



## "Rethinking tracing technology" during the COVID-19 pandemic

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**Abstract:** Human-centered design is an approach where solutions are derived according to the needs of the end-users. The solution developed is for the benefit of the people who use the products and services. In this project, our task is rethinking the design of an Italian contact tracing application, known as Immuni, to increase its adoption. We will investigate the reasons for low adoption in the design space and then collect, explore ideas and refine the solutions based on the feedback received by the application's end-users. Furthermore, evaluate the effectiveness of these proposed solutions by applying all the methods and principles we have learned in class to achieve a user-friendly contact tracking application.

Keywords: Human-Centered Design, Pact Analysis, Requirement Analysis, Prototyping, Questionnaire

Introduction	3
User Requirements Collection	4
Workshops	4
Comparative Analysis	4
Observation and Group Discussion	6
PACT Analysis	7
I. People	7
II. Activities	7
III. Context	7
IV. Technology	7
Proposed Solutions	8
Prototyping	9
Storyboards for scenarios	10
News Feature	10
Test Centre Feature	10
News Prototype	11
Low Fidelity	11
Medium Fidelity	11
Video Prototype	13
Low Fidelity	13
Medium Fidelity	13
Test Centers Prototype	14
Low Fidelity	14
Medium Fidelity	14
Questionnaires	15
Questionnaire Design	15
Audience	15
Questionnaire Structure and Design	15
Distribution	15
Questionnaire - Response Evaluation	16
Demographic Evaluation	16
Features Evaluation	17
Feedback Evaluation	18
Medium Fidelity Revisited	20
News Feature	20
Video Feature	20
Test Centre Feature	21
Conclusion	22
References	22

## Introduction

Although the pandemic is far from over, the world has recognized the need to work together to combat the virus, and the use of technology has made it easier to find people who may have been exposed and help contain the spread of the virus. In Italy, the relevant authority has partnered with Bending Spoons S.p.A. to create Immuni, a mobile application that uses Bluetooth technology to securely log contacts to determine who may have been exposed to the virus. The digital contact tracing system has given health officials a head start in helping the government make decisions and control measures to combat the spread of Covid-19. While the technology is promising, there are also some challenges with adoption that have made the adoption decline over the past few months, according to Google insights, and we would like to find possible challenges that are causing this and find probable solutions to increase adoption so that users better understand it better. In this report, we look at how we used a user-centric approach to redesign the application. We use the insights we got from the workshop, the class and team discussions, practicals, observation, comparative analysis to develop ideas that guide our workflow in the redesign process. Ultimately the changes made reflect the users' needs and requirements, improving usability.

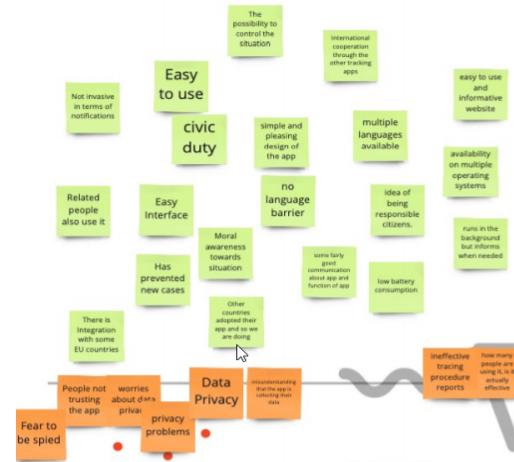
## User Requirements Collection

The first step we took was to gather information about the user requirements. We collected the first ideas from the class interactions, which had been drafted in Miro (an online platform that allows teams to collaborate and share ideas through interactive participation), researched and compared results with similar apps from different countries, and compared the adoption. It was crucial in identifying the issues that users might have encountered when using the Immuni app.

## Workshops

In the workshops, we discussed with other classmates who had used the app and had a basic understanding of how it worked. The first workshop interaction consisted of asking the participants probing questions about the mobile app and the COVID-19 pandemic in general, eliciting their interests and opinions. Then, the feedback/response would be visible to every one of us. The interaction resulted in a combination of positive and negative responses among the participants. Participants felt responsible for battling the pandemic, but if they could protect their privacy by participating anonymously. The fear of their location being monitored, and their data being used by the app, the unnecessary battery usage due to the use of Bluetooth, downloading the app from Google Play Store, a company based outside the European Union (EU), rather than the government site, raising privacy concerns - the negatives seemed to overshadow the positives and hence stopping people for using the application.

We then concentrated on the negatives to create new ideas for resolving user issues. We had determined that the critical issue was with the design implementation, and our main concern was that app users had feedback, but the app was not straightforward. The only way to address the transparency issue and give app users reason to trust the app was to introduce features that campaigned for awareness, ensuring viral downloads. Users would have more interest in the app if they understood how it operated. Then we looked at the new design and found that users faced some communication problems that should be resolved in the redesign phase. What we learned from the other workshop is that the government needs to be involved in encouraging adoption. If the government was involved by adequately communicating the need for this application to the population, then the population would be encouraged to adopt this application because the population would know that the government is doing its due diligence by ensuring that the data controllers and processors of the application are complying with all the regulations.



## Comparative Analysis

In addition to the workshops, we thought it would be better to compare other contact tracking apps to understand what possible drivers led to their adoption. We looked at the German contact tracking app - "Corona-Warn-App," the Indian app - "Aarogya Setu," and the Irish app - "COVID Tracker Ireland."

**Exposure Logging**

SETTING

**Exposure Logging**

Transnational Exposure Logging [Participating Countries](#)

[Start Screen](#) [Check In](#) [Journal](#)

7:10 PM 0.3KB/s 4G 4G 12:30 23%

Aarogya Setu [What Will App Do](#)

[Setu Mera Bodyguard #IndiaFightsCorona](#)

[Aarogya Setu App Guide | 11 Languages](#)

[Aarogya Setu | Green Color: What does it signify?](#)

We noticed a few things that contributed to their wide adoption, viz.

- 1) The German app has three different status views,
  - a) Unknown risk means that the risk calculation cannot be done because the function was inactive.
  - b) Low risk means that the user has not yet had contact with a positive corona person.
  - c) Increased risk means that one has been in contact with a CHD-positive person in the last 14 days.
  - d) There is also a survey option in the app, which is voluntary and helps the developers to understand the user better and also evaluate the effectiveness of the app.
- 2) The German government logo and a video of the Chancellor in the app make it more essential and signal the seriousness of the pandemic situation.
- 3) Finally, the colors used in the app also play an important role. In the German app, matte colors are used, while the Italian app uses bright colors.

The second application we looked at was the Aarogya Setu which had the following things that have contributed to its adoption in India viz.

1. The Indian application, Aarogya Setu, requests the user to complete a self-assessment as you enter the application. It asks a series of questions like the user's age, if any symptoms are observed, and if they traveled anywhere around the country or outside the country. Then, it decides your status ("You are Safe").
2. The user is not allowed to input the positive result by himself. That is done by the lab. The lab is authorized to enter the positive result into the premier research body, ICMR (Indian Council of Medical Research) portal, and they share the result on the application portal.
3. The application has many features like Useful Resources, which gives information in the form of FAQs about the application, its scope of usage, and privacy and technical details. It also lists the laboratories with COVID-19 testing facility available, missing in most of the contact tracing applications (including Immuni). Finally, a list of COVID-19 care centers in the vicinity of 10kms to 50kms of the user.
4. Then, there is a message from the country's prime minister (India) highlighting the importance of the application and its effectiveness in fighting the pandemic.
5. The last feature we observed interesting is the instructional videos educating the users on how the application works in 11 different Indian languages. It also has visual aids that benefit the users to gain insights such as app and medical authorities' interaction, registering for vaccines, and others.

The third application we looked at was the "COVID TRACKER" which had the following things that have contributed to its adoption in Ireland viz.

1. The Irish application - COVID Tracker Ireland requests the user to insert age and select configurations for Contract Tracing, Data Protection Information, and App Metrics. Add the phone number (optional) for Contact Tracing follow-up.
2. The user is suggested to use COVID Check-in to update daily symptoms by asking a series of questions. If there are potential symptoms, the user is advised or provided with the necessary service as per the need.
3. The app contains a lot of valuable features other than Contact Tracing, similar to other apps. Statistics is one feature that provides detailed statistics on vaccinations completed, the number of first and second doses delivered, updates regarding cases, deaths in time intervals, hospitalization numbers, and regional breakdown.



## Observation and Group Discussions

In one of the practical lessons, the instructors asked one of us to share the phone screen and use the app while the rest of the class watched what the person was doing. We took notes and then asked to say a few things about what we had observed.

We took the next step to look at the reviews available on the Google Playstore, which allowed us to understand the users' concerns and possible ideal solutions. We also had random pairing in Groups in our class practicals where we collaborated and discussed the application and its functionality with each other.

## PACT Analysis

To understand the needs and requirements of the Immuni user, we utilize a user-centric framework for rethinking the design space for the Immuni user. We used the PACT analysis to analyze user expectations and specifications in the following ways:

### I. People

The primary users of the Immuni mobile app are Italians or people living in Italy. There are mainly smartphone users who have some knowledge of how to use Bluetooth technology. But the secondary uses are occasional users, i.e., developers of the application. The tertiary users of the application, our health officials, and the government rely on the application's data to develop measures that curb the spread of the virus. Most of the users are tech-savvy, from what we gathered during the workshops and class discussions on relevant characteristics and skill sets.

### II. Activities

The application's functionality is tracking close contacts while maintaining the privacy of those who contracted the virus. There is also a notification system to monitor the positivity rate and a support desk whereby users can also report a positive test result on the application, which triggers the concerned authority to trace the contacts further. These are activities carried out by the users of this application. The news feature makes the user interact more frequently with the app by checking what has been updated by the trusted news sources. The app features a map showing the available test centers in a particular location that the user can navigate to.

### III. Context

The main context where the app is being used is when two or more people are in close vicinity and are directly exposed to one another, whether during work, leisure, or walking down the street to buy groceries.

### IV. Technology

The technology that the Immuni application uses is essential for users to know how to use the application. First, Immuni is a smartphone application that uses Bluetooth and, contrary to users' fears, does not collect GPS, location data. It uses Bluetooth (a wireless technology protocol to exchange data between devices over short distances). It uses a hash code to identify each of the devices and process accurate contact traces that are deleted after 14 days. The app uses Google Maps Platform to display a map of testing centers. News articles are fed from APIs of various trusted sources through the app's built-in news aggregator and filtered by administrators of the app.

## Proposed Solutions

There are a set of ideas we came up with from the data collected during the class interactions, group discussions etc which are:

i. The first suggestion was to add a News option that would keep people interested and stay longer, this would keep users engaged on what's going on, and incorporate a social sharing button that would help spread the news about the app by asking users to share news in real-time, as there is a lot of misinformation circulating during this pandemic, and it is necessary to have a single source of truth; the sharing button is integrated with the news feed, and when sharing content, the link to download the app is also shared with the new user, which ultimately increases the usability of the app not only as a tracking app but also as a news medium to share information with the public.

ii. The second feature is to redesign the current "how the app works" feature. We found in the "Miro" board - created at the workshop that privacy was an issue, and also on the second workshop educational video was suggested to show how the app works, participants feel adoption is low due to privacy and users think the app is monitoring or tracking their every move and hence, to improve the trust deficit barrier, we would like to add an informative video in the "How it works?" to make users understand better how the app works, as we saw in the Indian app Aarogya Setu.



iii. The third was to add test hubs to the list of solutions we had. We thought this would be useful for users who are planning to travel, require test results for official purposes, visit relatives, or who want to know if they have been or may be exposed to the virus in an unknown way.

## Prototyping

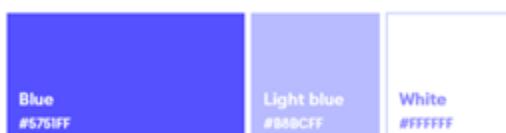
Prototyping is part of the development phase of design where solutions or concepts are created, prototyped, tested, and iterated. The final product will have been effectively evaluated in the design of an interactive product; one should prototype their ideas. Prototyping helped us communicate internally, and we were able to turn our ideas into tangible visual artifacts that could later be turned into code. The prototypes started with low fidelity. We started with sketches, then moved on to refining the sketches in medium-fidelity, and high fidelity, which is a more acceptable design ready to go into the coding phase. We used the design principles we learned in class to guide our thought process and how we added in the new elements in our design. Some of the principles we followed were:

- We made sure the design was simple, we kept the same color scheme and contrast as the existing design made sure we didn't deviate from what the users were used to, and kept the layouts compact and symmetrical.
- The different components of the design were sufficiently prominent and easy to see(visibility), and we used the Volte font that was also used in the original design.
- We also had to consider the limitations or pre-existing constraints. The first constraint was the color scheme in Figure 1 below and the layout and position of elements that we could only add within areas, but we had to avoid clutter. In the Immuni documentation, the developer mentions color code #5751FF as Dodger Blue in the branding document.



- But many people, including us, perceive this as a purple color. The color purple is not associated with positivity in Italy, as an article in [Shutterstock](#) mentions, “[2] Italy also strongly associates purple with funerals”. The emotional impact of colors on applications should not be ignored. And while some colors are considered universal in UX design, such as white or black, the colors they are combined with can significantly impact user perception. For example, white signifies purity in most countries but is not perceived as a good color in some parts of Asia. We had to consider the cultural implications of color palettes depending on the intended end-users of the application. We kept the color scheme as it is. Although it was a mixed reaction, we had to bargain with the pre-existing color scheme as we feared a new color scheme might confuse the users. We were also keen when adding the new features that they had to be consistent with the current layout, dimensions, aesthetics, size of the icons, etc.

Logo colour palette



In-app colour palette



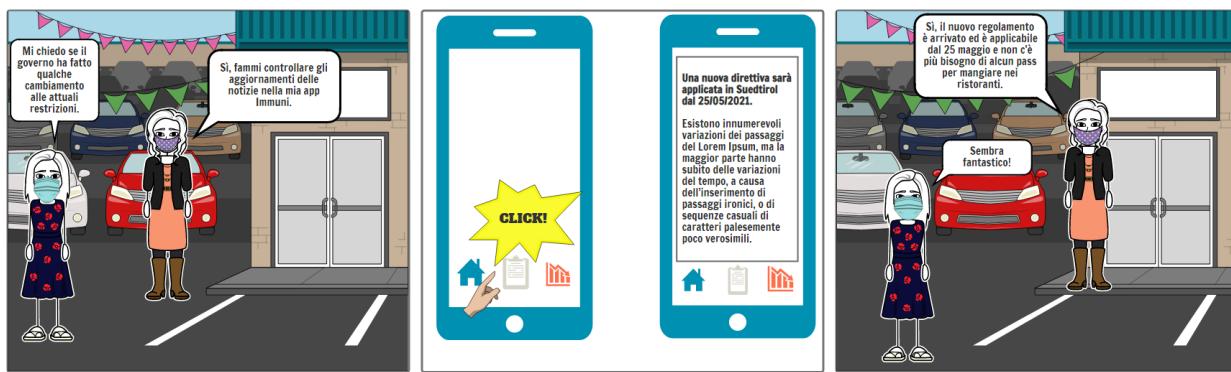
## Storyboards for scenarios

Storyboards help to disclose whether a concept will work or not through the steps a user might take to complete a specific task. A storyboard conveys the flow of the steps towards the end goal. We used [this tool](#) for the storyboards.

### News Feature

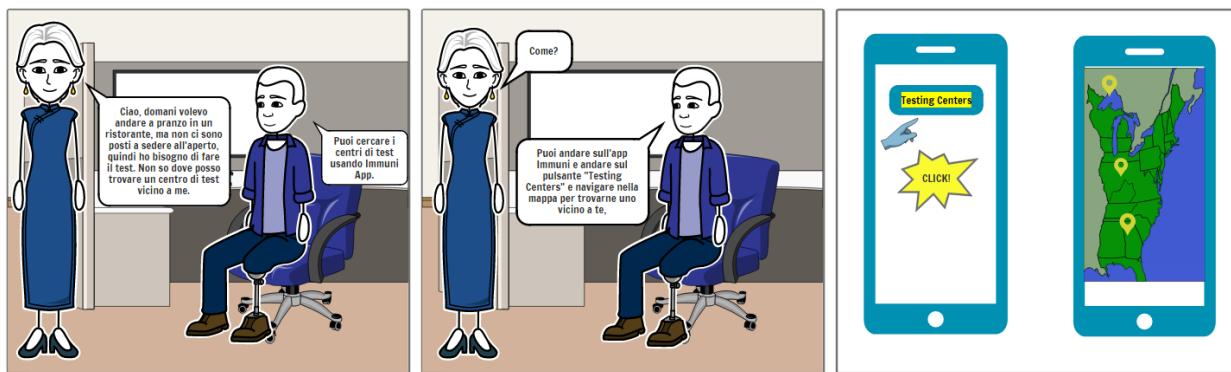
The storyboard shows the functionality of "viewing news" by a user. The person on the right (A) uses the news function in the app to reply to the person on the left (B) when there is change in the restrictions of COVID being implemented in the region and B communicates the news in the app with A.

The idea of the news feature is to keep the users of Immuni informed about the latest happenings related to the COVID-19 pandemic. We believe there is a lot of misinformation surrounding the pandemic. That is why we narrow our source to the government press releases and related sources.



### Test Centre Feature

The storyboard shows the functionality of "viewing testing centers" by a user. The person on the right uses the "Testing centers" function to check the available test centers at a specific location. Hence, it helps users find test centers in a particular area near them.



## News Prototype

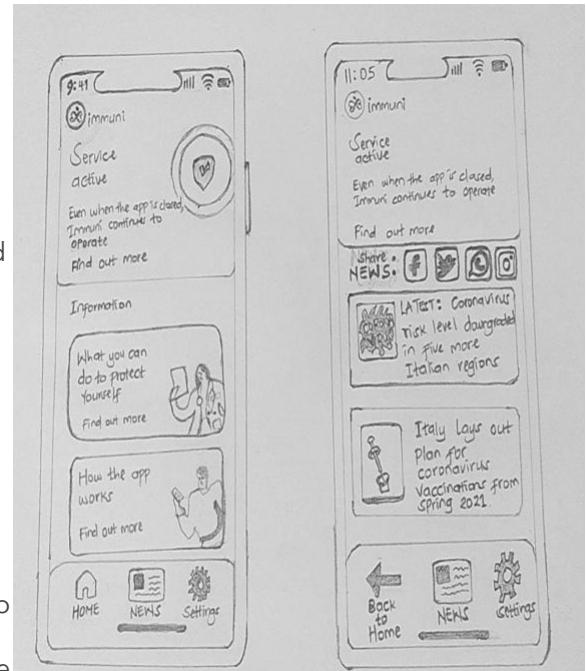
### Low Fidelity:

After analyzing the requirements and their possible solutions, we sketched the ideas on low-fidelity prototypes used to test the functionality rather than the visual appearance. Therefore, we made freehand sketches to model the proposed solutions.

Firstly, the news was thought of as a possible solution, and discussions were held about how the functionality would be used in the actual application. Online meetings were held with all group members in a video call. One person was drawing sketches on pen and paper and discussing and redrawing in an iterative process until the final prototype was agreed upon.

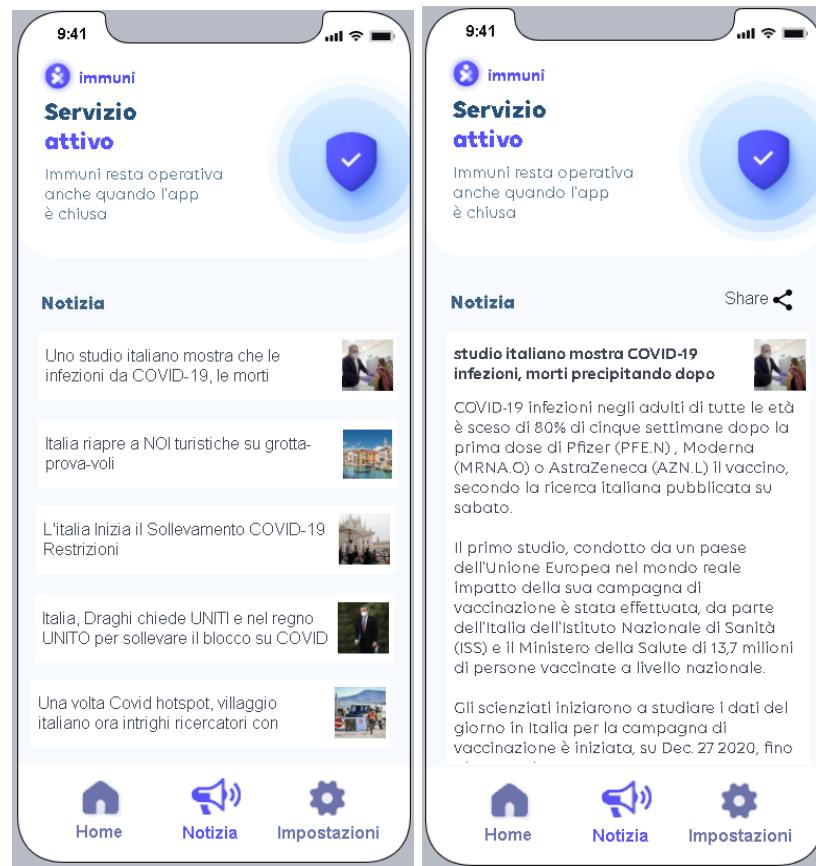
A "News" icon was added in-between "Home" and "Settings" icons in the menu bar for access to the functionality, and when clicked, it navigates to a page with the list of recent news.

The concept of a low fidelity prototype states that it should be easier to create and adaptable to changes by also contributing to visualize a clear path. The low-fidelity prototype we had now designed for the news feature translated our ideas into a tangible concept ready to move into the medium-fidelity phase.



### Medium Fidelity

The first image shows the homepage with the news feature in the central position between the settings icon and home icon. The second image shows the idea of rectangular news boxes (5 in number) on a scrollable page, and the boxes will keep updating while the user scrolls down, the news headline is bold and readable, and the icon is clickable. Finally, the third image is the result of clicking on one of the news boxes. This page also included the social networking icons that allow users to share the news with friends, family, or colleagues; this was our idea to improve adoption by making it shareable. The news icon on click opens a new page. The prototype had limited functionality but made it possible to navigate through the application.

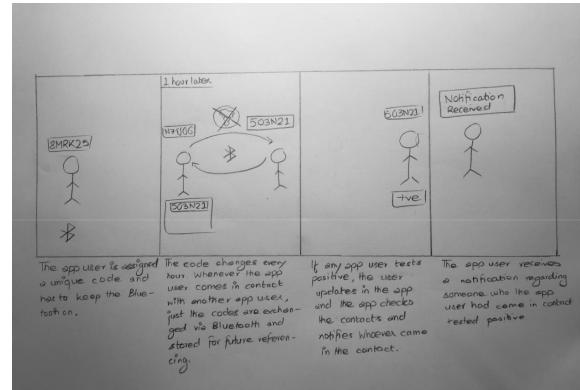


## Video Prototype

### Low Fidelity

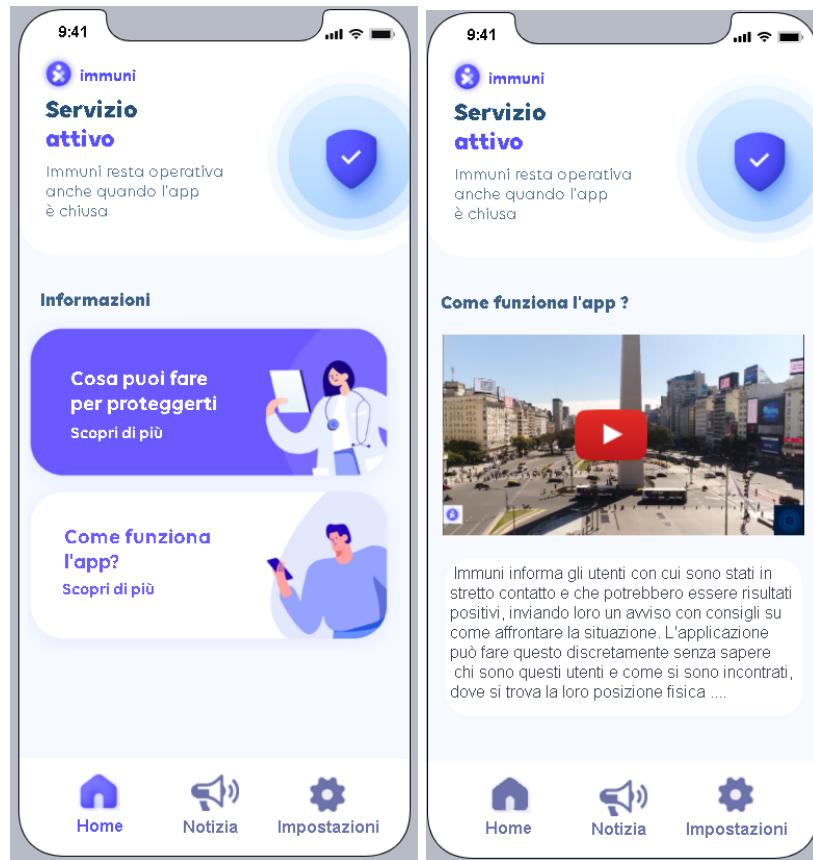
The low fidelity for the video prototype started by drawing the sketches whereby we introduced different characters. We wanted to show how the application works. Hence, we drew sketches that will show interactions and how the application works between two people and how information between two connected devices is shared. So when two characters met, the application would signal some form of data exchange between Immuni enabled devices.

The first image shows a character with a phone. The second image is when the character meets another character, and there is Bluetooth code exchange after a few minutes of a meeting. The third and fourth illustration is when the characters receive a message of possible exposure.



### Medium Fidelity

The medium-fidelity was refined a bit more, and a video prototype was suggested because we observed the space we were working in, and one of us did not want to be cluttered. The existing one involves users scrolling and thus decreasing the attention span.



We used the old design space of how it works.

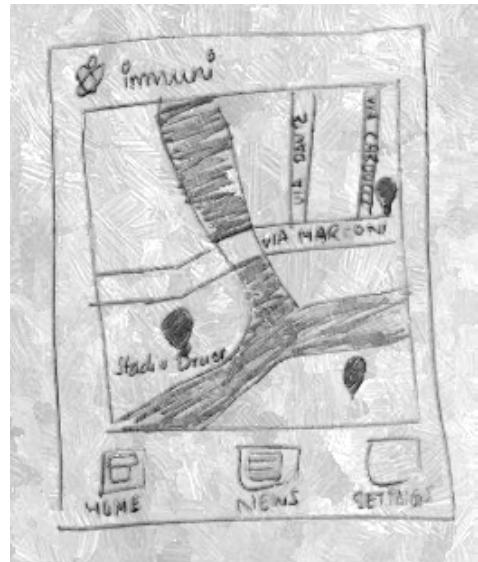
## Test Centers Prototype

### Low Fidelity

A similar approach of freehand sketching was used for the testing centers feature, and discussions were carried out for sketching with the group members communicating through a video call.

A page with an app was added, and properties of a map such as roads, rivers, and landmarks were added, and locations of the testing centers were pinned using the 'inverted-teardrop' icon.

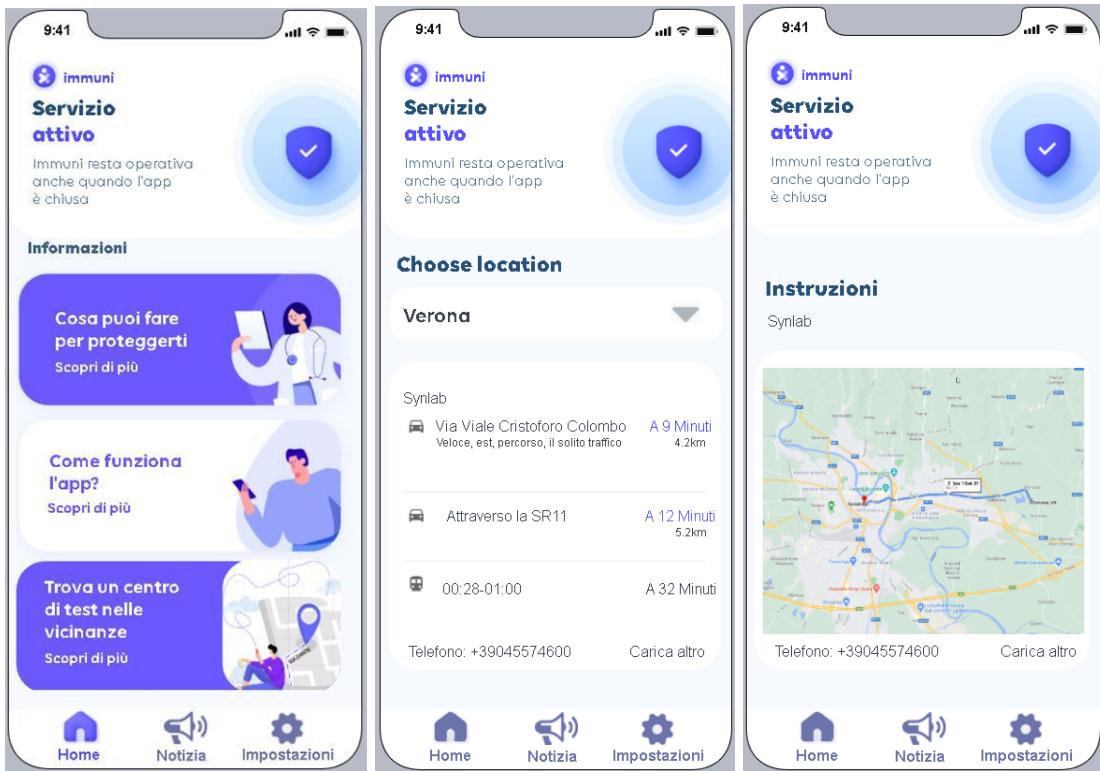
The idea here was to have a new feature that would show where the test centers are.



### Medium Fidelity

We progressed through the low fidelity of the third feature whereby we improved the "Find a test center near you" feature and image 2 is navigated by clicking on the test center on the homepage and as a result, a map with testing centers represented by the 'inverted teardrop' icons on the map and a search field, which is used to search the locations using the text input from the user. This is one of the proposed solutions because this feature can be important to the user as testing is required for different day-to-day activities such as attending classes in person, traveling to another region, and others.

The homepage labeled 1 shows the additional information section for the test center. We utilized this space because it's conspicuous, and from our design methodology, we wanted to avoid clutter; having the location as a menu would make the space cluttered.



## Questionnaires

### Questionnaire Design

The main purpose of the questionnaire is to understand the attitudes of different participants on the added features to know if they had impacted them and utilize the feedback provided by them to make improvements to our Prototypes. A questionnaire was developed with 9 questions of types such as closed questions, Likert -type scale, and one open question. We sent the questionnaires to our friends and also asked them to pass them on with their families. We included a mock-up and sent them a link to test and give us their feedback about the features that we added: the ability to keep up to date with the latest local news and the ability to share the application among social media sites, along with non-functionality features: clarification about how the application works, trying to dispel the confusion around the privacy concern of the users.

### Audience

We contacted 32 participants. One important issue is to reach a representative sample of participants, in this case, the people currently living in Italy. However, since we could only contact our friends and family, the responses came from them.

### Questionnaire Structure and Design

The structure is divided into four parts: context description, the motivation behind the questionnaire in brief and related resources; demography-related questions, Immuni and added features related questions, user opinions, and feedback.

The demographic questions are used to gain the participants' background attributes, which will be important to understand the answers from different users coming from different contexts. This is what we gained from the questionnaires. This section used closed questions to restrict the participant to limited responses.

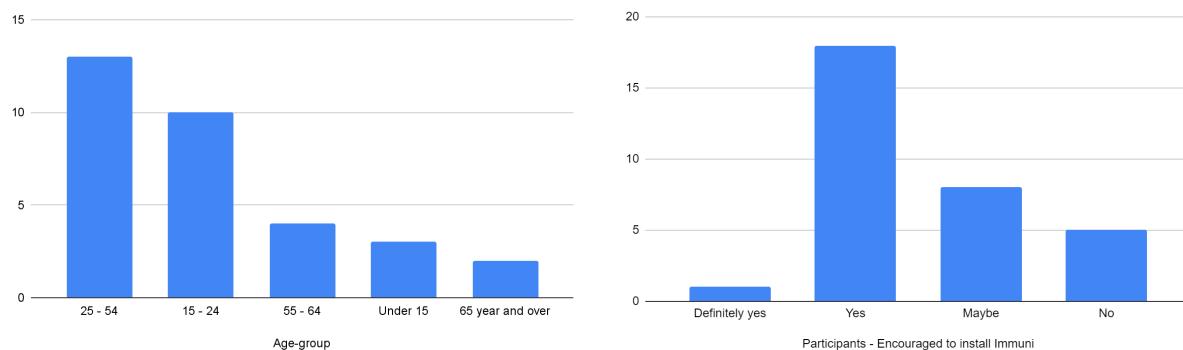
The Immuni and added features related questions are used to gain insight into app usage by the participants and how intuitive, easy to use were the new features for them, and how they felt about the design consistency. According to Sharp, "[1] Likert scales are used for measuring opinions, attitudes, and beliefs, and consequently, they are widely used for evaluating user satisfaction with products" and this section uses Likert -type scale questions to understand the satisfaction of the participants for the added features. The participant had to respond on a scale from "Strongly Disagree" to "Strongly Agree".

### Distribution

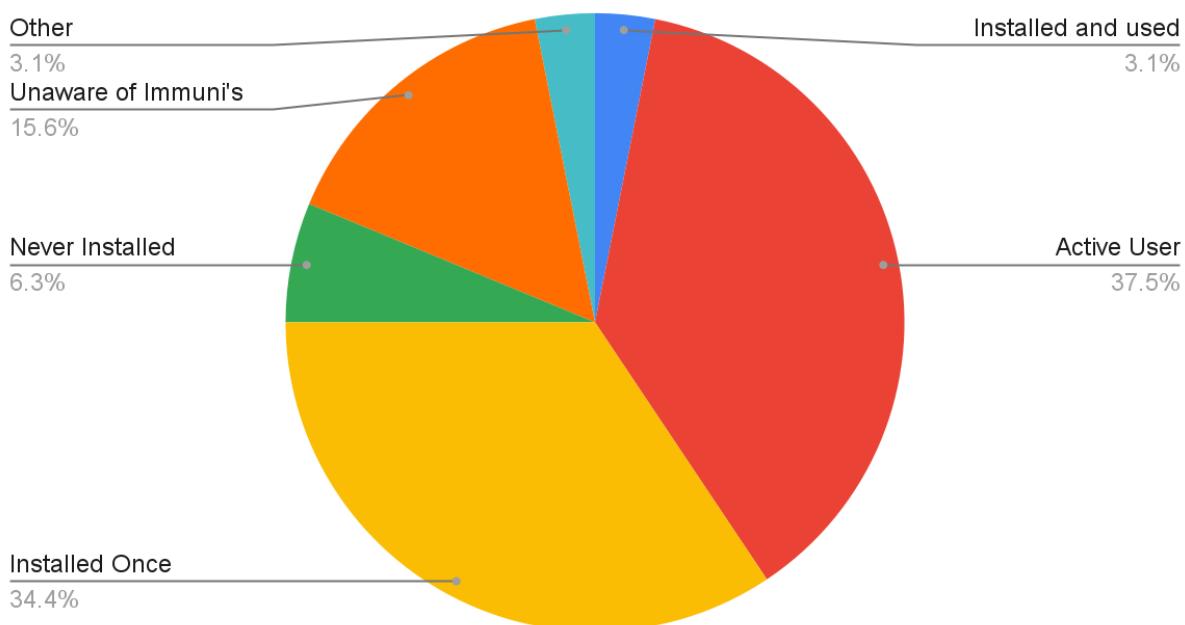
The questionnaire was distributed to friends via email and we asked them to forward this to their friends and families. The link for the questionnaire is [here](#).

## Questionnaire - Response Evaluation

### Demographic Evaluation



## No. of Participants - Immuni user category

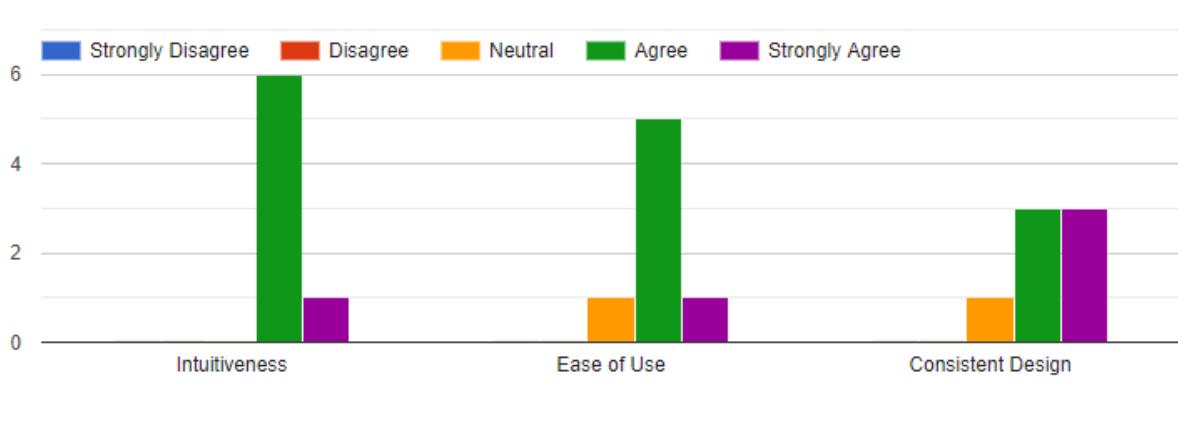


As you can see from the pie chart, 15% of the participants are unaware of Immuni, and 6.3% had never installed the Immuni app. This further proves the point that the adoption of the application is not very high.

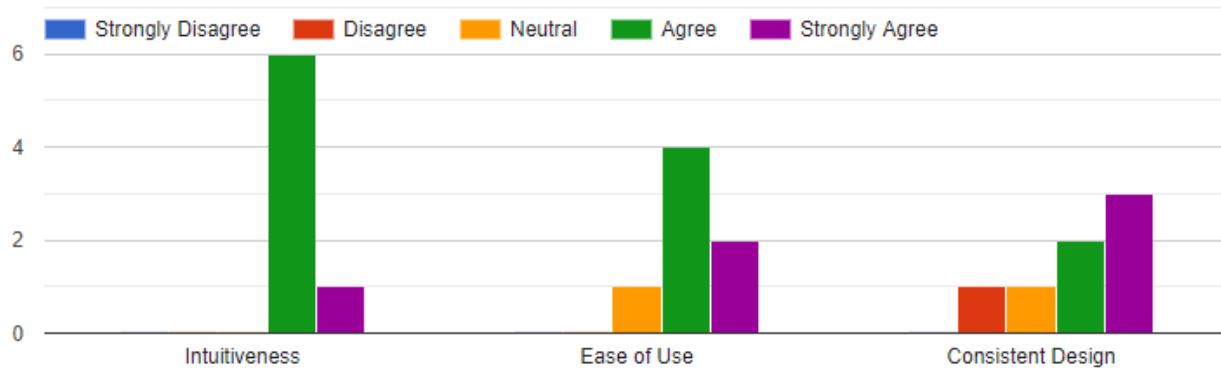
## Features Evaluation

We structured our questions about proposed features for  
a. Intuitiveness b. Ease of Use and c. Consistent design.

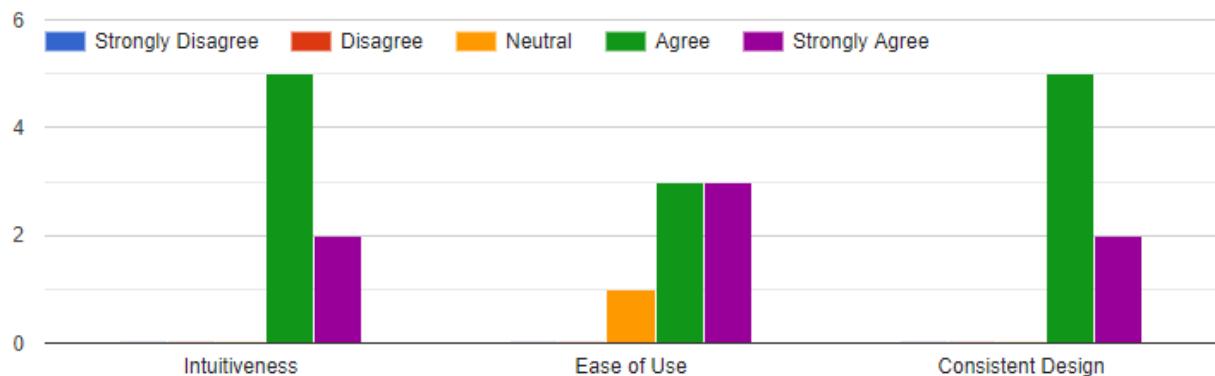
The responses for the News feature:



The responses for the Video prototype:



The responses for the Test Centers prototype:



The results demonstrate that the proposed questionnaire is an excellent tool to understand how good the proposed features are. Also, it gives a good understanding of what we can improve in the next iteration.

## Feedback Evaluation

Do you have any suggestions or feedbacks for the added features?

32 responses

-  
Add the vaccination details information on the maps.

Information about the vaccine would be great

The news feature - please add "already read" feature

yes, I wish we could give individual news a thumbs-up if it was useful or otherwise.

you should make watching the video compulsory for every new user. new videos about health, hygiene will be huge help

Nothing

I do not have any suggestions.

Had live statistics about the current situation

Do you have any suggestions or feedbacks for the added features?

32 responses

I do not like my privacy hijacked

The video is so superficial. I don't know why it's important.

I believe it would be nicer to have easier search for vaccination and test centers.

Add smart feature to turn device on or off, when I am at home, it must be turned off

Make it compulsory to enter any public places like masks

I didn't know anything about nasal swab testing or vaccination until my university mentioned. That information could be integrated. Would be very helpful.

Nein

Bad application

It would be great if I could interact with news articles like make comments and react to it.

Do you have any suggestions or feedbacks for the added features?

32 responses

Excellent Application

it would be efficient if there is a notification when a news article is published.

The video doesn't look official.

a notification when any new information is published.

No. Everything is good for now. Timely updates would be appreciated.

Please add a notification  like on other mobile application

I would like to add be able to contribute to the news.

love the news feature is it okay to add a like and share button, I would also like to give a suggestion when I read a news article

I would like to be able to find the nearest vaccine center I only see that in the application you have test

the font is very small to read, I love the video and the test center navigation.

I love news feature. I am learning to use it.

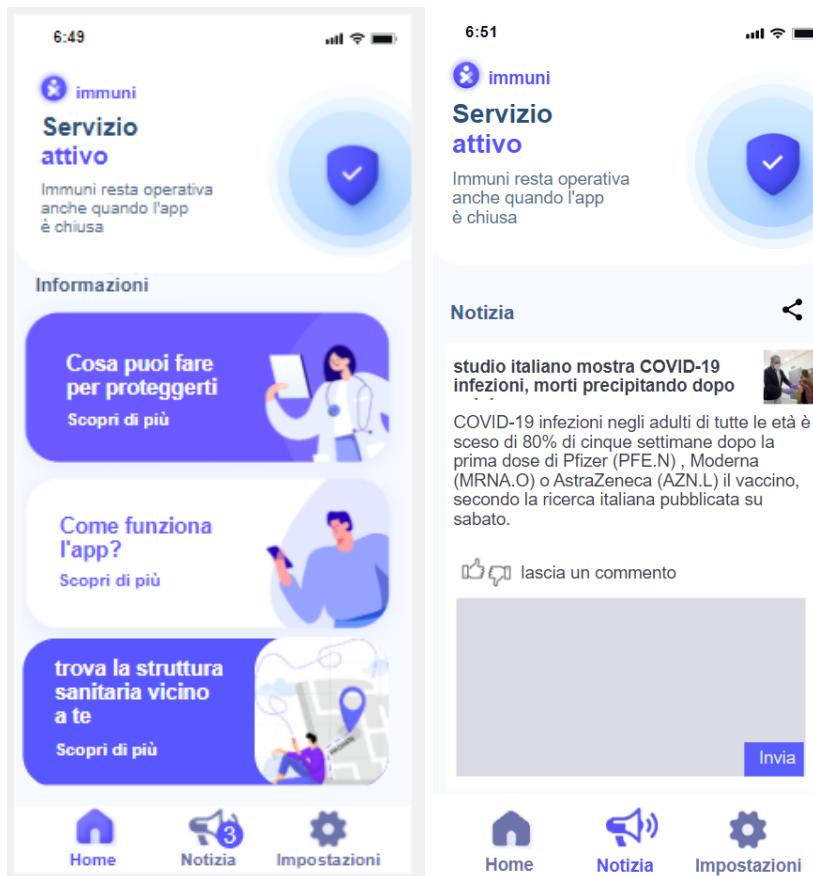
We picked the following ideas from various feedback received on the proposed features:

1. The users want to share their views on the news section and also want to be notified of the latest news published.
2. We got the impression that the users still did not trust the source of how it works video. Adding a government spokesperson, emblem, or incorporation of government logo to the video would go a long way in helping adoption.
3. The participants were interested in additional features about vaccine centers - care centers.
4. The users suggested an extra search filter to find the nearest test centers according to what users input on the search box.

## Medium Fidelity Revisited

### News Feature

We used the new color to our medium-fidelity, retained the symmetry, removed thick boundaries and conspicuous lines, and added graphics.



The images above show the difference between how the app looks without the news icon and how it looks after adding the news feature. It is important to note that we need to define the interactive elements like the news icon to show how users can switch from one screen to another. And when they click on this icon, it will be highlighted in blue, indicating a transition to the active state, while other icons remain grey.

The image on the left shows the second page after clicking on the news icon. This page shows the headline highlights of the news that is trending in Italy. The prominent black borders and well-defined images of the news updates and the well-positioned text in their respective locations. The image on the right shows the last page of the news article when you click on one of the news highlights on the previous page.

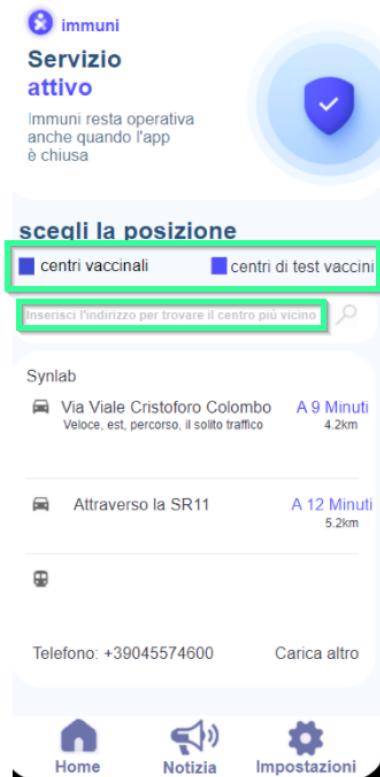
### Video Feature

The image consists of the logo of the Ministry of Health of Italy signifies that the video is from a valid source. We believe this will improve the adoption because the users will discover the logo as a symbol of government endorsement.



## Test Center Feature

We improved the Test center feature by adding the vaccine centers information along with the test centers. We also added a search functionality where you can filter the facilities for your location.



## Conclusion

Due to time constraints, our focus was limited only to awareness, to address the privacy concern of the users, along with adding a few new functionalities to the app, for instance, news features along with the testing and vaccination center information. Ideas such as COVID-19 statistical data, gamifying, health-related services, and others that could have been applied in the app were not added due to the limited focus. We learned a lot about human-centered design and how important it is to consider the users' views as the top priority for design. And indeed, design principles, if followed to the end, can have a significant impact on the adoption of an app.

The class interactions were stimulating for us. We learned a lot in this class, which we will apply in our works, especially when designing applications for people. There needs to be an interaction between the users and the system designers. Come up with a user-friendly system the users can use and recommend to their friends to improve the adoption of such systems.

## References

- [1] Sharp, H., 2019. *Interaction Design*. 5th ed. Wiley & Sons Canada, Limited, John, p.280.
- [2] <https://www.shutterstock.com/blog/color-symbolism-and-meanings-around-the-world>