bank's location

data. After these precautions, it will mostly fall on the user to ensure their safety. Since some sort of blood donation request systems already exists (e-mails/announcements), we do not think our project will introduce any new safety concerns that do not already exist.

Level of Effect: 5/10

7.1.3 Privacy

Privacy is another extremely important factor to consider because HelpingHands will hold vital personal information, including but not limited to: Name, Surname, Phone Number, E-Mail, Blood Type, and such. While we are not set on how much will be stored on the mobile client, all information of all participants will be stored on our server. Therefore, it is important that this information is kept securely and is not shared with other people without the said individual's confirmation.

Level of Effect: 10/10

7.1.4 Public Welfare

HelpingHands will be completely free to download and use. Also, the application will not contain any paid services. All a person will need is a compatible mobile phone and an internet connection. Therefore, HelpingHands is not constrained by public welfare.

Level of Effect: 0/10

7.1.5 Economic Constraints

As the entire development team consists of CS 492 students with their own equipment, we do not foresee any costs during development. For now, we are using GitHub Pages to host our project website, which is free. To distribute our application, we can use our website, which will eliminate any distribution costs, otherwise, if we use platforms such as Google Play Store or Apple App Store, we will have some costs. Finally, we plan to host our server in a cloud service, for which we are considering Amazon Web Services. While we cannot foresee the potential costs of using the service, our Innovation Expert explained to us that it is free for some amount of usage time or storage amount. To conclude, we do not foresee any costs in the context of CS 491/492, but we may come across potential costs if we decide to continue the project after that.

Level of Effect: 0/10

7.1.6 Social Constraints

HelpingHands will not concern itself with gender, race, or any other social aspects. The only consideration we will have to make is that we have to make sure that participants are over the age of 18, which we plan to verify during registration.

Level of Effect: 1/10

Factor	Level of Effect (out of 10)
Public Health	2
Public Safety	5
Privacy	10
Public Welfare	0
Economic Constraints	0
Social Constraints	1
Any other factors	0

7.2. Ethics and Professional Responsibilities

Firstly, the societal implications of HelpingHands will be considered. HelpingHands will be a social-service application that will be free to download and free to use. The application is intended to be used by all classes/races of people, except for possibly people, who may not fit the criteria for donating blood i.e having tattoos.

In compliance with the General Data Protection Act, Helping-Hand will not publish or sell any 3rd party information and will self-sustain costs incurred via other means such as advertisements, if needed. The application is a health-service app and will abide by the rules of patient confidentiality.

The application is also a health-critical application and urgent blood donations will be prioritized and process delays will be minimized.

7.3. Judgments and Impacts on Various Contexts

Judgement Description: Impact in	Impact Level (Out of 10)	Impact Description
Global Context	8	English is the number one spoken language in the world
Economic Cotext	8	Free application and no app-in purchase
Social Context	7	Brings the society together

Impact in a global context:

We choose the language of our program to be in English since we have 2 members in the group who are non-Turkish speakers hence to make it easier for them in implementation. Also, the English language is known to a large segment of society in Turkey, and it's known in most other countries. English is the number 1 spoken language in the world [4] and in case we want to expand our application to the whole world, it would be easier for us to do so.

Impact in Economic Context:

HelpingHands will be a completely free app with no in-app purchases.

Each of the app's features is beneficial to each user. This condition has an important economic impact.

Impact in Social Context:

HelpingHands is planned to be a helpful application as it assists the people in need of blood to request it on a big platform of people who can donate and also to be of service for people to donate. It allows people to meet new people and brings the community closer together.

7.4 Teamwork Details

7.4.1 Contributing and functioning effectively on the team

Because a project had a clear goal, it was critical that everyone involved in the effort was aware of it. A project member can make better individual judgments and decrease confusion and rework by understanding the target outcome. Furthermore, each individual was an important part of the larger project structure. Everyone was aware of their own and others' responsibilities. Each group member often communicated with one another by asking questions and providing updates on the portions of the project for which they are accountable. Furthermore, each group member adapted to the changes that may occur during the project's various phases. As a result, they could contribute the most to the project. Apart from that, the project's tasks were separated so that everyone could work efficiently. This was accomplished by splitting the tasks into areas where project members have extensive understanding.

7.4.2 Helping Create a Collaborative and Inclusive Environment

To develop a collaborative and inclusive project environment, all team members were informed of their teammates' pluses and minuses and acted accordingly. They attempted to compensate for their team members' weaknesses so that the project's flow would not be disrupted. Each group member had the

opportunity to be open-minded about their ideas and behaviors in order to approach each problem from a different angle. This had a good impact on the team's overall performance.

7.4.3 Taking the Lead role and sharing leadership on the team

We divided the project into work packages and assigned everyone to lead one of them to encourage everyone to participate in leadership. Each team member was assigned to all work packages so that they all had the same amount of work. As a result, every project participant was informed of the project's processes. To execute work concurrently, all team members were in contact with each other at all times during the project. The project's code base and progress are kept in a dedicated GitHub repository. The archive is accessible to all members of the team.

7.4.4 Meeting objectives

During the analysis phase of our project, we created a project plan for the project's design and development. This part will evaluate our initial project plan and see how well it was followed.

Our initial goal was to fully implement the main features of our application which are logging in, registering, searching for nearby banks, reserving a time slot to donate blood, and requesting blood. When this goal was achieved, we started looking forward to implementing the rest of the features like viewing blood history, viewing blood cards and badges. We discovered throughout the development phase that the time slots we set aside for specific units were optimistic assumptions, and as a result, we were unable to include these procedures in the application.

Given the problems we faced as a team during the development of our application, we realized that our time predictions were unrealistic. We experienced difficulty as a team since none of us had adequate experience for such a large project over such a lengthy period of time; as a result, our estimates for each

element of the project were lower than what was required. As a result, we had to speed up some project components and were unable to incorporate some of the previously indicated functionality.

As a result, the objectives that we met can be listed as follows:

- Implementing a social platform that allows users to donate and request blood
- Implementing a system to get user's current location automatically
- Implementing a simple and well User Interface

Finally, as a team, we consider our development life-cycle a success because the application's essential capabilities have been effectively realized. Each of us obtained an experience with the progress of such a project as a result in working on it.

7.5 New Knowledge Acquired and Applied

Although we already have some knowledge about web and mobile development from CS102, CS353, and CS319, we did not have enough experience to fully implement HelpingHands. Therefore, before implementation, we had to acquire more knowledge in

- Mobile Development
- Web Development
- Application Design
- Database Design
- Software Development Planning
- Software Architecture Planning

So, we started to meet and discuss what we should exactly learn in each topic in order to help us implement our project. Our main source was watching videos on the internet and google searching. We needed to use the internet to learn about new frameworks, architectures, and their working principles, as

well as some of the difficulties we confront. We used online learning to pick up new programming languages and learn how to use frameworks like JavaScript, Node.js, and React Native. We gained additional experience and worked together, as well as using tutorials, to expand our knowledge of version control systems and Git with the Github process. Finally, we found that the practical learning experience was the most effective technique because we learned a lot from our mistakes.

9. Conclusion and Future Work

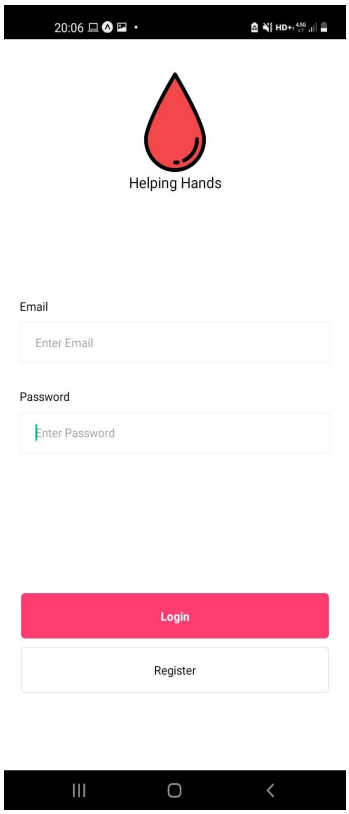
To conclude, HelpingHands runs almost perfectly. Its main features are to request and donate blood, check nearby blood banks, view badges and view blood cards. It is free to use, and we intend to open source it so that others can benefit from our experience with frameworks, programming languages, and design patterns. There was a link between the app's progress and our coding, design, testing, and development, as well as our friendship. We definitely need to improve, but we've seen that if you put in enough work, you'll get better at what you're doing.

Regarding our future work, firstly, we are waiting to receive feedback from our supervisor, jury members, and colleagues. After that, we want to receive feedback from the people who might be interested in our application like hospital members, donors, and people working in social events. Then we will look forward to editing our application features in case of any better suggestions. Finally, when our application runs perfectly without any bugs, we will send our app to the App Store and Google PlayStore.

Since we’ve been together for almost one year, we became a great team where we always helped each other throughout the whole journey. It would also be great and possible to create new applications together but for now, we will make sure that HelpingHands is free and safe to use.

10. User Manual

10.1 Sign in Page

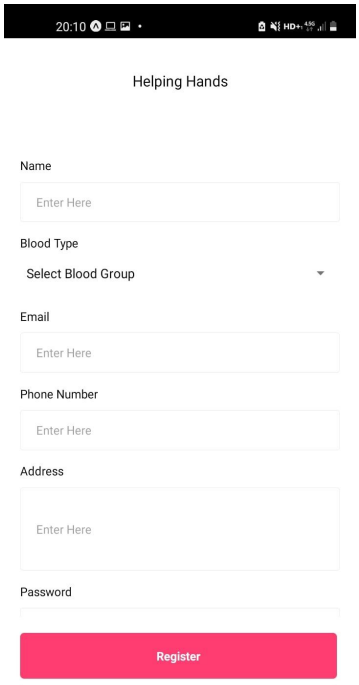


This is the screen that opens when the application is launched.

Users that already have registered accounts can log in to the application by writing their verified emails and passwords to the correspondent fields and tapping the login button.

If they do not have a registered account they can do the registration page by tapping the register that is at the bottom.

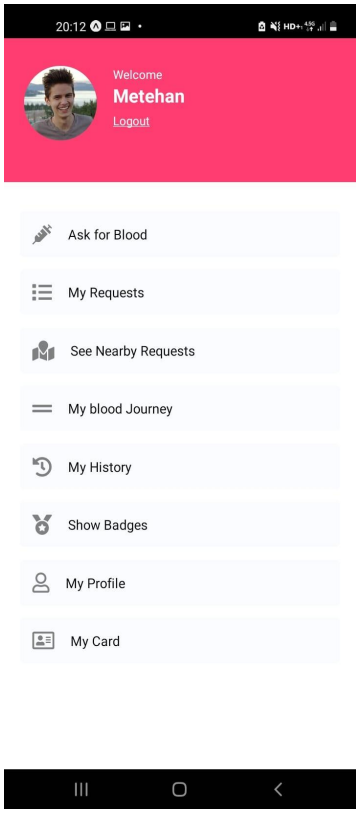
10.2 Register Page



This is the “Register” page where users can sign up for the application. In order to register, users need to add their identity information which is: name, email, phone number, address, and a password.

Additionally, they need to select their blood type.

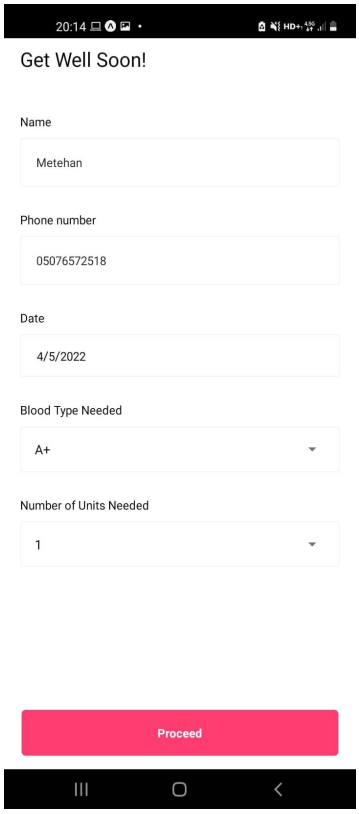
10.3 Home Page

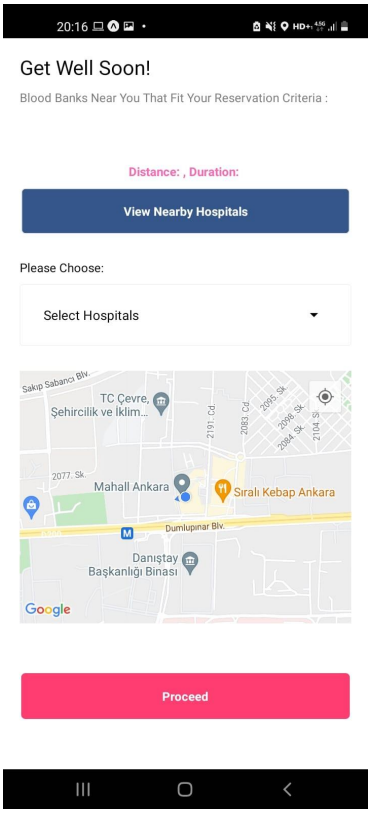


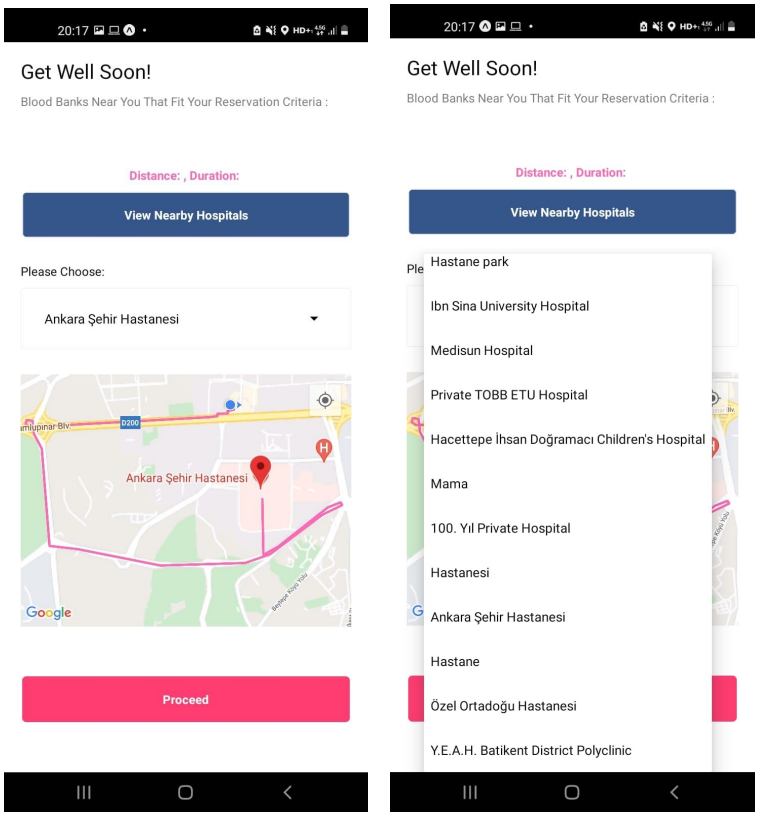
On the homepage of the application, users are greeted and given an option to log out at the top of the screen. Users are given many options which they can choose from by tapping on the corresponding buttons.

From the home page, users can go to the pages “Ask for Blood”, “My Requests”, “See Nearby Requests”, “My Blood Journey”, “My History”, “Show Badges”, ``My Profile” and “My Card”.

10.4 Ask For Blood

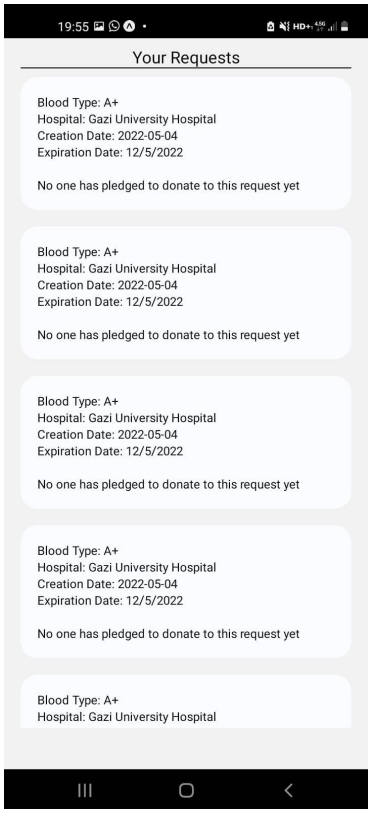






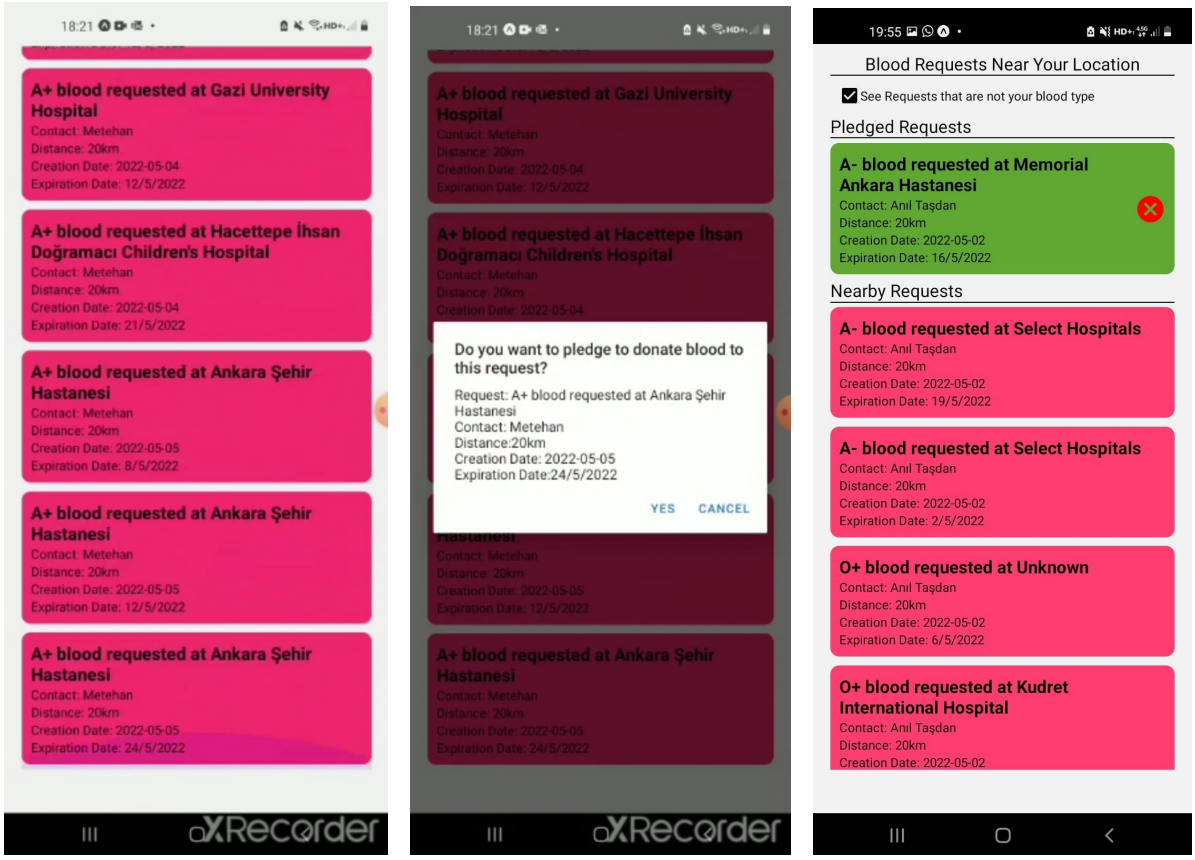
The “Ask For Blood” option is for blood reservation. The page to be opened after clicking this option is displayed below. Name and phone number are to be filled but they will be already filled by the application from the user’s information. However, they can also be changed in case needed. Then, the blood type needed and the number of units must be filled by the user as their needs. Finally, the date for collecting blood must be specified in order for the reservation to be completed. After finishing filling the required information, the application will direct you to another page that displays the blood banks near the user that fits the reservation criteria that the user can choose from. If the user is sure that all the information he/she entered is correct, then he/she can confirm the reservation, or else, the user can modify them. Also, if the user already confirmed a reservation, they can still cancel it.

10.5 My Requests Page



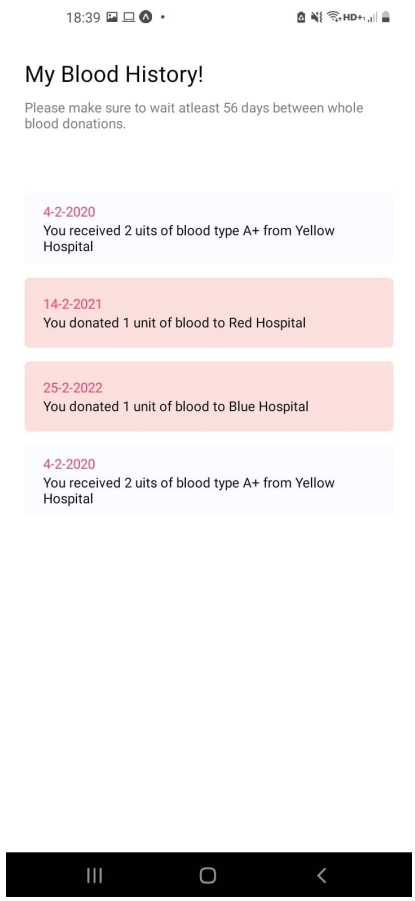
This page allows the users to view the blood requests that they asked for with all the necessary details like what blood type was requested, in which hospital, the creation and expiry date, and if someone pledged to donate for this request or not.

10.6 See Nearby Requests Page



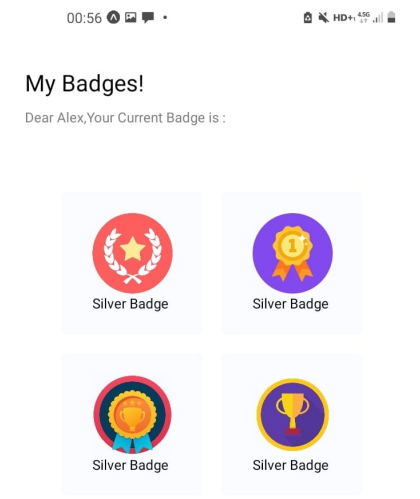
This page allows the users to see nearby requests for other people. In case the user wants to donate for that request, he/she should press on the request which will ask them for a confirmation message. Then after confirming, users can see their pledged requests at the top of the page.

10.7 My History



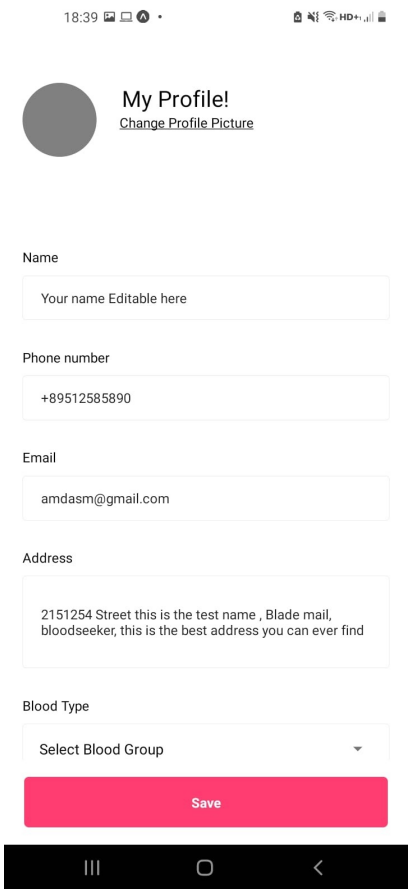
"My History" option is added for the user so that he/she can keep track of their blood donations and reservations. On the top of the page, it reminds the user that they cannot donate blood if it was less than 56 days for their previous donation. And then, the page shows the dates of previous activities, from the most recent one to the oldest one with blood reservations being marked with white highlights and blood donations being marked with red highlights to easily differentiate between them.

10.8 Show Badges



"Badges" option is added to encourage the user to engage more in blood donations and reserve blood for them and people in need. There are currently 4 consecutive badges: bronze, silver, gold, and platinum. Whenever the user engages more in using the application, the badge will be upgraded.

10.9 My Profile

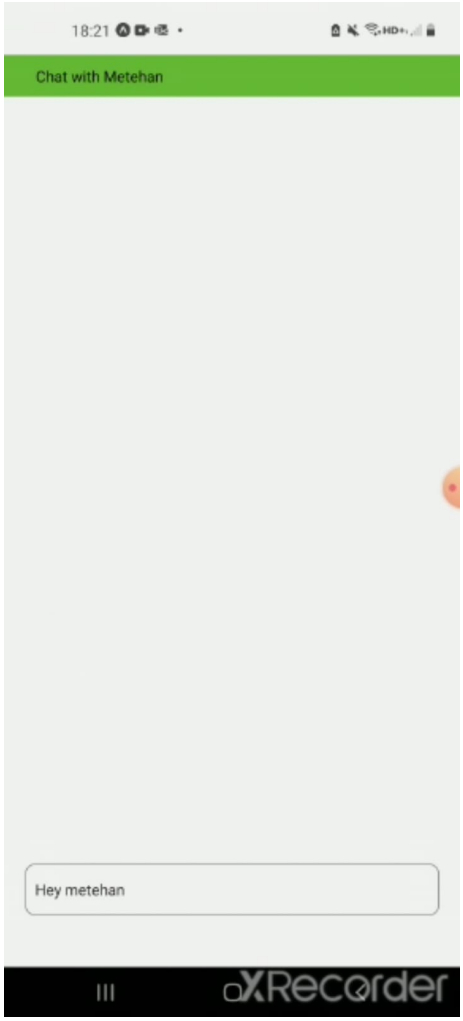


"My Profile" option is set for the user who wants to change any of their personal details. In case of any incorrect information the user entered in the registration period, the user can still change them. Also, in case any of the information has changed in time, the user can still change them at any time. This information can be to change the profile picture, incorrect names, and blood types during the registration period, also, the email, phone number, and address can be changed in case the user wants to change them.

10.10 My Card

"My Card" option is given to blood donation users like any other card that people can use for identification. The card is designed to look like any ID card that has the user's name, a special donor number on the card for the user, a group number, and the user's blood type. The user can also choose to save the card on their phone if they wanted.

10.11 Text Messages



This feature is added in the “See Nearby Requests” section after the user pledged for donation where he/she can contact the person who announced for their blood request in case the donor wanted to ask for extra information.

10. References

[1] *What is the history of blood transfusion?* Latest Medical News, Clinical Trials, Guidelines - Today on Medscape. (2020, December 6). Retrieved October 10, 2021, from https://www.medscape.com/answers/434176-183004/what-is-the-history-of-blood-transfusion#:~:text=The%20earliest%20known%20blood%20transfusions,Blundell%20in%20London%20in%201818.

[2] U.S. Department of Health and Human Services. (n.d.). *Blood transfusion*. National Heart Lung and Blood Institute. Retrieved October 10, 2021, from https://www.nhlbi.nih.gov/health-topics/blood-transfusion.

[3] *US Blood Supply Facts*. Facts About Blood Supply In The U.S. | Red Cross Blood Services. (n.d.). Retrieved October 10, 2021, from https://www.redcrossblood.org/donate-blood/how-to-donate/how-blood-donations-help/blood-needs-blood-supply.html.

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