

Comprehensive Covid-19 Tracking Software

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Comprehensive Covid-19 Tracker

Introduction

Returning to society may be a challenge as we recover from the impacts of Covid-19, especially to those who may not have received the vaccine. Additionally, there is still a need for social distancing, with the problem of not knowing how crowded a place is. While there are existing websites for crowd-tracking, they do not include the details that are most relevant at the moment.

With academic institutions planning to welcome students back in class, we can only imagine a completely different on-campus environment. People may still be hesitant to resume their activities as they did pre-covid. Even when people have received the vaccines, it must be noted that those who have received the vaccine also need some time before the body can fight Covid-19 (Weber, 2021).

Covid tracking should allow its users to detect crowds in a given public area (say, a classroom or the library). To ensure social distancing, it should entail the number of people in the room, the room's size, and if everyone can be 6 feet apart. It should identify whether the person is vaccinated or will be vaccinated because those who are vaccinated can still get Covid-19 (Weber, 2021). It should allow individuals who survived the virus to identify as Covid survivors on the software and include long-term symptoms like fatigue in their bio so that the people around them know that they may need help.

This Covid tracking software could also help the government and healthcare providers track the number of vaccines that should be rolled out and the amount that needs to be in

production. This data might still be relevant in the future if there are features for vaccine follow-ups.

Demographic

This software can be used by individuals of all age groups, sex, race, and religion. It could potentially be more useful for those in high-risk groups - adults and seniors. As the demographic of Covid-19 cases have changed, there should be increased use of the software among younger individuals. Furthermore, women are more likely to be exposed to the virus because they are more likely than men to be employed in the service sector (Gender Differences in Sectors of Employment, 2013).

The software may work differently across different locations and geographic regions with the US. In areas that are less densely populated, people may not need the software at all. This software is intended for the United States since other countries may have been using government-required existing software to manage Covid-19. For instance, Singapore has its government application Trace Together ([TraceTogether.gov.sg](https://www.trace.together.gov.sg)).

In areas where privacy is a highly prioritized concern, fewer data may be made public. For instance, California has the country's toughest privacy laws, with the California Consumer Privacy Act of 2018 (Tollefson, 2019). Among others, the law states that customers can request the information that the business is collecting and about them (Tollefson, 2019). This software can be transparent in providing information to its respective users. That is because its primary purpose is to provide essential crowd and healthcare information that could help contact trace (by providing information such as the places they last visited) if they contracted the virus.

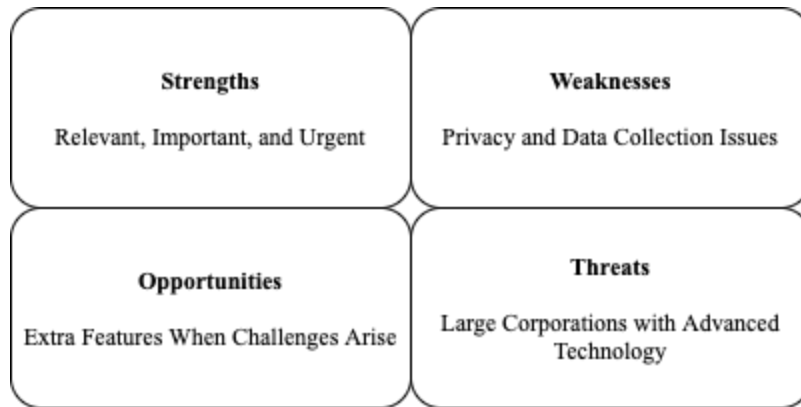
The comprehensive covid-19 tracking software mostly serves those who are in more social contact. Its users include those employed (i.e., white and blue-collar jobs), students, and seniors in assisted living. This software could encourage employees to go back to work, especially those who are previously reluctant because of the risks. Initially, when the virus first spread, younger individuals had a lower incidence of Covid-19. The demographic of Covid-19 itself has changed. In particular, younger individuals are now at a higher risk of Covid-19. The CDC Morbidity and Mortality Weekly Report states that from August 2 to September 5, the weekly incidence of Covid-19 among individuals aged 18-22 years increased significantly, by 55.1% across the country, a more severe case for university students (Salvatore, et al., 2020). Hence, younger individuals like students are more likely to use the software now.

Furthermore, women of the same age group are also at a higher risk of exposure than men. The nature of the jobs they undertake (i.e., the service sector, like wait staff in restaurants) exposes them to more crowds and a larger dose of the virus (Venkatesan, 2020). It shows that anyone can reap the benefits of crowd management if the software can help track crowds. Notably, the service sector would observe a lower risk of incidence for their service staff.

Given the considerable gender inequality in employment resulting from the pandemic, there seems to be an increasing need for women to protect themselves further. Based on the 2019 data from the Economic Policy Institute, frontline workers are predominantly women. More than 70 percent of healthcare workers, social workers, and government and community-based are women. On top of that, based on the data from the Bureau of Labor Statistics from March to September 2020, more women have been laid-off due to the pandemic. In April, when the male unemployment rate was at 13.5%, the female unemployment rate was 16.2%. In comparison, the

pre-pandemic unemployment rates for men and women were the same, at 4.4% (Gender Economic Inequality, n.d.). Therefore, women would probably make up a larger proportion of the users because service staff can likely use the software for crowd management and a reasonable expectation for women to return to the workforce.

While this software's primary purpose is to track crowds and vaccinated individuals, the software can branch out with more features to make everyone feel safer by publicly updating body temperature, and publicly updating the most recent Covid-19 PCR test results. The software can also add vaccine-related features such as where one is on the priority list, reminders for follow-up shots, and the recommended vaccine for the individual. The use of this software certainly raises concerns regarding privacy and possibly, discrimination. However, it may serve as a comprehensive tool to keep everyone informed and protected from the virus.

Analysis***SWOT***

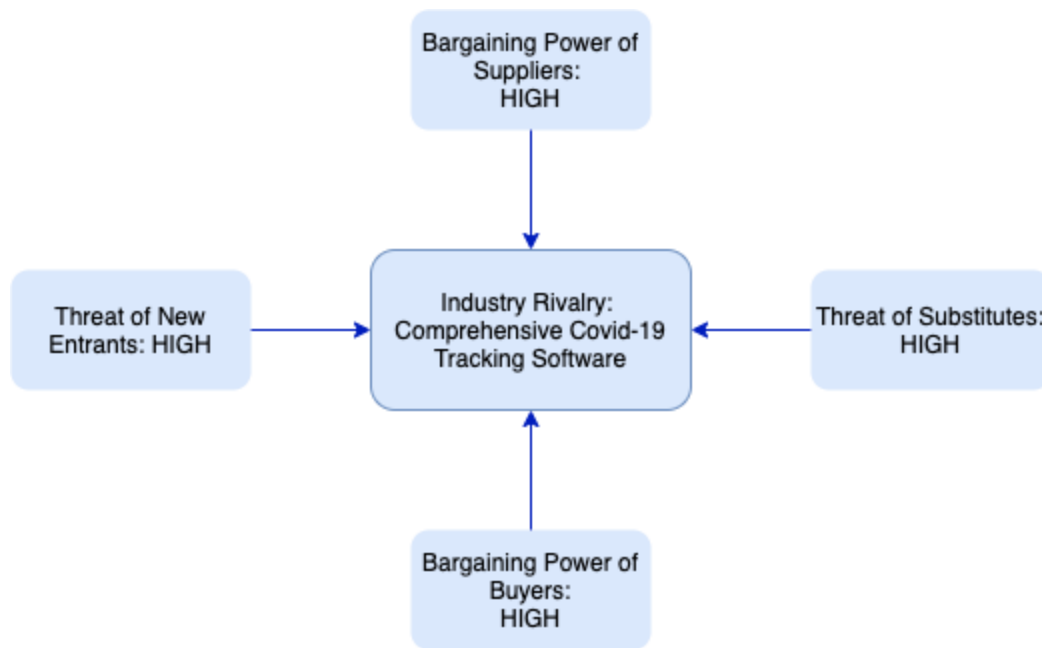
Strengths: This software remains relevant, important and urgent for the time being. Given the current situation, there is a need for this software. The software can be used by people of all age groups, sex, race, religion, and location.

Weaknesses: There are issues of privacy, data collection, and how the data is used. Since this is not coming from a reputable large company, people may not necessarily trust the company and how the data is used.

Opportunities: there are plenty of opportunities for this software to branch out. This software can come up with more features as we face more covid-related challenges. However, the opportunities may not last if the software is not needed anymore, when everyone is vaccinated.

Threats: Large companies can easily design this software and get people to use it (for example, facebook, instagram or twitter can easily incorporate this into their existing apps).

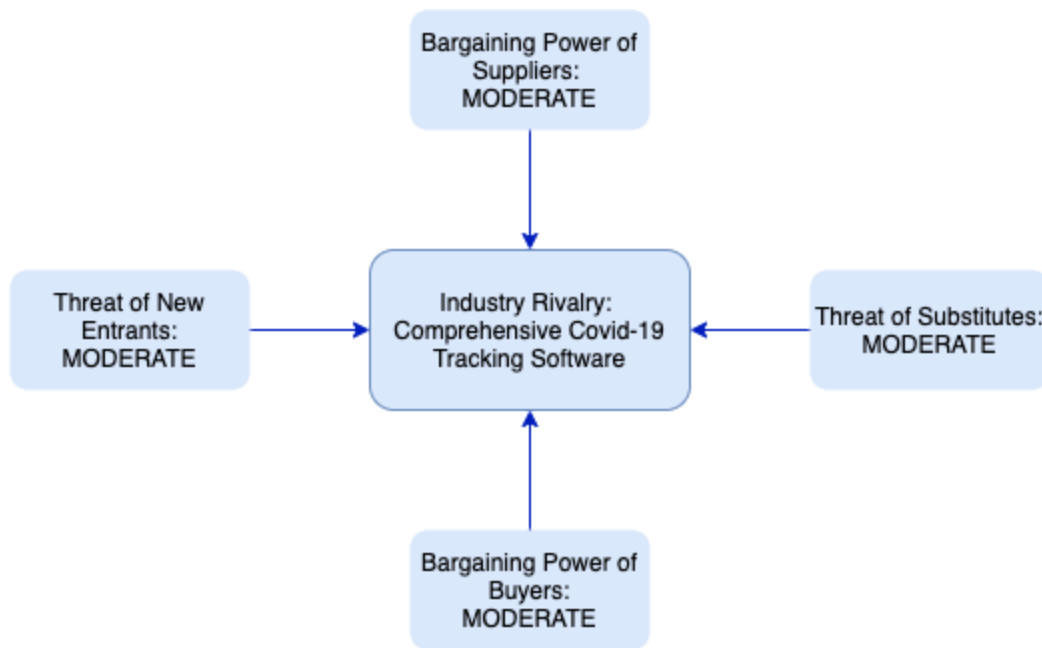
A more comprehensive SWOT analysis can be found later in this document.

Porter's Five Forces

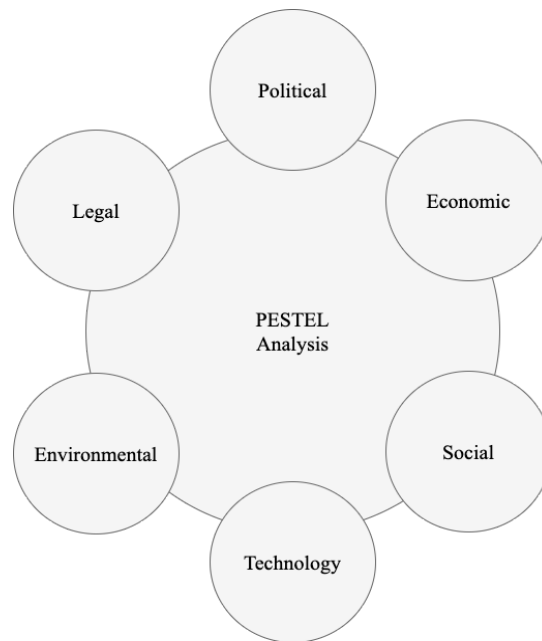
In Porter's Five Forces Analysis, there is definitely a high threat of new entrants and threat of substitutes for this software. Large corporations like Facebook could easily come up with a software as such or even add those features on apps like Instagram. But with the data misuse case involving the 2016 Presidential Election (Lomas, 2020), people may be doubting the way large corporations use our data, especially data concerning our health.

With high threat of new entrants and high threat of substitutes, we have high competition. Consequently, we also have a high bargaining power of buyers. Users of the software can easily switch to other platforms. An existing application is Zenly, that allows users to find where their friends are. If Zenly adds Covid-19 feature into their maps, users of this software can decide to use Zenly instead, because of their existing data in the app.

There is also high bargaining power of suppliers. Suppliers can decide to supply to larger corporations at a larger scale.

With Government Mandate

With high bargaining power of suppliers and buyers, and high threat of new entrants and substitutes, there are a number of ways this software can survive. If the government were to mandate the use of this software, or if healthcare providers were to require patients to use this app, then there would be a lower threat of new entrants, a lower threat of substitutes, lower bargaining power of suppliers, and lower bargaining power of buyers.

PESTEL

Political: The government may interfere with what data may and may not be collected, and how they decide to use the data. On the other hand, the government can make it mandatory to use the software when receiving the vaccine or when traveling.

Economic: Since many apps are free, this software should also offer its services for free in order to get people to use it.

Social: The demographic analysis above shows that this software can be used for all age groups, sex, race, religion, and income levels. However, the US has a tendency to raise privacy concerns, unlike Asian countries like Korea and Singapore where contact tracing apps are widely used (Utzerath et al., 2020) .

Due to large companies' popularity, reputation, and the large user base, large companies can attract users that would otherwise be users of our software.

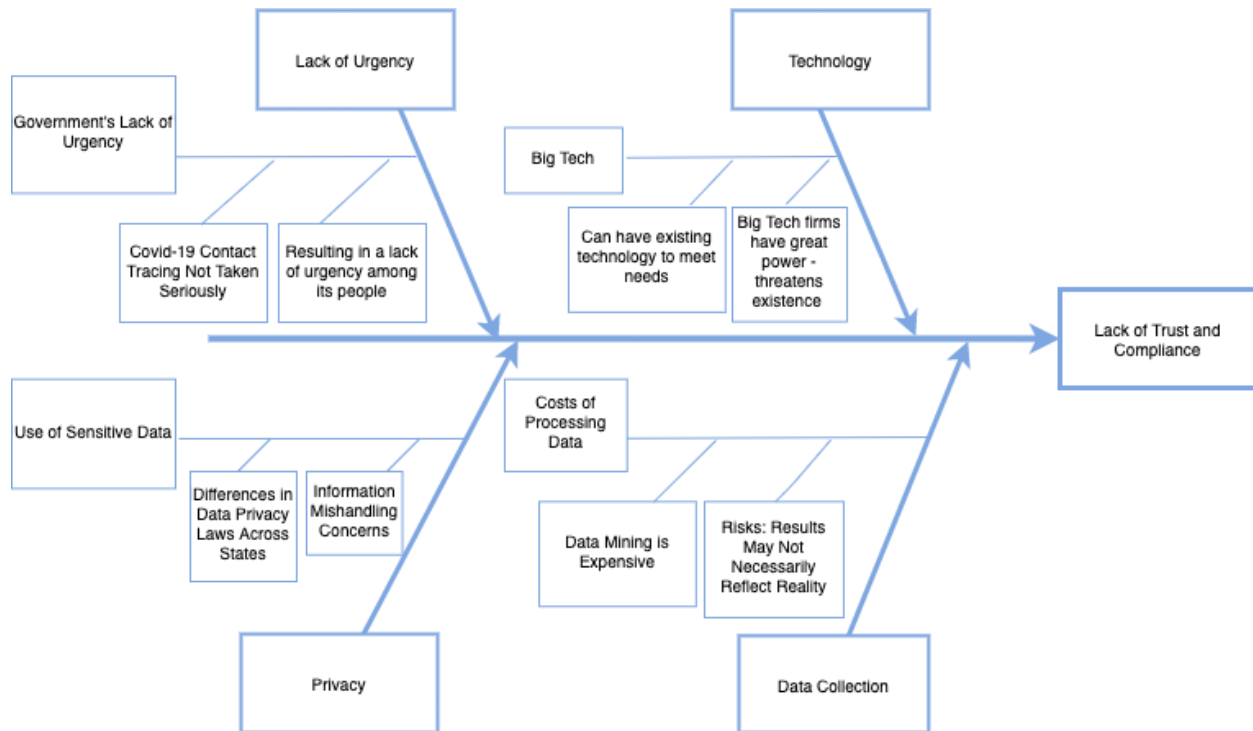
Technology: The technologies that larger companies (such as Facebook, Google, and Snap Inc.) have may outperform our software.

Environmental: There are no environmental factors that can significantly impact the software's performance.

Legal: Health and safety laws, consumer protection laws and data protection laws can dictate what is allowed on the software and what is not.

Ishikawa Diagram

An Ishikawa Diagram on the problem domain:



There is a lack of trust and compliance in using this mobile app due to lack of urgency, the technology, issues relating to privacy, and data collection issues.

Firstly, the lack of urgency in tackling the virus. The lack of app usage may be caused by the country's overall culture when faced with Covid-19. This lack of urgency is caused by the government and leadership's lack of urgency. Covid-19 contact tracing was not taken seriously when the virus first spread, making contact tracing a far more significant challenge now. The central government's lack of urgency dramatically influences the people's behavior and habits in the Covid-19 era. If the government mandates the use of this app, a lack of compliance is highly

likely because of the mistrust in local and central government. Hence, the lack of urgency results in a lack of trust and compliance.

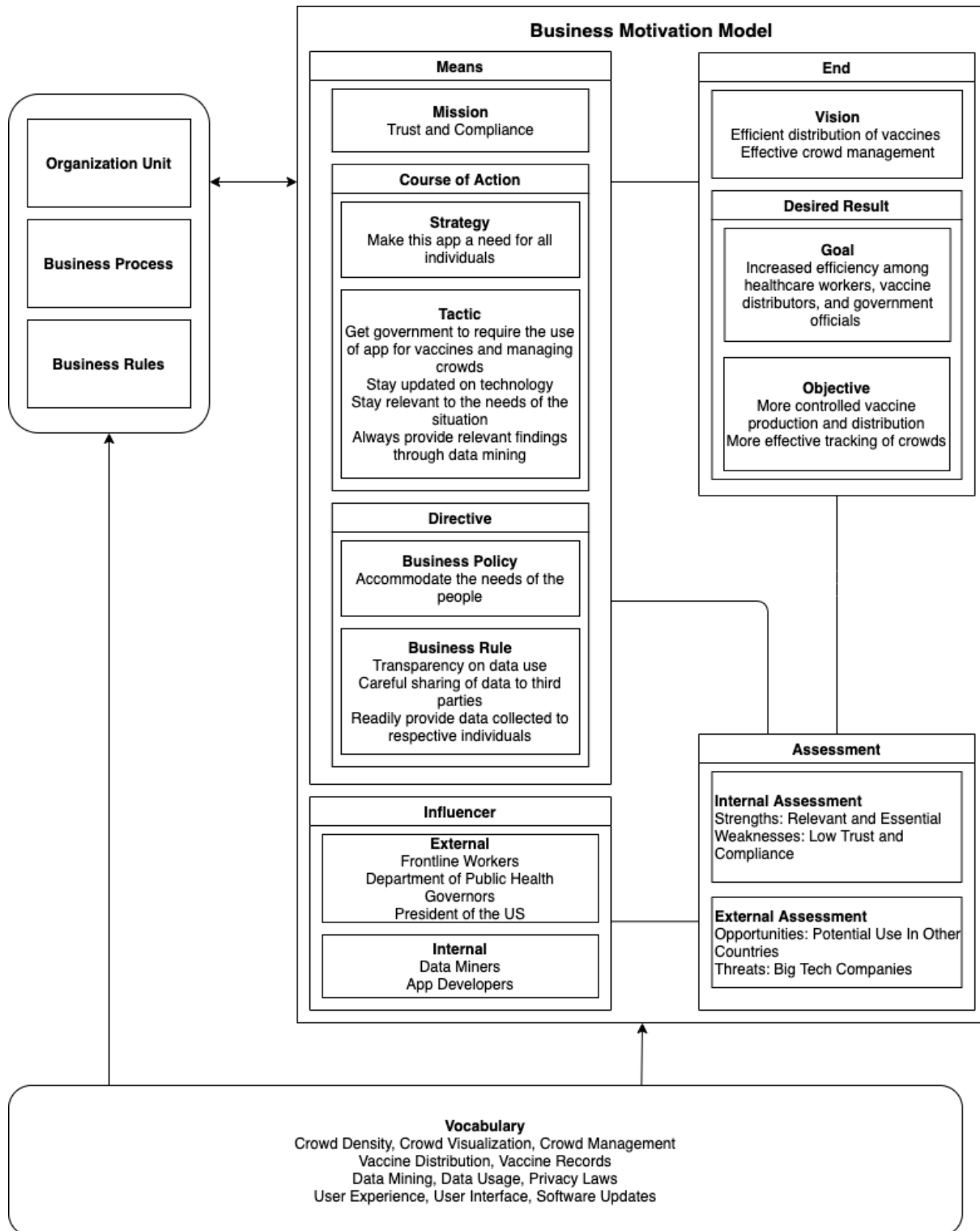
Since this mobile app caters to such a broad demographic of users, a tremendous amount of data will be collected. Collecting data thus raises concerns regarding the use of sensitive data. As an app that can be used all over the country, differences in data privacy laws per state dictate who can receive data collected by the app and what can be done with the data. For example, we do not want our personal information to be shared with insurance companies because of a potential increase in insurance premiums. We also do not want the public to have easy access to our personal information and use it against us in legal battles. Such instances lead to a potential lack of trust and compliance.

Another concern relating to data is the costs of data collection or data mining. Data mining as we know it is costly and can be risky. It is expensive to gather data, clean it, and transform it into valuable information. Even if distinct patterns are identified immediately, there is a risk that the findings do not accurately reflect the reality. If actions are taken based on such data, the consequences can be damaging.

Since this mobile app is not developed by Big Tech companies like Facebook, Apple, Amazon, Netflix, and Google, it seems like it can miss out on some advanced technology. Furthermore, the developer's lack of mint reputation can spark some doubt among users. As a new player in the industry, there could be doubts among users—the app's accuracy and performance and the handling of their data.

Because of the lack of urgency, issues relating to privacy, challenges in data collection, and not having the most recent technology that Big Tech owns, the performance is not at its full potential.

Business Motivation Model



The BMM on the problem domain outlines several important ways to minimize low trust and compliance. The problem addressed in the Ishikawa Diagram leads to a mission of gaining the people's trust and having people use the app as a tool to combat the virus. This in turn leads to a vision of efficient crowd management and vaccine distribution to ease the workload of frontline healthcare workers.

Main influencers include frontline workers, the Department of Public Health, governors, and the US president. Frontline workers can provide feedback on how things should be. The Department of Health, governors, and the US President should provide explicit instruction on vaccine distribution and crowd management. Data miners are essential assets to the team as they would be finding patterns in the data. App developers should also make the app the easiest to navigate for users.

The app should accommodate everybody, but at the same time, hold strict values and regulations within. There should be transparency on data use, limited and careful sharing of data to third parties, and be readily available to individuals who request their personal data collected by the app. This is to add to the existing data privacy laws. The strict rules with regards to data answer the privacy and data collection aspects in the Ishikawa Diagram.

The app should also be updated to be relevant to the situation. This answers the technology aspect in the Ishikawa Diagram. The Business Motivation Model also outlines clear objectives that are meant to support increased efficiency in producing and distributing vaccines and managing crowds. This would be measurable in the respective fields of vaccine production and crowd management.

Having clearly defined objectives, tactics and rules allows the organization to better manage their priorities. It also allows the organization to work on their smaller goals that would ultimately allow the organization to reach its mission.

Agile Method: Kanban

An agile method I would recommend for this project would be the Kanban. Kanban, inspired by the Toyota Production System, is one method to achieve just-in-time manufacturing. As the father of the Toyota Production System, Taiichi Ohno emphasized reducing waste, identifying problems, and reimprovement (Wikipedia, 2020). Similarly, Kanban is about eliminating waste, mistake-proofing the system, and learning through experimentation. While this was previously meant for manufacturing, the main ideas of Kanban can be adapted and implemented in our problem domain for the following reasons.

Firstly, as depicted in the Ishikawa Diagram, this project needs to be relevant. Being relevant also means keeping up with the trends and needs and making sure that the services and products are delivered at the right time and exactly when the users need them. Adapting the idea of just-in-time manufacturing or just-in-time flow ensures that the products and services created on the app are not wasted and are pertinent to the current needs. Features to the app have to be released at the right time, just when the users need them. For instance, every software update has to be worthwhile and provide valuable features to each user. It also has to be released just when the users on the other end (i.e., health workers and government officials) need them to make informed decisions. This ensures that the effort of the team is not wasted. There is no need to develop features on the app that are unnecessary and irrelevant, as this would divert the team's attention and efforts. Furthermore, as explained, it has to be Just-In-Time. Having features released too early could mean that they may be left unnoticed when those features are actually needed. This project would be smoother with Kanban because it would force it to only develop

features that are essential. In other words, the developer would only supply the demands of the users. There is no need for additional unimportant features.

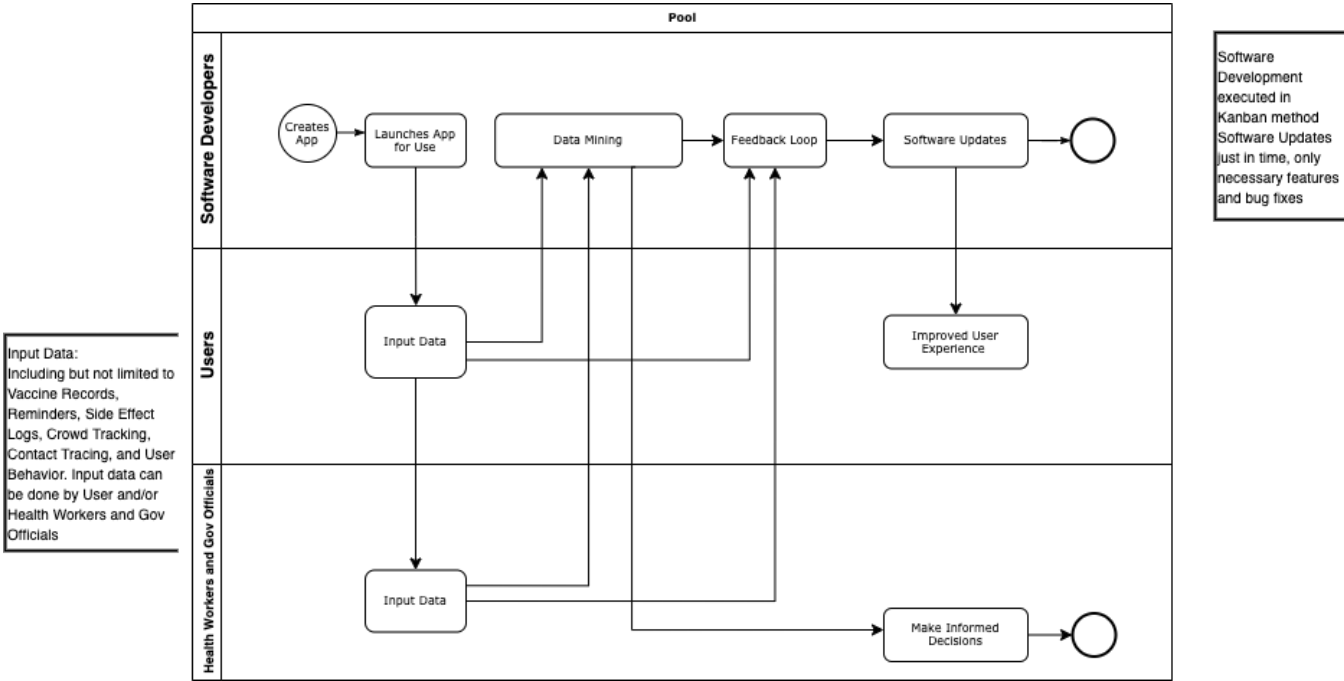
Next, with regards to the technology aspect in the Ishikawa Diagram, this project can adopt the mistake-proofing system in the Toyota Production System in software development. Developers should constantly check for errors because problems would be much more difficult to solve later on. Mistake-proofing would minimize errors and call for a smoother process.

Finally, Kanban highlights reimprovement. Here, there is a need for constant learning and learning through experimentation. In software development, developers can experiment with several different things before settling with one. This can be done in the feature preparation stage where ideas can be selected, eliminated or processed. Having the feature preparation stage ensures that not only does the organization consider various ideas, just-in-time production can also be executed. There is minimal waste of effort. Having multiple ideas at first means that new ideas are not restricted, but considered. The app should also have a feedback loop (Wikipedia, 2021) to help create a better product or service. In the long run, having the drive to improve collaboratively is essential for the organization.

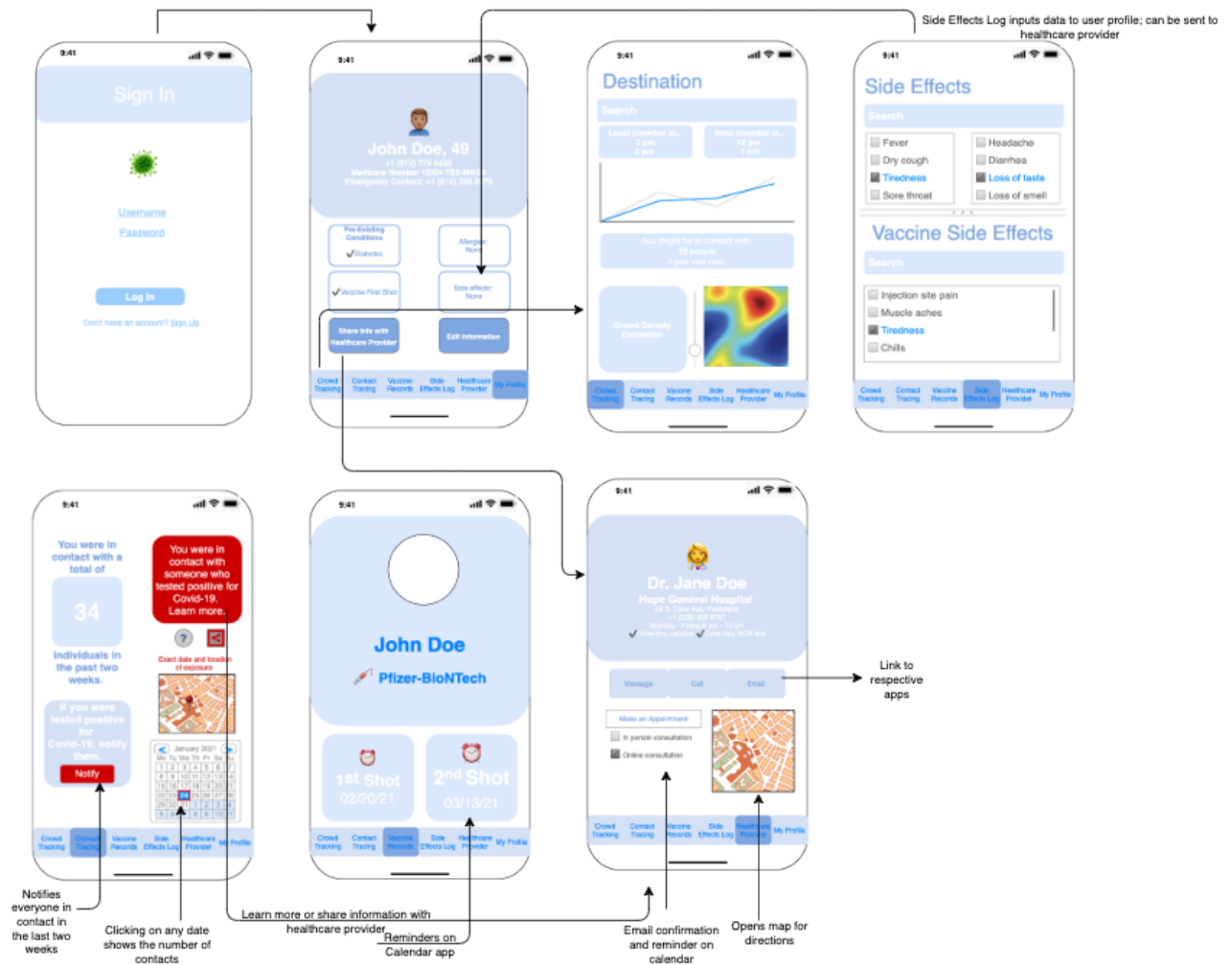
The Kanban board below is a rough example made to better visualize how Kanban works in software development. To present how an idea flows through the system, the board below shows how ideas move along the process instead of the various work in progress at a given time. The board shows clear guidelines on how many tasks are allowed at a given moment. This ensures an adequate but not overwhelming amount of work in every step of the way.

Pool of Ideas	Feature Preparation 3-10		Feature Selected 2-5	User Story Identified 30	User Story Preparation 15		User Story Development 15		Feature Acceptance 8		Deployment 5	Delivered
Vaccine Records	In Progress	Ready	Vaccine Records	Story	In Progress	Ready	In Progress	Ready (Done)	In Progress	Ready	Vaccine Records	Vaccine Records
Follow Up Vaccine Reminder	Covid-19 Side Effects Log	Vaccine Records	Follow Up Vaccine Reminder	Story	Story	Story	Story	Story	Vaccine Records	Crowd Tracking	Follow Up Vaccine Reminder	Follow Up Vaccine Reminder
Learning About Vaccines		Follow Up Vaccine Reminder	Vaccine Side Effects Log	Story	Story	Story	Story	Story	Follow Up Vaccine Reminder	Contact Tracing	Vaccine Side Effects Log	Vaccine Side Effects Log
Vaccine Side Effects Log		Vaccine Side Effects Log	Crowd Tracking	Story	Story	Story	Story	Story	Vaccine Side Effects Log		Crowd Tracking	Crowd Tracking
Progress to Herd Immunity		Crowd Tracking	Contact Tracing	Story	Story	Story	Story	Story			Contact Tracing	Contact Tracing
Covid-19 Side Effects Log		Contact Tracing		Story	Story	Story	Story	Story				
Pre Existing Conditions and Covid-19				Story	Story	Story	Story	Story				
Pre Existing Conditions and Vaccines	Discarded			Story	Story	Story	Story	Story				
Crowd Tracking	Pre-existing Conditions and Covid-19	Pre-existing Conditions and Vaccines		Story	Story		Story					
Contact Tracing	Progress to Herd Immunity	Learning About Vaccines		Story								
	Ideas are filtered at this stage			Creating User Experience							WIP limit: 5 Risk <input type="text"/> Assessed	

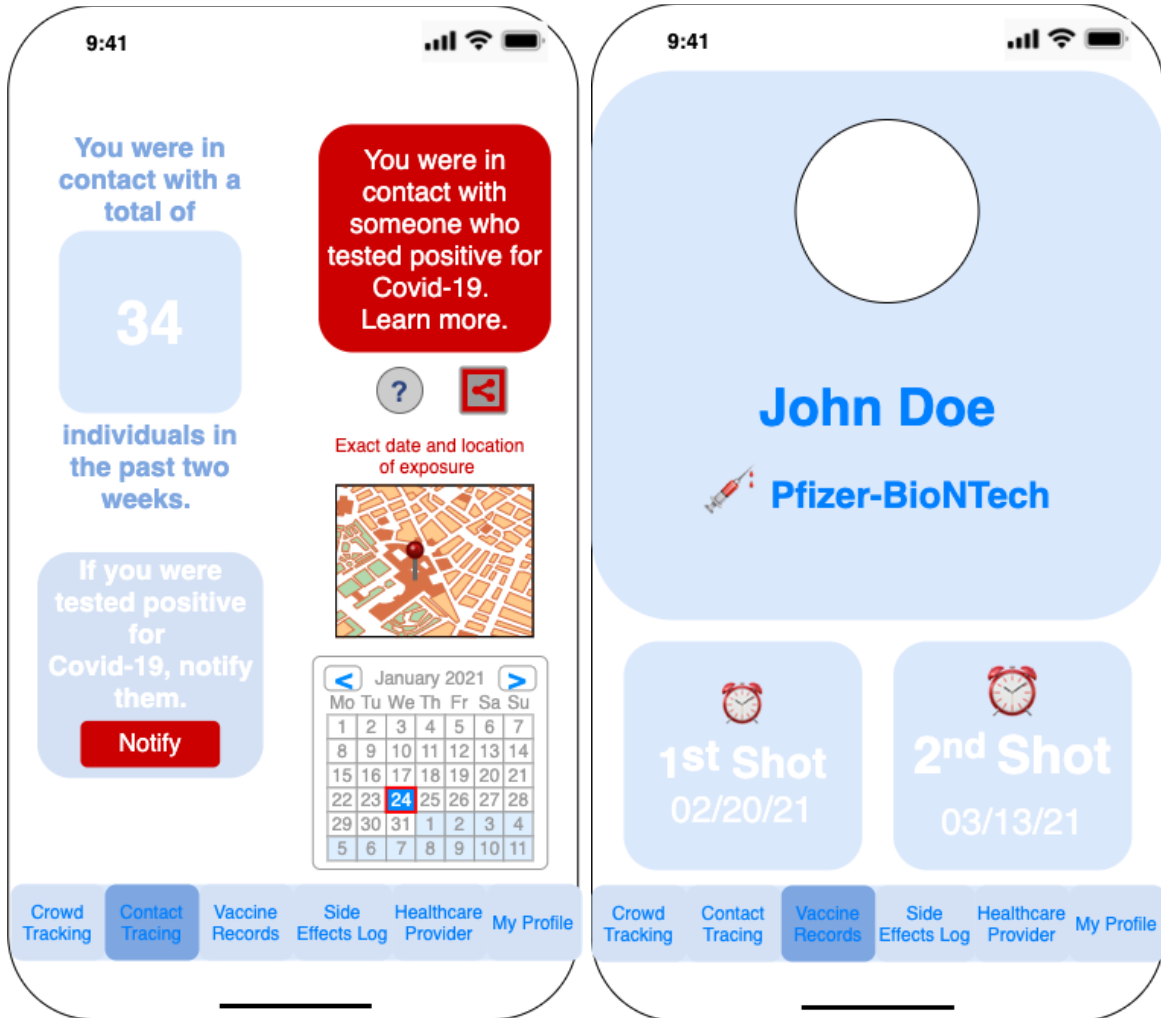
BPMN

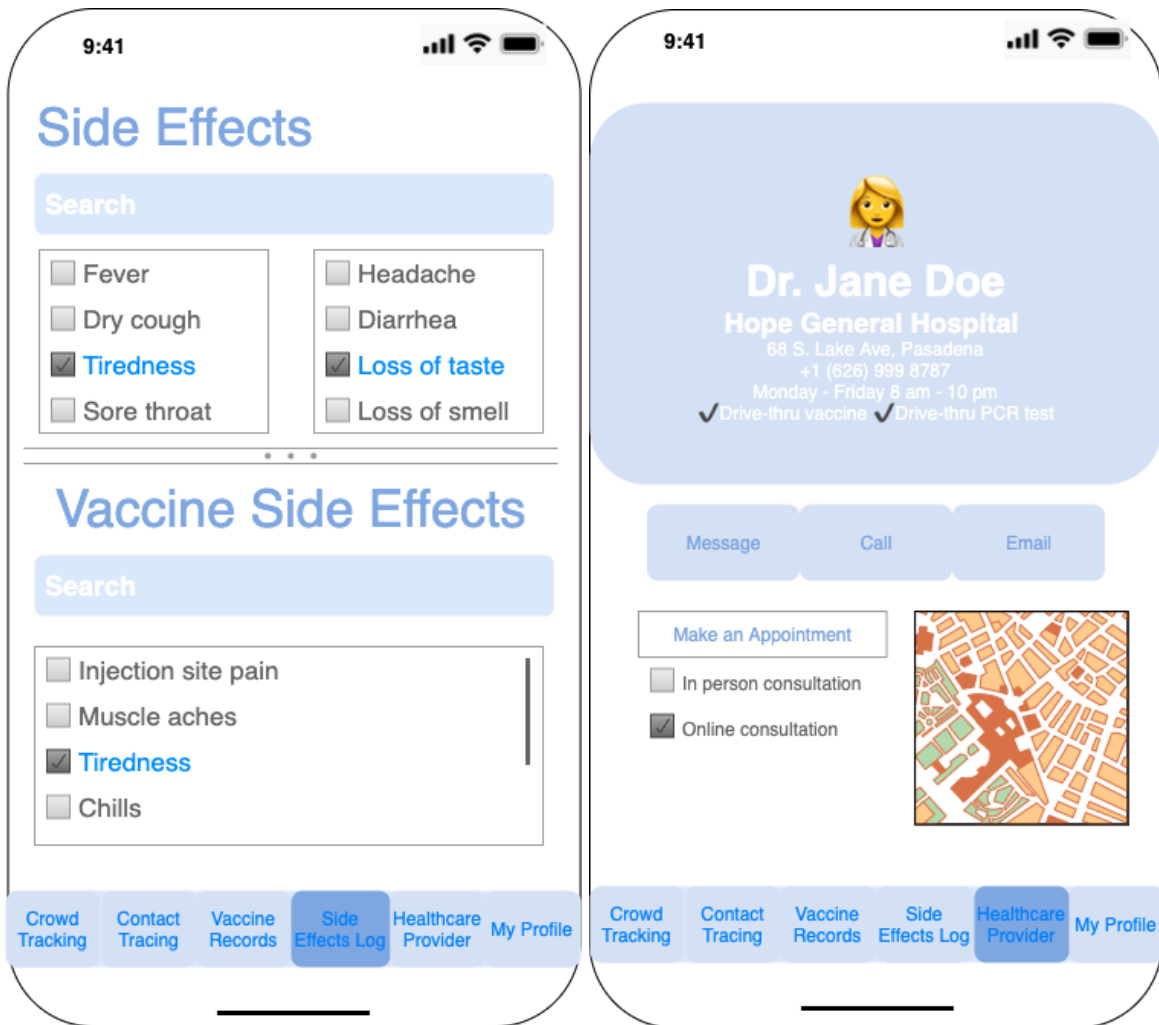


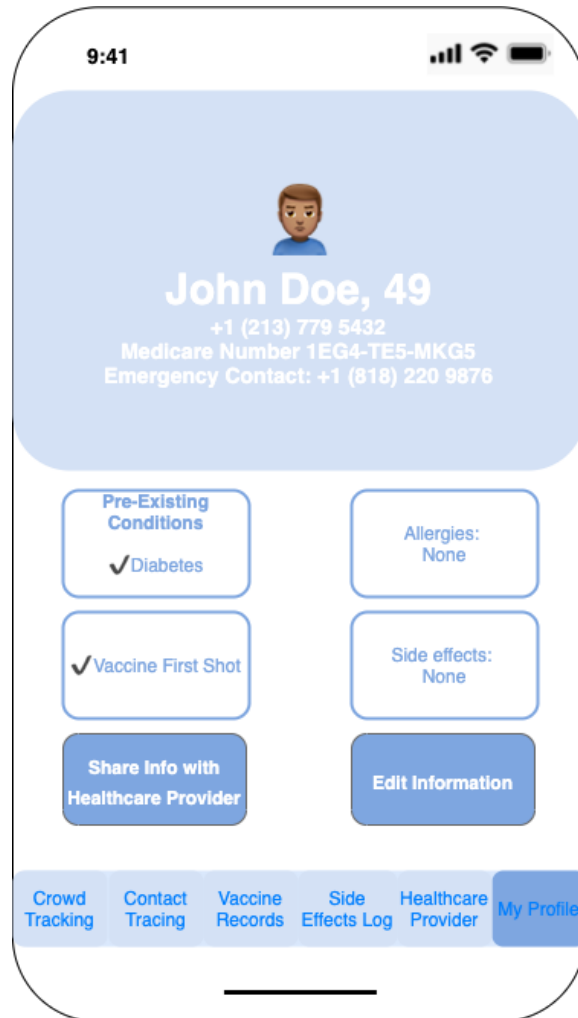
UI Wireframe











The UI has helped the project progress into a more realistic one. It brings the vision and mission of the organization together. With a basic UI, the organization can further decide which features to include or exclude as well as the placement of certain buttons on the app to streamline user experience. The design should also be intricately considered to ensure that more urgent and important features are placed at a conveniently located position on the screen. For instance, a ‘help’ button or ‘contact physician’ button should be placed where it can be easily found but not easy to click on by mistake.

The diagram illustrates the organizational structure and data flow for a COVID-19 app. At the top, a horizontal flow shows the data path: User → Crowd Tracking → Contact Tracing → Medical Profile → Vaccine Records → Side Effects Log. The main organizational chart is divided into two primary branches: the Software Company (left) and the Hospital (right).

Software Company Structure:

- CEO (Software Company)**
 - Deputy Director**
 - Office of Public Relations**
 - Counsel Division**
 - Operations**
 - Software Development Division**
 - UX/UI Designer
 - Software Architect
 - Software Engineer
 - Software Engineer
 - Data Mining Division**
 - Database Administrators
 - Data Collection
 - Data Mining Specialist
 - Data Analyst
 - Data Visualization Specialist
 - Support**
 - Support Engineer
 - Support Engineer
 - Customer Service Representative
 - Customer Service Representative
 - Regulatory and Enforcement Division**
 - Office of Regulatory Policy
 - Office Compliance
 - Office of Enforcement
 - Office of Regulatory Support

Hospital Structure:

- Board of Directors (Hospital)**
 - President of the Board**
 - VP Diagnostic Service Center**
 - Radiology
 - Cardiology
 - Neurology
 - Laboratory
 - VP Clinical Services**
 - Physician
 - Nurse
 - Medical Assistant
 - VP Support Service Center**
 - Emergency Preparedness
 - Clinical Engineering
 - Facilities and Planning
 - Safety
 - Purchasing

Data Flow and Annotations:

- Software Company to Hospital:**
 - CEO to Board of Directors:** "medical profile shareable to physician, can be updated by physician"
 - Deputy Director to VP Diagnostic Service Center:** "data mining division sends analysis to diagnostic team"
 - Deputy Director to VP Clinical Services:** "data mining division sends analysis to medical team"
 - Deputy Director to VP Support Service Center:** "data mining division sends analysis to medical team"
- Internal Software Company Flows:**
 - Software Development to Data Mining:** "data processed by data mining division"
 - Data Mining to Support:** "app shares data about the population gov make announcements through the app"
 - Data Mining to Regulatory:** "app helps gov ensure that users are following strict guidelines"
 - Data Mining to VP Clinical Services:** "gov enforces regulations on data privacy"
- External Flows:**
 - Government to Software Development:** "to hospital support service center, direct communications, visuals, and alerts regarding new cases to prepare for emergencies"
 - Government to Data Mining:** "data from diagnostics sent to data mining division for knowledge discovery"

The organizational chart presents various communication lines for the users of the app, the software company, healthcare providers, and the government. This four-way communication supports the efficient sharing of data, information, and knowledge, thus combating the problem.

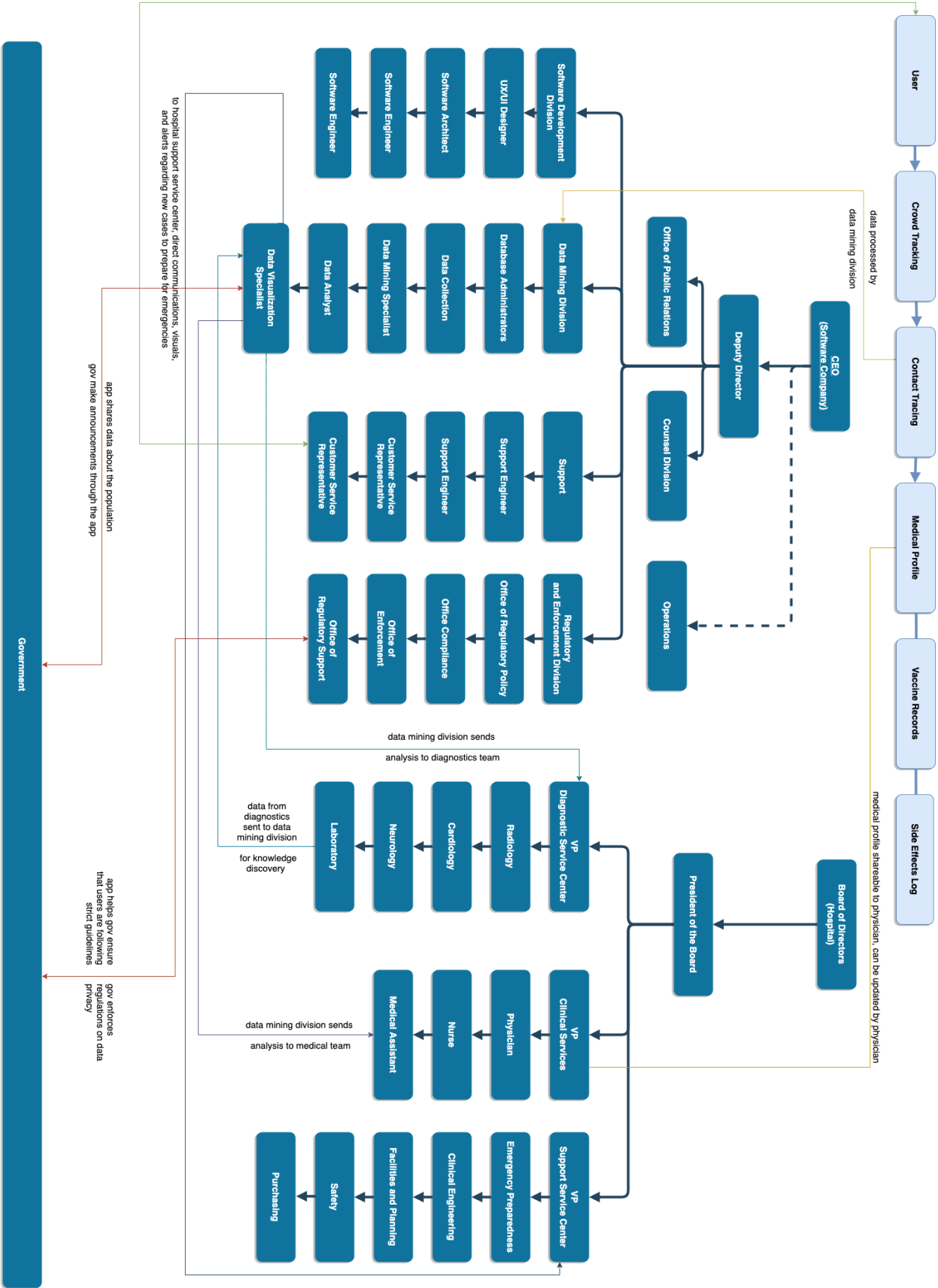
This chart shows the importance of the roles of all parties. All parties can contribute to the sharing of essential data and information. The direct relationships that different roles have with one another shows that different data and information that can be shared. It also emphasizes what information can and cannot be shared to a given party. For example, personalized or

individual data shall not be shared to the government, and the government may only receive data and insights about a population. On the other hand, physicians would have individual profiles of their patients shared to them.

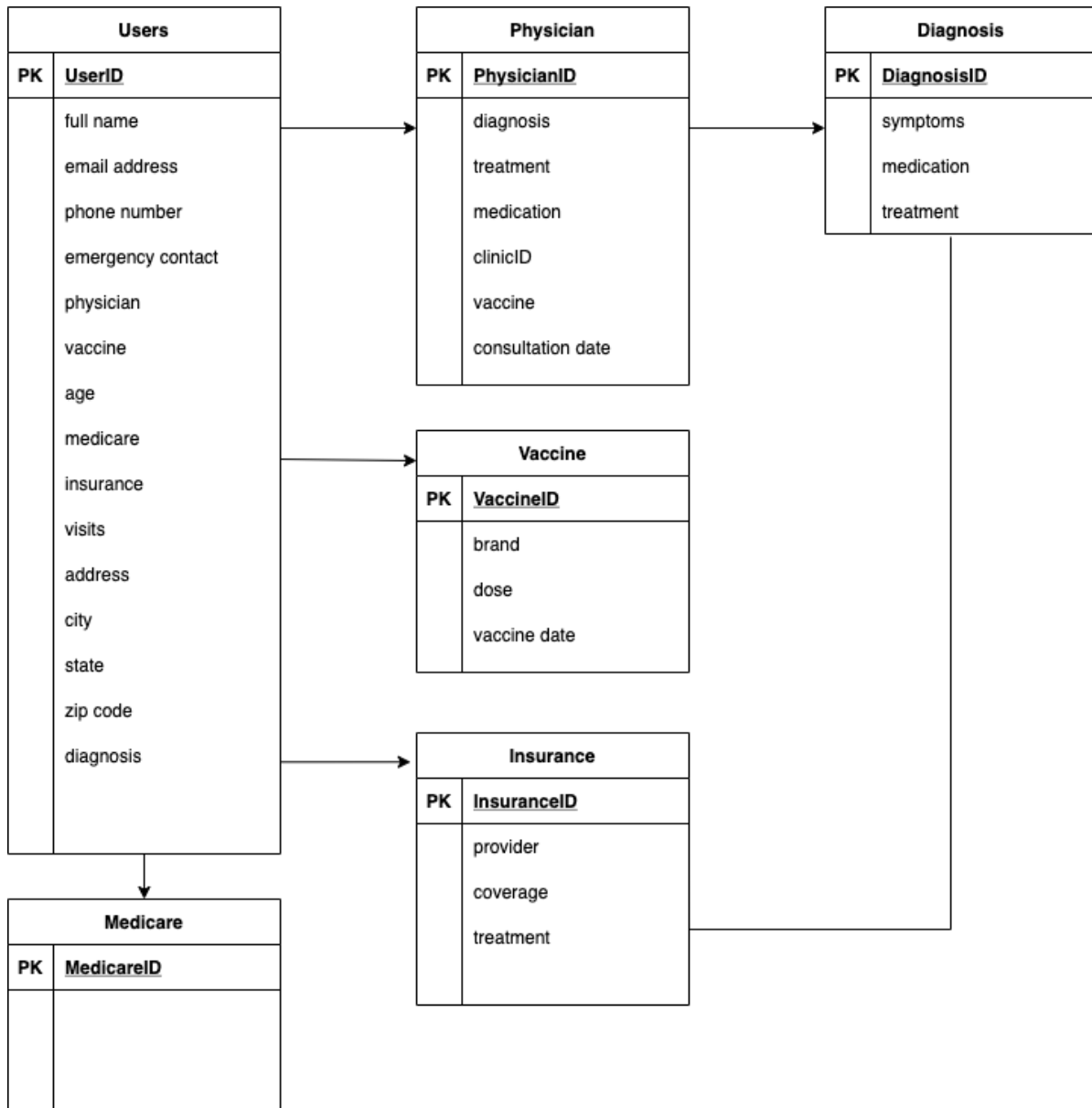
While creating this organizational chart, the most overlooked division would be the data mining division. The data mining division holds the responsibility of ensuring that the discoveries, insights and visualization are accurate and actionable. The division heavily relied on to produce information that is catered specifically for users, healthcare professionals, and the government. The discoveries, insights, and visualization produced for different parties would be vastly different. Furthermore, the data mining division has the responsibility of alerting hospitals and the government when there would likely be a wave of new cases to ensure emergency preparedness. The same division also has the responsibility of analysing diagnoses, medical images, and laboratory results for knowledge discovery to share with healthcare professionals.

As previously mentioned, there is a feedback loop between users and software developers so that the app can always be improved. Likewise, the direct communication between the data mining division and the diagnostics team serves as a loop for health data.

The government and regulating body of the software company should address concerns with regards to data privacy and the sharing of sensitive information. However, as we can see at the top of the chart, it is really up to the user to share the data that they want to share. As gaining user trust is initially a huge problem, this chart can be included in the terms and conditions as a supporting document to better explain how the company handles and shares the data.



ERD



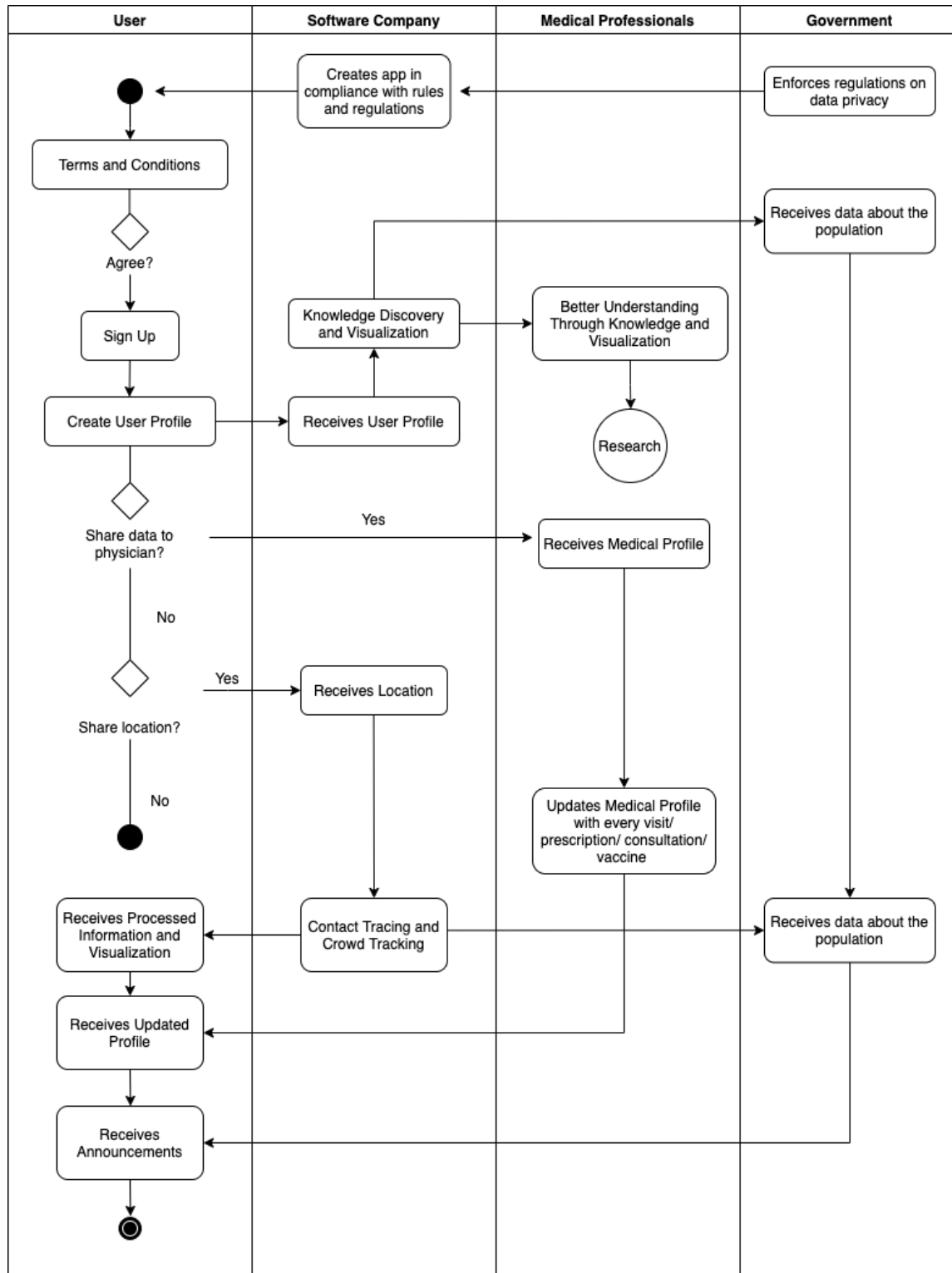
This Entity Relationship Diagram shows the relationships between different people or concepts within the system. Having a clear ERD allows the data mining division to smoothly deal with the information, especially when dealing with sensitive data. The data mining division needs to clearly organize to whom data belongs to. This helps to avoid overshare data to parties that are not supposed to receive them.

The ERD allows one to understand what goes into the user profile. The data that goes into the user profile is then carefully selected and compiled to create a personal medical profile that would be sent to physicians.

Having address, zip code, and state as part of the user profile allows government officials to track the density of the cases in a particular area. This also helps the data mining team to alert the support service center in local hospitals of incoming patients.

Having detailed vaccination records also allows the data mining team to discover new patterns with certain vaccines and understand how certain demographics react to vaccines. Their findings can be communicated with the diagnostic service center of hospitals. The medicare information provided by users can be shared to the government because medicare is a federal program.

Activity Diagram



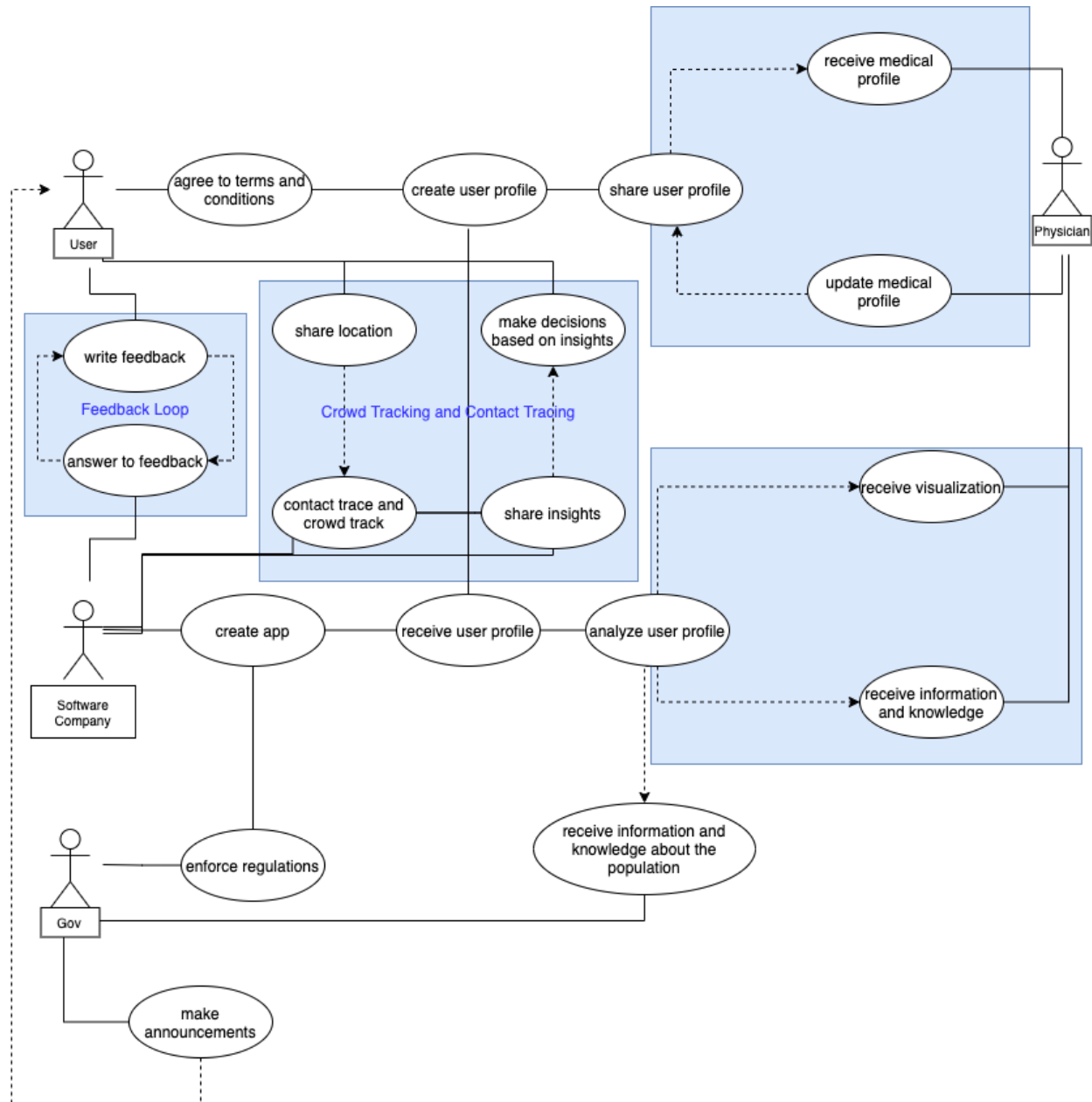
The Activity Diagram above visually describes the process within the organization. The Activity Diagram here seems to be a more detailed but summarized version of the BPMN, UI, Organizational Chart, and the ERD combined. The Activity Diagram was a more complex diagram to create, and it is a diagram that is more challenging to understand compared to the BPMN. It describes the processes, the relationships, and the responsibilities of each party.

With privacy being the main concern for many, the organization/company has made permissions and transparency a top priority. Any data that is shared is permitted by the user. With the activity diagram, it is also clear that the user has the upper hand in data sharing. Users choose what data they input, the organization needs the user's approval to collect and share any data. The purpose of collecting and sharing the information is so that the user can have a better understanding of their health and the situation outside concerning Covid-19. The role of the software company is to create an app that complies with data privacy laws while serving the needs of the users and medical professionals. Besides that, the software company also has the responsibility of gathering insights and visualizing data so that medical professionals, users, and the government can easily understand the data to make more informed decisions. Indeed, the knowledge provided to each party differs as they would be used differently. The government only receives data about the population in order to make decisions that would impact the population.

The UI has shown the type of data that users can provide, and the ERD shows the type of data collected and how they are separated into each category. The organizational chart highlights the relationships that the various parties have and describes the relationships in detail. The

BPMN serves as a structure for the activity diagram as it was a rough sketch created for the organization's mission and vision. Unlike the BPMN, the feedback loop was not included in the diagram to make way for the details involving aspects like knowledge discovery, data visualizations, and more parties such as the government. This is not to say that the feedback loop is less significant but that the activity diagram highlights the actions and processes within the organization while incorporating the details in the BPMN, UI, Organizational Chart, and the ERD.

Use Case Diagram



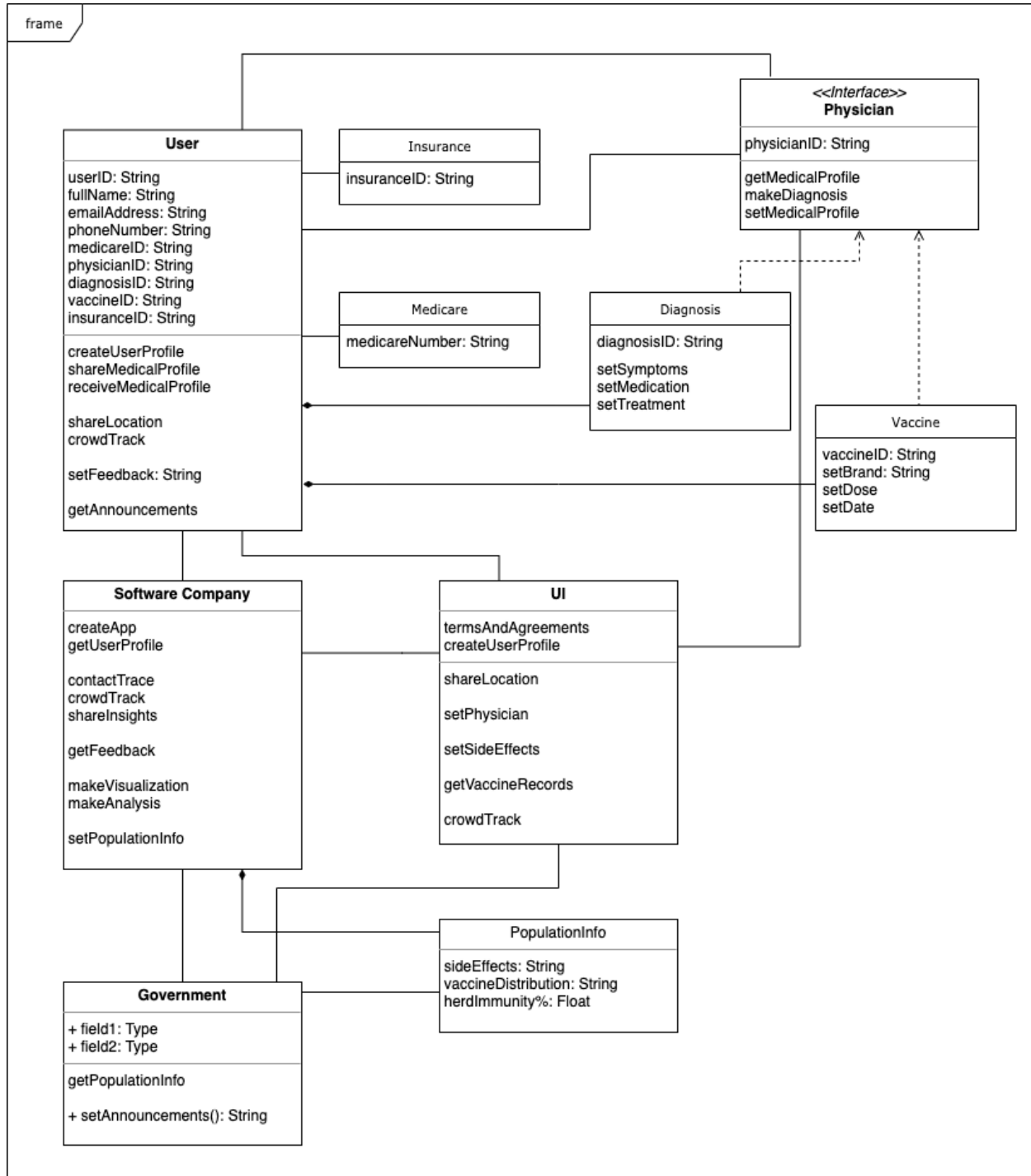
As per the recommendations made in the BPMN and Activity Diagram, the Use Case Diagram shows each user's critical actions. The Use Case Diagram above highlights the actions of the actors (i.e., User, Software Company, Physicians, and the Government) and relationships between them. It also further highlights the various systems within, such as the feedback loop, the crowd tracking and contact tracing loop, the medical profile loop, and the knowledge discovery loop.

Like the BPMN and Activity Diagram, the Use Case Diagram shows each actor's key and the process of the whole operation. When creating the Use Case Diagram, the mission of trust and compliance was kept in mind. The Use Case Diagram above also closely follows the Course of Action and Directive introduced in the Business Motivation Model to meet the mission and work towards the vision of efficient distribution of vaccines and effective crowd management.

A critical aspect of this Use Case Diagram is the system boundaries (the blue boxes) which show the limits where certain information and knowledge can go. The feedback loop is its own system between the user and the software company. The crowd tracking and contact tracing loop is a separate system between the user and software company. Similarly, the medical profile loop is its own system involving only the user and physician. Lastly, the knowledge discovery loop is between the software company and the physicians. These system boundaries or loops emphasize that other actors, such as the government, cannot be involved in the loop.

The Business Motivation Model, the BPMN, the Organizational Chart, and the Activity Diagram are excellent supporting material to better understand the Use Case Diagram above.

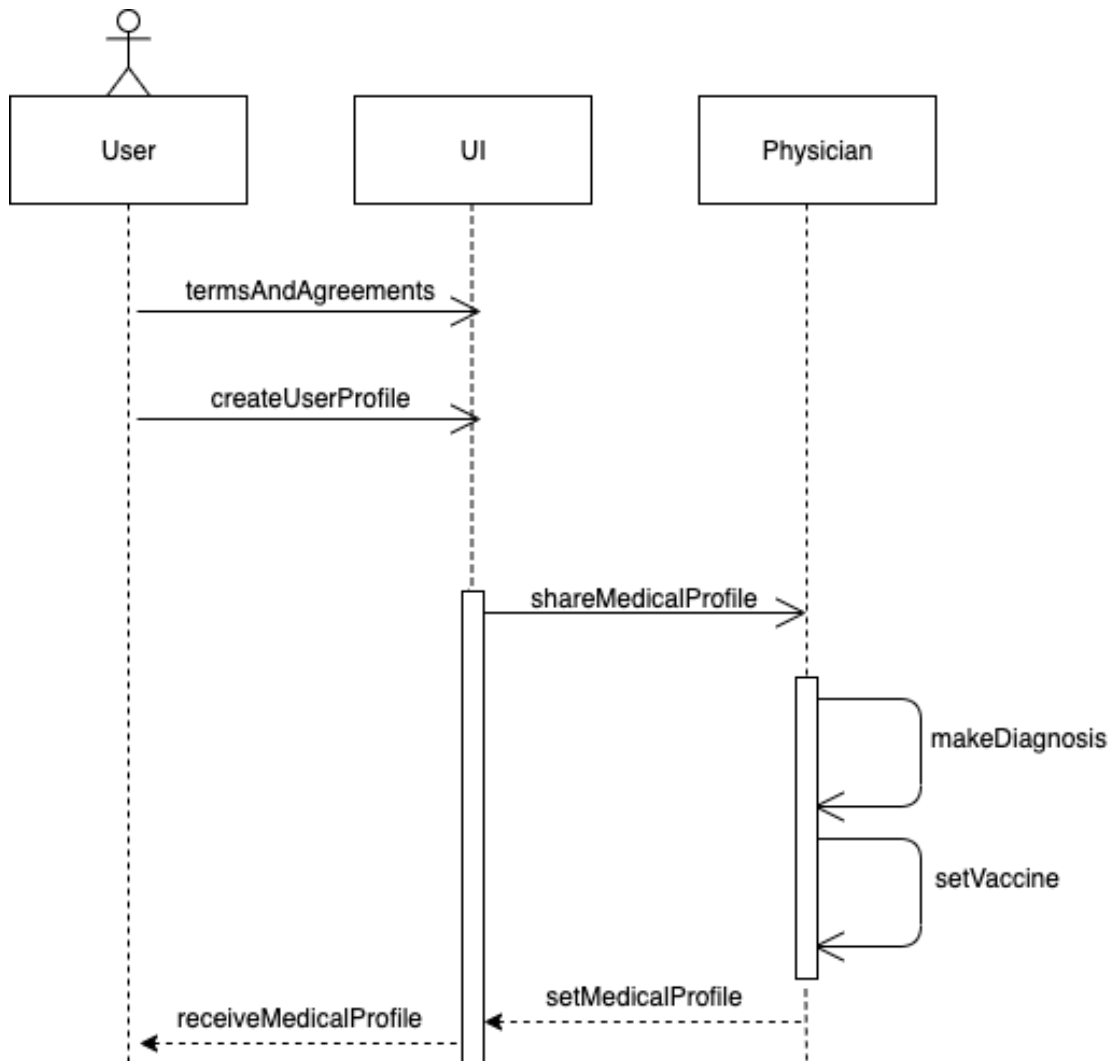
Class Diagramming for OOP

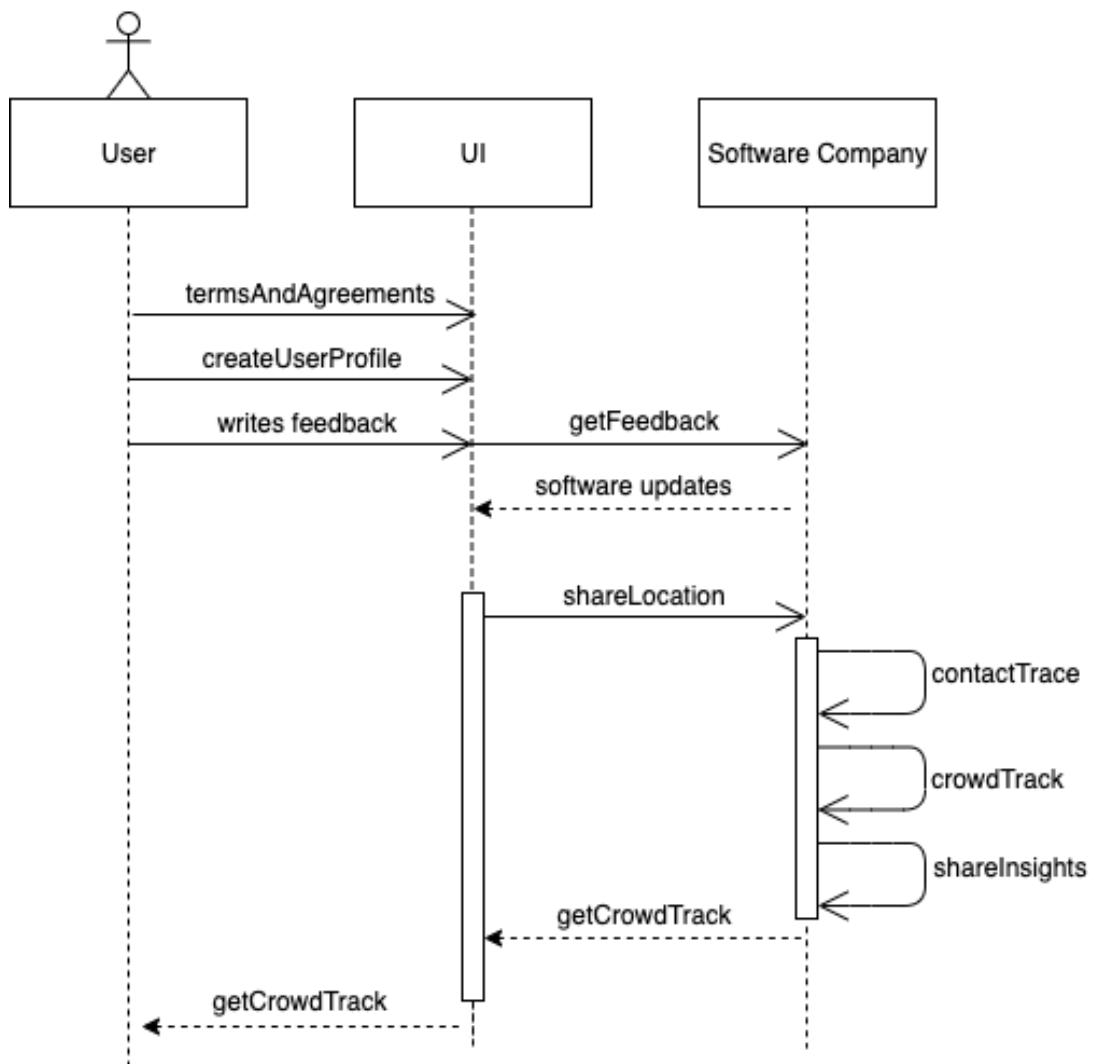


The Class Diagram provided more clarity as it helped visualize the system's structure. The class diagram serves as an excellent foundation for software developers as it communicates the objects in the system and the relationships.

The class diagram allows for a better understanding of the classes. Specifically, which classes can and cannot exist without the other, and how they are interdependent. This class diagram also takes the project another step further by including all the other elements. With the use case diagram as a basis, the class diagram undoubtedly contains details from the Business Motivation Model, the BPMN, the Organizational Chart, and the Activity Diagram. Also, this Class Diagram shows class relationships like composition and dependency, which ultimately helps to show the system's structure. Unlike the Use Case Diagram, however, the Class Diagram above does not show processes. Instead, it shows the system's layout, thus conceptualizing and specifying the components of each class.

The diagram takes the project to the next step as it effectively communicates to developers. Overall, with the Use Case Diagram, the project now has an intricately thought-out structure and activities drawn out in diagrams.

Sequence Diagram*User, UI, and Physician*

User, UI, and Software Company

The Sequence Diagrams visualized the simplicity of the processes when the roles of each object are clearly defined. To make the diagrams easier to understand, the interactions between the user and the physician and the user and the software company are separated. The sequence diagram also shows that the UI is a major communication tool for users, physicians, and the software company. Unlike the Class Diagram, the Sequence Diagrams present a more organized view of the process. The Activity Diagram is sort of a bigger picture of the entire system, while the Sequence Diagram breaks down the roles.

Upon completing the Sequence Diagram, it seems that it also supports more software updates and easier adaptation to more features. Processes can easily be added without disturbing the entire system. This would allow us to see how things would work out on its own before implementing them to the system. The ease of adding features supports the business policy of accommodating the needs of the people which is outlined in the Business Motivation Model.

Overall, the Sequence Diagram showed a simplified view of the processes within the Activity Diagram which could be more complex to understand. It highlights the key roles and processes that each object fulfills.

Deployment, GitHub, Continuous Development, Versioning and Teamwork

In choosing a continuous delivery technique for the potential team, the needs of the users and the overall management and containment of Covid-19 are taken into consideration. As such, the BMM serves as a basis in deciding which continuous delivery technique to use.

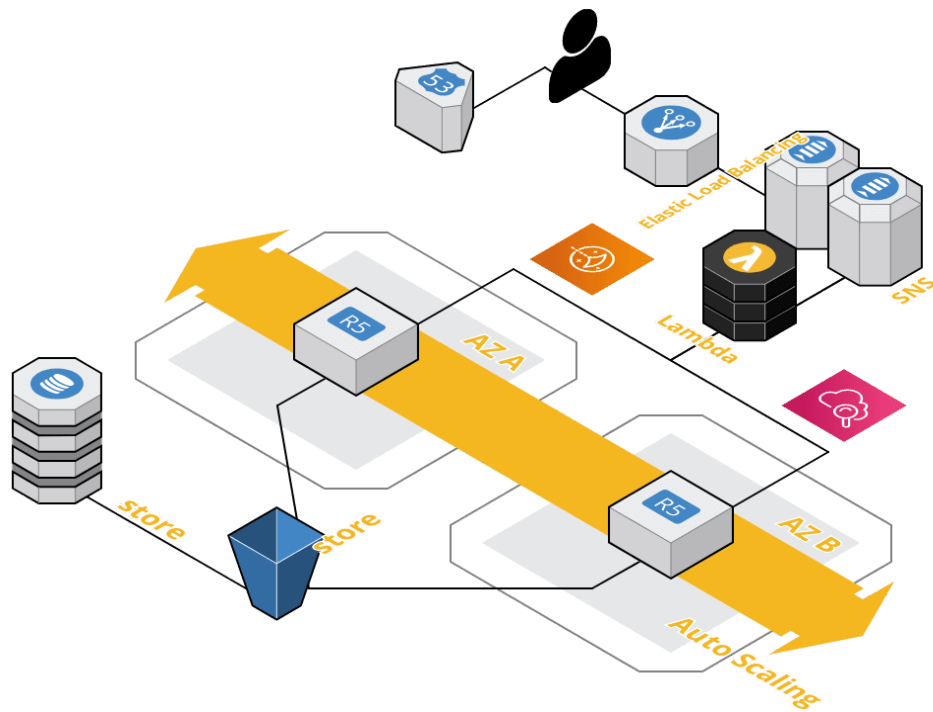
The company has chosen to operate with continuous integration and continuous delivery. With continuous integration, the company can save time and costs in testing, and can focus on significant improvements in quality culture (*Continuous Integration Vs. Continuous Delivery Vs. Continuous Deployment*, n.d.). With these techniques, continuous integration needs to be solid enough to support continuous delivery. Continuous delivery suits the needs of the company because there is a manual trigger to deployment here. This ensures that there is human intervention during the release and someone is there to check for errors. Having such human intervention is crucial for this software because any errors can directly affect human lives. In the early stages of the company, continuous deployment does not seem fit since the testing culture needs to be streamlined and perfect. Another advantage of continuous delivery is that the company can release more frequently, thereby enhancing the feedback loop between developers and users. This is a direct answer to the tactic in the BMM, which emphasizes on staying updated and reliable to the current conditions and user needs.

On the other hand, there is continuous deployment which seems to be faster and more efficient. However, the testing quality and documentation process needs to be at their best to keep up with the speed at which continuous deployment operates in (*Continuous Integration Vs.*

Continuous Delivery Vs. Continuous Deployment, n.d.). This makes continuous deployment less manageable because it could be too advanced and complex for the team to manage.

Hence, continuous integration and continuous development are best suited for the team.

Network Diagram and Software Architectures for Web Based Systems



The diagram illustrates the software architecture and the technologies used. Firstly, the user is connected to the Elastic Load Balancer to automatically distribute traffic across instances and the Lambda function. The user is also connected to Route 53 for simple routing. Then, we have two SNS's, one for mobile push notifications and one for email notifications. These notifications are to communicate with the user, which is essential to our software. We have the Lambda to run without provisioning or managing servers and charges only when computing is done. For computing, we are implementing CloudWatch to monitor resources and applications and Lightsail for simple application and website building. Then we have two R5 instances for data analytics. On the left (AZ A), we have one that is located in North California, and on the

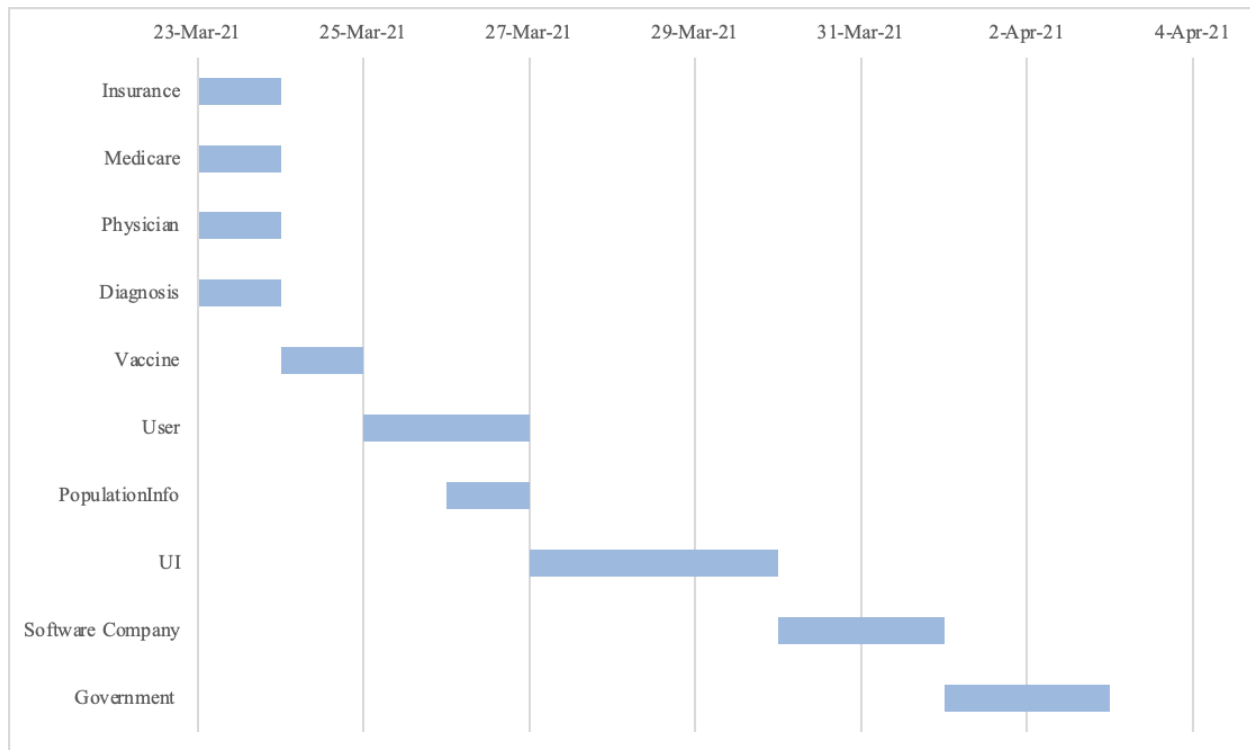
right (AZ B), we have one tht is located in North Virginia.

Then, we have the S3 with 1024 GB storage. We are also using DynamoDB data warehouse because of its built-in security.

Obviously, this diagram is a simple one to roughly communicate the ideas that can bring the software to life. There are many more functions that we can bring to our software to improve the system, like the Elastic Beanstalk and CloudTrail that will bring enormous benefits. Updates on this diagram include the use of Route 53, Elastic Load Balancer, CloudWatch, and Lightsail. The organization has also changed the EC2 instances to R5 and the storage to DynamoDB which are better suited for the data processing and analysis needs of the organization.

Gantt Chart

Class	Start	Days to Complete
Insurance	23-Mar-21	1
Medicare	23-Mar-21	1
Physician	23-Mar-21	1
Diagnosis	23-Mar-21	1
Vaccine	24-Mar-21	1
User	25-Mar-21	2
PopulationInfo	26-Mar-21	1
UI	27-Mar-21	3
Software Company	30-Mar-21	2
Government	1-Apr-21	2



The Gantt Chart has helped the project progress further into reality as the timeline is established. As opposed to the diagrams designed in the past, the Gantt Chart shows an overview of the order in which things will be done, how long they will take, and when certain things should be completed. Unlike previous diagrams that illustrate what will go into the project, the Gantt Chart emphasizes when the building blocks of the software will be constructed.

Using sample dates, a project schedule is created, starting from the date the class diagram was created. The y-axis shows the classes that need to be created in the order in which they need to be created first to last. The x-axis shows the dates the programming will begin and end. The length of the bars shows the duration. As scheduled, the UI design should be ready on 30th March 2021.

This chart enables the decision-maker to estimate the workflow and the duration developers should focus on a class. In hindsight, the decision-maker could decide to speed up the entire process because it takes almost two weeks in total just to program the classes. By then, the Covid-19 situation would have changed completely, deeming some features unnecessary. The situation can even call for a different set of features. Hence, the Gantt chart is an important tool that can be used to ensure that features can be provided in time to satisfy the plans in the BMM.

The chart also allows one to visualize the tasks that require the most time to complete and the tasks that can be completed in a short period. Decision-makers can also see the bottleneck of the process and decide to deploy another developer to work on it to speed up the process. By implementing a measure as such, the project can move forward to the next step at an earlier date. Additionally, the Gantt chart allows the organization to identify activities that are on the critical path, such as the UI, and also identify whether the activities are independent, sequentially

dependent, interdependent with static coordination or interdependent with dynamic coordination.

In the diagram above, the first four classes are activities that are interdependent with dynamic coordination, followed by the Vaccine and User classes which are sequentially dependent, the independent PopulationInfo class, and the last three classes are sequentially dependent. This illustration is meant to present the schedule and order in which it is created and not the dependence, independence, or interdependence of the classes themselves.

Having the most basic chart allows the CEO to look at the bigger picture and allocate time frames or deadlines to complete important tasks. This chart can be used throughout the planning of the entire project from creating the diagrams to finalizing the updates. It is a great tool that can be used to estimate the time that should be spent on each task.

Business Model Canvas

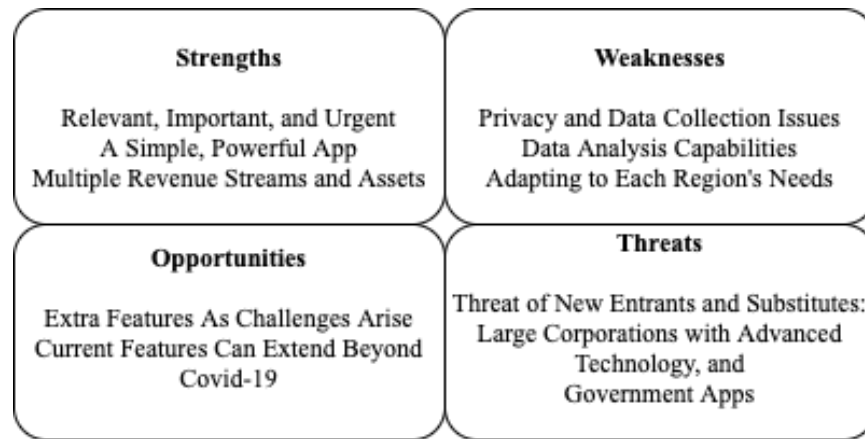
The Business Model Canvas				
<div>Key Partners</div> <div>Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners?</div> <div>Key Partners: Government Hospitals Urgent Care Clinics Private Practice Restaurants Libraries Educational Institutions Workplaces Key Suppliers: -</div>				
<div>Key Activities</div> <div>Key Activities: Developing valuable software capabilities Bringing valuable information and knowledge Managing the supply of vaccines Vaccine availability alerts</div> <div>Distribution Channel: App Store and Play Store Customer Relationship: Maintained through the app, email, and text notifications</div> <div>Revenue Streams: Healthcare providers who opt for the in-app service (e.g., referrals) Governments who opt for data analytics</div>				
<div>Key Resources</div> <div>Physical Resources: Computers Human Resources: Software Engineers, Developers, Data Scientists Intellectual: Data, Data Processing Patent Financial: Government Funding</div>				
<div>Value Propositions</div> <div>What value do we deliver to the customer?<ul style="list-style-type: none">• Live Data, Bite-Sized Information, Referrals to Healthcare Providers or Hospitals, Crowd Information, Prescriptive Analytics in HealthcareWhich one of our customer's problems are we helping to solve?<ul style="list-style-type: none">• The absence of reliable information regarding Covid-19.What are we offering to each Customer Segment?<ul style="list-style-type: none">• We are segmenting customers based on region as they face different variants of the virus. The differences in products or services are as follows:<ul style="list-style-type: none">◦ Information about vaccine availability (depending on the vaccines that available)◦ Government Announcements (depending on whether the Government opts for this)◦ In-app information (with respect to data collection laws)Which customer needs are we satisfying?<ul style="list-style-type: none">• The need of being informed anytime and anywhere to make informed decisions.</div>				
<div>Customer Relationships</div> <div>In areas with an older population, we would offer more personal assistance like in-app customer service calls. In general, the app establishes self-service and allows users to discover information in the app. Customer service calls are not well integrated with the rest of the business model. Operating call centers come at a high cost. As such, these services can be outsourced to areas that are cheaper and can offer 24-hour service.</div>				
<div>Customer Segments</div> <div>We are essentially creating value for the mass market. The people are our most important customers. However, to maximize the value that we can bring, the cooperation of the government and healthcare providers would be appreciated.</div>				
<div>Revenue Streams</div> <div>Because the app concerns health, users should generally be willing to pay at least \$1 per month. As currencies vary, a suitable price should be set for every country. Because this is not a cost-driven company, it seems like user subscription fees can be omitted. For the benefit of the country, governments should be able to negotiate and omit subscription fees. They are currently not paying for the services. They can pay through the app store or play store. Depending on the deals made with the government and the usage in each country, each revenue stream would make up a very different proportion of overall revenues. If we are following the basic \$1/month subscription plan for all users, then user subscription will count for the majority of the revenue stream.</div>				
<div>Cost Structure</div> <div>What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?</div> <div>As a value-driven organization, building processing capabilities that can be patented is critical. The most expensive resources include talent and hardware to keep the organization running and developing. The most expensive activities include processing big data and analyzing data.</div>				

The Business Model Canvas strategic management template largely evaluates how the organization can create value along the way. It has primarily taken the organization to assess ways of generating revenue. We discover a variety of other features and services that we can offer to help contain Covid-19 and beyond.

The features and services can extend beyond the scope of Covid-19. From physician referrals based on patient needs to prescriptive analytics in healthcare, the organization realizes that there are countless ways to offer better user or patient care and experience. The Business Model Canvas brought to light the amount of revenue that can be brought in through various streams and how these revenues can be maintained in the future. For one, a new data processing method can be patented and can be a great asset. Furthermore, the prescriptive analytics in the app offers great potential in the app because of its long term functionality. The physician referral feature can be personalized according to patient needs and preference as well as the physician's availability, making the app a comprehensive tool that extends beyond Covid-19.

In accordance to world events, the app can be beneficial to countries where physicians are struggling to cope, and where there could be a more steady number of incoming patients. App features like hospital capacity, physician referrals and appointments can be beneficial to countries like India (as of May 2021) for better crowd, patient, and vaccine management. The app can play an instrumental role in regions where governments are struggling to offer care to its people (Bhat, 2021) as users can make more informed decisions for themselves.

The Business Model Canvas is a significant model that has helped progress the project into one that would serve a purpose even after the pandemic. Realizing the possible revenue streams also reveals that the organization can be sustained and the technology can be protected.

SWOT, Verification and Validation with Business Case, Corporate Strategies

With the development of thoughts and ideas as the project progresses, the SWOT analysis has also advanced. By creating the BMC and the UI, it is clear that the app is a valuable and realistic one. Moreover, it can be much more powerful than what it was first planned to be.

As the pandemic continues, the app continues to be relevant, important, and urgent. The way the virus works becomes more familiar to researchers and physicians, and there is more available information in building a model accurate enough for predictive analytics. Furthermore, there is an increasing need in areas that need additional assistance, like India. This shows that the app can readily be offered to those who need it and can provide direct management assistance. The UI shows how simple and easy to navigate the app can be, without limiting its capabilities. The BMC shows that there are multiple revenue streams and assets in building this app that make it a worthwhile pursuit from a business perspective. Revenues can be from government deals, services offered to physicians, or from the users themselves in the form of purchases or subscriptions. The predictive data mining techniques can also be patented and used in other areas of healthcare, which presents the functionality and relevance the organization can bring.

A problem that the organization faces would be to readily comply with each area's local and national data collection and privacy laws. The organization should be armed with people who are familiar with international laws and immediately tweak the app following each country's needs and restrictions while keeping most of its capabilities. With the incoming revenue, the organization can quickly expand and hire talents to cope with the expansion or even get freelancers who are experts in their respective fields.

The organization can also consider moving towards other areas of healthcare like precision medicine where healthcare is individually tailored or in connecting patients with physicians, clinics, hospitals, and even clinical trials. Besides, the organization can constantly offer new features necessary in the scope of Covid-19. There is a tremendous growth opportunity for the organization.

As for threats, the threat of new entrants and threat of substitutes remain. One way the organization can derisk is to have an agreement with management or the government to enforce the use of the app. For instance, universities leaning towards requiring vaccines can similarly require the use of the app for contact tracing. Another issue is the lack of urgency in the US where some people may not take it seriously enough. The goal is for the government to enforce the use of the app so that such threats are minimized. Alternatively, the organization needs to earn the trust of its people in ways that are unique to each area.

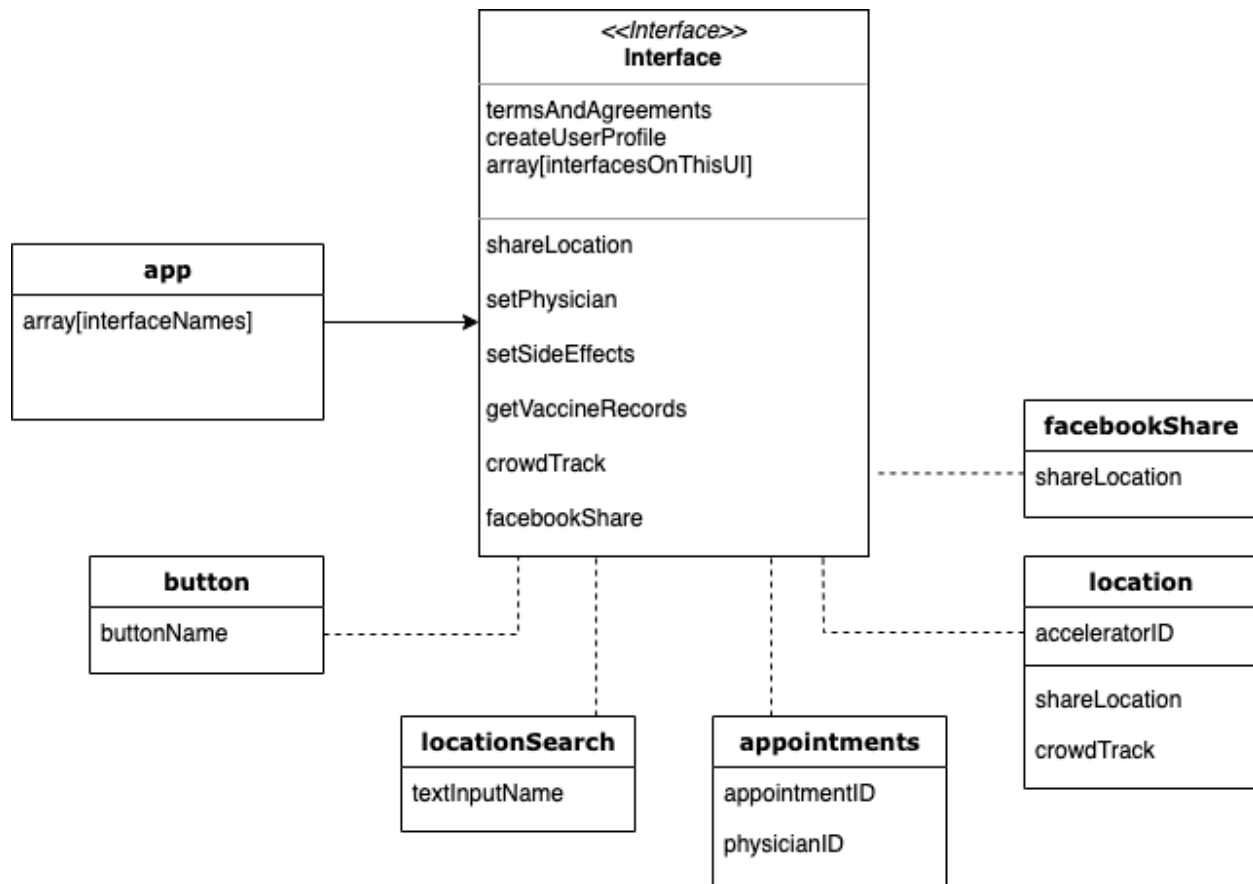
The SWOT analysis illustrates that the product fits in the US market where people are using smartphones and combating the virus is still a struggle. The organization is also meeting the needs of the current social condition of its users. The product helps not only the individual problems of its users but the overall management of the virus, which is the larger problem. With

the mentioned weaknesses, the organization can hire employees or freelancers for a smoother expansion. The threats to the organization are considered significant as visualizing how the app should work is easy. However, the software development and data analytics that goes behind this app are complex enough as it considers all parties involved, how the app can serve the parties, what we can learn from them, and what we can share.

The organization should ensure that the product fits in the market that it caters to. The product has to be as adaptable as possible. This means everything from the purchase or subscription price, the in-app language, to the availability of vaccines. The pricing should be affordable to the people, the language should be the country's language with specific terms standardized, and any information must be relevant information concerning the area. As mentioned in the BMC, in areas with more seniors, the organization can outsource call centers for more assistance with using the app. As per the UI and laws of each area, there can be different ways for crowd tracking and crowd management. In countries with stricter location tracking laws, public spaces can have barcodes for users to sign in with. The app should be simple and user-friendly while providing maximum information and visualization for its users.

All in all, this organization is about serving its users with useful, powerful features and learning to implement models on other needs as well. The organization strives to be updated and relevant while maintaining a revenue stream to support learning within the organization. The organization hopes that users make informed decisions about where to go, who to seek help from, and how to be protected. That being said, the organization will always fit the product to its markets because its purpose is to serve, learn, and share.

Analytics and User Acceptance



In assessing user acceptance, the organization looks at the buttons clicked, the number of users allowing the sharing of location, the number of appointments made, the number of facebook shares, and the location searches. The buttons clicked shows which features are mostly used. The number of users allowing the sharing of location represents the number of users who trust the app in terms of data collection and data privacy. The number of appointments made can represent the impact - how many of the users are taking actions for their health after using the app, and after how long of showing symptoms. The location searches show the places that matter to people. Places like the airport, restaurants, and the local grocery store are important places

serving the community that people want to be informed about. The number of facebook shares show the number of potential users in the app. Facebook shares also indicate positive reviews of the app.

With such data, the organization can evaluate user engagement and explore ways to improve user acceptance.

Summary

Having outlined the strengths and weaknesses of the organization and the ideas proposed, the organization has devised various strategies and tactics to face the challenges outlined in the Ishikawa diagram. With several analyses and diagrams, the project has answered the questions of who, what, when, where, why, and how. From the beginning, the paper has a clear purpose, answering the question of ‘why’. With the demographic and Or, the paper answers ‘who’ it caters to. Among others, the SWOT, Porter’s Five Forces, and PESTEL analysis answers the question of ‘what’. It shows the areas where the organization can work on to provide users with a better experience and for the organization to thrive. The Ishikawa Diagram and the Business Motivation Models are key diagrams that help the organization to stay in line with its vision and mission while effectively dealing with the problem domains. The UI is critical in communicating what the app should look like and how users can benefit from the app. In answering the question of ‘when’, the Gantt chart shows not only the sequence in which things can be done, but also how dependent and interdependent the activities are. Lastly, charts like the BPMN, ERD, Activity Diagram, Use Cases Diagram, and many others have provided the organization a sound understanding of ‘how’ the software works.

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