COVID-19 TravelCover: Post-Lockdown Smart Transportation Management System

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1 Introduction

The outbreak of coronavirus pandemic, 2019 (COVID-19), has created a global health crisis that has had a deep impact on the way we perceive our world and our everyday lives. COVID-19 is highly contagious and mortality also very high, this makes the disease all the more dangerous [5, 14, 21]. One of the major prevention is to maintain social distancing, which would smash the chain of the expansion of the disease. Lockdown has been implemented to implement this idea but we can't keep lockdown in a country for a very long time, otherwise the country's economy will drastically decline. Post lockdown many things will change around us. And after the daily routine resumes post lockdown, the public transportation system will play a crucial role, as it is most commonly used by people, and to prevent the further spread of COVID-19 cases, social distancing needs to be maintained at all the public places [12, 22]. So there has to be proper management for public transportation which can allow its use, without further producing more COVID-19 cases.

To solve this problem we have been implementing a solution, by building an intelligent application to schedule the timings of various transports, avoiding the over occupancy of buses/railway stations, etc. [16].

This work describes a unique approach to solve the issue of maintaining social distance while traveling due to the COVID-19 outbreak and also to make public transportation function like it used to function early. Our application will also check

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the user's authenticity and accountability by asking for their Aadhaar Card (12-digit individual unique identification number issued by Government of India, used widely for identification and address proof) details to enter while they log in to our application. The purpose of travel will be kept track of for future references and maintaining a priority queue of allocation of the ticket. This app will assign the shortest possible routes between source and destination, after the checking of the route availability, while ticket allocation, to provide ample amount of space inside the bus for people to maintain the social distance criteria. There is also a ticket validation system on the basis of masked and unmasked images of the user. So, this app will avoid congestion, which will help in maintain social distancing.

1.1 Problem Statement

COVID-19 is a lethal virus that spreads via direct contact with infected items or people. Therefore, it is extremely important to maintain social distance and wear mask to slow down or stop the transmission of this virus. Almost every nation in the world has imposed a full lockdown for the same reason, but this cannot be sustained for an extended period of time. As a result of the lockdown, several industries will be virtually closed, with daily wage employees being the most impacted. The GDP growth of many nations has slowed, and in some cases has even gone negative; similarly, the GDP growth of India has been also affected, as can be seen from the most current data. Worldwide corona cases are increasing but here we are specifically talking about India as our research is particularly based on India's data. Here are some characteristics of the current scenario of India with respect to COVID-19 till first November 2020 [7].

- Total corona cases 81,84,082
- 91.54% Cured/discharged/migrated (74,91,513)
- 6.97% Active cases (5,70,458)
- 1.49% Deaths (1,22,111)
- Total COVID-19 confirmed cases = Cured/discharged/migrated + Active cases + Deaths

Analyzing the data trends over the past few months, according to the report published on Government of India COVID-19 dashboard [7], we observe the following:

- The surge of new coronavirus cases started somewhere in the month of April, with 129 new cases in Delhi and 74 new ones in Tamil Nadu had come up due to the Nizamuddin Markaz congregation.
- In May, the growth rate of new infections encountered on daily basis was drastically increasing due to which the initial 21-day lockdown period had to be extended a few times.

- Finally, on June 08, 2020, the 75-day lockdown ended and the unlocking process, divided into several stages, commenced.

Also, unforeseen employment issues became a threat to the survival of daily wagers. Thousands of migrant workers were seen hurdling at Anand Vihar bus terminal and railway station of New Delhi, wanting to go back to their villages due to a shortage of food and resources in the city. This in turn led to a dramatic rise in COVID-19 cases in the capital. Incidents like these compelled us to think of a way of managing such traffic on roads and compelled people to follow the guidelines in public places.

Post lockdown many things have changed around us. As of now, we can see that the lockdown has been resumed in India, and day by day cases are getting increased. People are going out and maybe getting in touch with infected people, which is increasing the infection throughout the country. Thus, the public transportation system will play a crucial role, as it is most commonly used by people, and to prevent the further spread of COVID-19 cases, social distancing needs to be maintained at all the public places. So there has to be proper management for public transportation which can allow its use, without further producing more COVID-19 cases.

1.2 Related Works

This section includes methods that formulated the problem, addressed a central or related problem, used a similar methodology as our work to a similar problem, and also how our work is inspired by their work.

By clearly describing previous work, we can better describe the current limitations and the need for a new methodology. It also allows demonstrating our area of work and will help others to relate our current work to other scientific areas. We collected, analyzed, and coded the author-assigned keywords of other research works to start a discussion on the topic "Intelligent post lockdown transportation management system." Presently, how to maintain social distancing while traveling is a boiling area of research. Managing traffic, safer routes, and also telling the public about the shortest route to reach out to their destination have been used in designing many applications in the past [25]. Some of those existing approaches from the past are discussed in this section.

Existing work in the field motivated our design idea to tackle the needs of a safer traveling environment for the public. A handful of solutions have been suggested pertaining to the issue in discussion.

Transit app was designed for aggregating and mapping real-time public transit data and crowdsourcing user data to determine the actual location of buses and trains. This app was first released for iPhone users, then it was launched for the android users as well. It offers upcoming departure times for all nearby transit lines and alerts for various types of transportation where available, including both bus and

train. If it is found that public transit is not cooperating, people can easily request an Uber or grab the closest bicycle.

Whether you ride the train, subway/underground/tube, bus, light rail, ferry or metro, use bikes, ride-sharing like Uber, getting the best urban mobility information is critical [17].

Moovit [6] guides you from point A to B most easily and efficiently. Get train and bus times, maps, and live arrival times with ease so you can plan your trip with confidence. Find critical alerts and service disruptions for your favorite lines. Get step-by-step directions of optimal route bus, train, metro, bike, or a combination of them [13].

GoTo is the first ever Real-time Bus Booking Platform for Intercity Travels (Harsh Vardhan [9]). It is focused on saving your precious time which is generally wasted waiting for buses at the boarding point, with no clue of bus arrival. Though booking operators claim that you can track the bus, in most cases you are unable to get its actual expected time of arrival.

All the abovementioned applications help people to book tickets, reach their destination in time, provide them with a scheduled timetable, and notify them of numerous modes of transportation. There are several such applications like Chalo, UTS, NextBus, etc. So, after exploring all the previous works we have come up with an application which in addition to existing features provides new and innovative ways to implement social distancing in public transport [2, 3, 20]. These features include priority-based ticket allocation, validating the ticked through masked images, etc.

"Data Privacy" is one of the most important concerns in any data collection module. It has been observed that many of the existing applications are asking for way too much information from people for providing more efficient services, which is not ethical. The Supreme Court of India has recognized the right to privacy as a fundamental right under Article 21 of the Constitution as a part of the right to "life" and "personal liberty" [4].

H. R. Schmidtke [18] presented and reviewed services based on location tracking for COVID-19 contact tracking. In his observation, it clearly states how vulnerable a user can get if he/she shares a large amount of his/her personal data with such COVID-19-related applications. For instance, they have talked about the Cambridge Analytica Case [8].

Kumar et al. [11] proposed a new digital twin-centric method for the prediction of the intention of the driver and also for avoiding the overcrowded traffic paths.

H. R. Schmidtke [19] studied the approaches used for the verification method by the various smart transportation systems. In his study, he also discussed about the intelligent environment aspects that authenticate local safety and security techniques.

After exploring several design options, we eventually decided to develop a website which will have features from several of our brainstormed and existing ideas named COVID-19 TravelCover. By integrating the features of distinct applications together in one platform, COVID-19 TravelCover offers a more holistic and effective solution than the existing applications by providing them with a variety

of tailor-made features as per user's requirements. Another highlight is that the currently available applications fail to provide a solution to the COVID-19.

But in our work, we have made sure that no such information is asked from the user which can pose data privacy concerns to our users, but ensuring the authenticity of the users at the same time (by asking for Aadhaar Card details while registration, used as a legally acceptable document for unique identification in India) [10]. Also, we have verified the perspective of an intelligent environment by making all the processes digital and by minimizing the physical contact during the overall process.

1.3 Scope and Objective

The goals of the proposed work are as follows:

1. It will provide the shortest route for the traveler's desired destination thus saving time.
2. This app will be used to make public transportation possible while maintaining social distancing. It will help in avoiding occupancy not only on the roads but also inside public transport.
3. We have tried to make it user friendly so many people can easily use it.
4. It helps to detect on a mass scale whether people are wearing a mask or not. In the case of defaulters, they will not be allowed to take up the journey. This would implement strict rule implementation through our application.
5. It will keep a track of the travel of healthcare officials for analysis by maintaining a priority.
6. Payments will be online so no requirement for handling physical currency is present.
7. For future scope, we want to collaborate with the government to install cameras in all buses and through those cameras; using OpenCV libraries, we can implement mask detection failing which the person will be charged with penalty accordingly.
8. We are also planning to implement a better ticket validation mechanism such that before boarding particular public transportation we will be required to scan a QR code which will click a photo of the user then and there, thus increasing efficiency and reliability of our application.
9. For further research purposes, we can align our application with appropriate cloud storages to handle the data efficiently and expand the functionality of our application.

1.4 Novelty

In our application, we are using a fully customized and extremely simple to understand algorithm to allot the shortest available route to the user to take up their journey. Our application will check the user's authenticity and accountability by asking for their Aadhaar card (identity proof) while they sign up for our app. This application will provide services based on the preference of people's urgency for the purpose of their travel. There is a whole different step which the user is required to go through in order to validate the allotted ticket based on the mask detection mechanism, failing which the user will not be allowed to take up the journey. We strive to maintain social distancing not only on the roads but also inside the public transports as well. The efficient allocation of available transport resources ensures less congestion on roads. Through our application we will allow only 50% of actual occupancy allocation in a mode of particular transport, thus providing ample space inside the transports as well.

1.5 Scientific Contribution

1. A very simple and hassle-free, shortest path allocating algorithm that can be used by anyone, even those new to the development domain.
2. Through this application, we provide a methodology that can be used to implement priority-based ticket allocation, thus allowing health officials to reach the needy on time.
3. We have tried to introduce an idea of 50% occupancy of transports which can considerably reduce the risk of people getting affected with coronavirus.
4. As we are able to maintain a track record of travel history, we can analyze the data to track down people visiting red zone areas (areas having a heavy number of cases within a short period).
5. We have seen that people failing to generate masked images will not receive validation for their tickets. Thus, we have introduced a way for stricter implementation of the safety rules.
6. ***Impact on the Environment.***

   The design and implementation of our application would require a greater number of vehicles to be available as we have planned 50% occupancy of the buses in order to implement social distancing inside the bus itself. But at the same time, we are implementing the efficient utilization of our resources. When we have no option at that time we should ensure minimal wastage of resources. Analyzing the pattern of demand based on the area, the buses can be scheduled accordingly so that the minimum number of buses can be implemented to cater to people's needs. On a small level, we are also saving paper by making payments and issue of tickets online, thus saving trees.

The organization of this chapter is arranged as Section 2 briefs about the proposed methodology employed in this work including COVID-19 TravelCover Architecture and Software Designing. Section 3 explains the Algorithm and working of the proposed work consisting of Route Allocation, fare calculation, Unique Ticket Number Generation, Ticket Validation through mask detection, Security features, Imposing guidelines, and Customer-first approach. Section 4 briefs the discussion over the result and outcome, and the final Sect. 5 provides concluding remarks and future work of this chapter.

2 Proposed Methodology

2.1 COVID-19 TravelCover Architecture

In data flow architecture, we have presented the flow diagram of the proposed work with respect to the input and output flow of the data in different phases of the application. The flowchart shown in Fig. 1 depicts the data flow diagram of our COVID-19 TravelCover application.

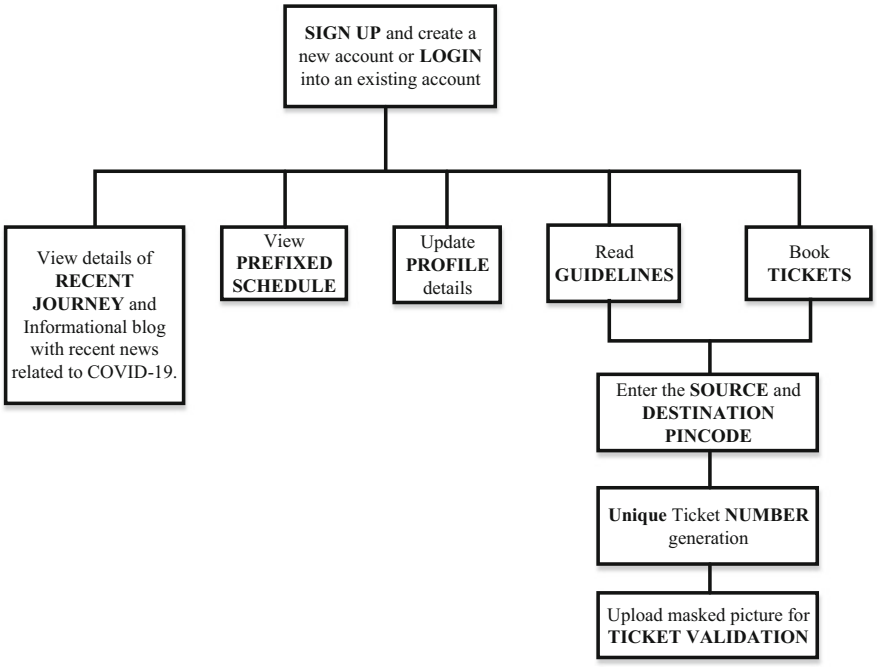


Fig. 1 The flow architecture of proposed COVID-19

The application required some standard details while using it for the first time, such as name, email id along with Aadhaar card number for checking the authenticity of the user, from the SIGN-UP section. Then the users will also be required to enter their home and "usual" destination address details so that these options are readily available for the user while booking tickets. The personal details of the user will be available in the profile section which he/she can change as and when required. While booking tickets users will have to either enter or choose from available options the required source and destination pin codes after carefully viewing the prefixed timetable and deciding an appropriate time. They will also have to go through guidelines compulsorily before navigating to the "Book Tickets" options. After submitting the details, the user will receive a unique ticket number which subject to validation will complete the process of booking the tickets. For ticket validation, the user will be required to upload a masked image of themselves from their corresponding device, if the image fulfills the criteria then will give a validation signal which has to be shown while boarding the vehicle.

2.2 Software Designing

In this section, the structure of the software application is explained elaborately which has been aided with a flowchart representing all the pages of our application. Figure 2 presents the block diagram depicting the overall software designing steps and processes.

(a) ***Index.html*** is the first page of our website ("welcome page"). It will direct a user either to "registration.html" (registration page) or login.html (login page).
(b) ***Registration.html*** page a user will fill in their required details and the details will get stored in the backend database register.java (/register). After this, it will direct the user to the next step in the registration process.
(c) ***Registration2.html***, the user will fill in the other required details remained and the details will get stored in the backend database register2.java (/register2). If the user is already registered, then the user can directly go to the "LOGIN PAGE".
(d) **Login.html**–It is where his/her credentials are already there in the database login.java (/login Action). Then the next page after the registration page will be home.html where a user can store his/her HOME ADDRESS so that it will get stored in the database Home.java (/source), with the help of which user need not enter their home address every time they want to book tickets. Similarly, the destination.html page will ask all the usual destination details where a user usually goes and the details will get stored in destination.java (/destination). Then comes the Dashboard page (dashboard.jsp) where the user's recent journey will be displayed. Dashboard directs to the other pages:
(e) **Guidelines.jsp**, here the user can find the few most important guidelines for the prevention from COVID-19.

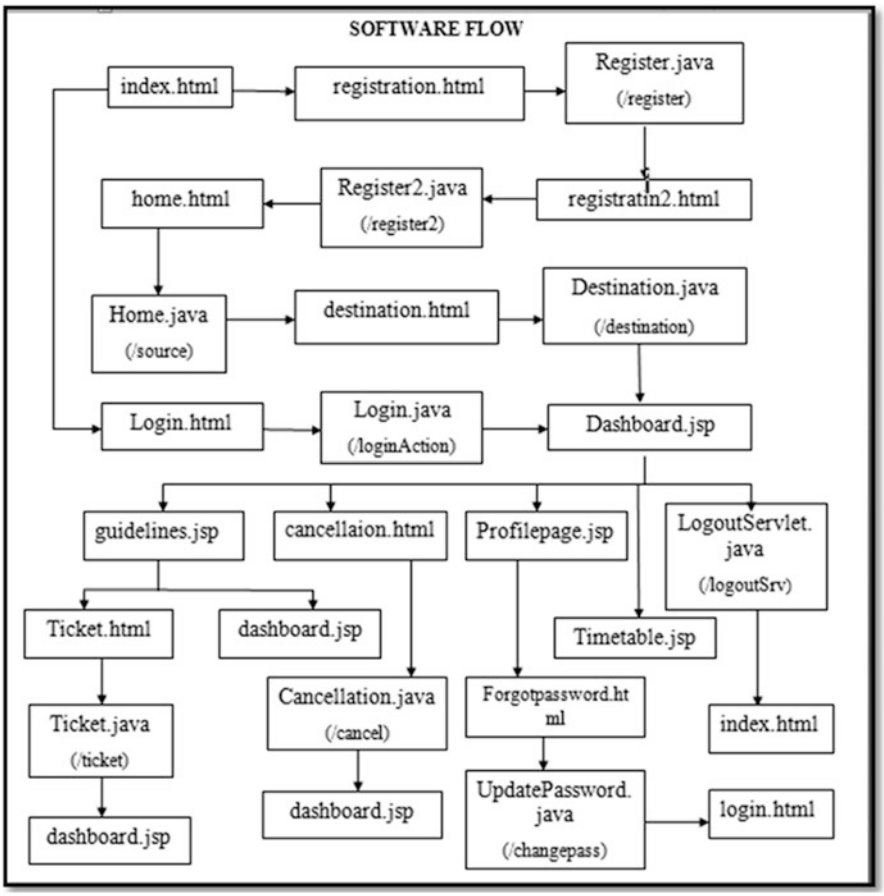


Fig. 2 Block diagram of consisting software details

(f) **Cancellation.html** from this page the user can cancel his/her booked ticket, and it will then update in the database cancellation.java (/cancel) and then redirects to the dashboard.jsp.

(g) **Profilepage.jsp**, where people can see the information they have entered during the registration process.

(h) **Timetable.jsp,** here the user will find the timetable which will make it easy for the user to see timings and book tickets according to their convenience.

(i) **LogoutServlet.java** (/logoutSev), here the user can log out their account, then will get directed to the index.html page. From the guidelines.jsp, the user can get back to the dashboard or to the Ticket.html where the users will book their tickets and the data will get stored into the database through Ticket.java (/ticket) and then directs again to dashboard.jsp.

(j) **Profilepage.jsp** (PROFILE PAGE) contains a forgot password option which redirects to the Forgotpassword.html (FORGOT PASSWORD PAGE) where the user will have the provision to update his/her password and the password will get updated in the database through Updatepassword.java (/changepass) and then this page will redirect to the login.html.

3 Algorithm and Working

3.1 Route Allocation

This section explains the process or steps for determining the shortest distance and fare calculation for each route. Whenever we want to go from one place to another, we might have more than one possible path to choose from, to take up the journey. In such a case, we all prefer going through the path which involves the least time to reach the destination, as it would save valuable time. In our application also, we tend to improve customer satisfaction by allotting the shortest path possible as it would save the customer's time and money. Presently, we are using a very simple to use and understand algorithm for shortest route allocation as it complies with the simplicity of our project and is easily modifiable. This algorithm also uses the concept of priority while allotting the tickets. This is implemented in a way that if two users are booking tickets at the same time then, the user with higher associated priority will be allotted the ticket first. The users are required to enter the purpose of travel while booking the tickets. Now using pattern matching, the algorithm will look for words like "doctor", "health worker", "medicine", etc. in the purpose entered by the user to associate a greater priority with that user.

The steps to find the shortest route and how to decide the priority has been explained through the example. Let us suppose we are considering a small district, comprising of nine PIN codes. Also, four possible routes are connecting these pin codes among themselves. Let the pin codes be numbered as **1, 2, 3, and so on till 9,** and the routes are named as **R1, R2, R3, and R4** as shown below. Now, the task is to find the shortest route possible that can be allocated to the user. Destination page will look for the address of where the customer wants to go most often may be on a daily basis (if any), therefore his usual destination like office address, college address, hospital address, etc. Table 1 shows the route number and vehicle stops details for finding the shortest distance based on Fig. 3.

Table 1 contains the route details, the first column represents the particular route name and the rest of the columns consist of the bus stops in order of their traversal during the journey. Let us assume a person "A" wants to go from pin code "1" to pin code "5". Now on referring to the above figures it is clear that all the four routes can take A to his destination. The number of stops between the source and destination in corresponding routes is as follows:

Table 1 Vehicle route and corresponding stop details

ROUTE NAME	S1	S2	S3	S4	S5	S6	S7	S8	S9
R1	1	2	3	4	5	6	0	0	0
R2	1	2	8	3	4	5	6	0	0
R3	1	2	8	7	4	5	6	0	0
R4	1	2	3	8	7	4	5	6	0

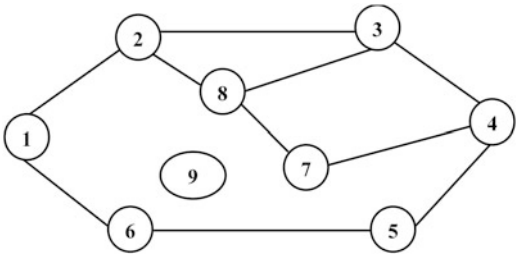


Fig. 3 Shortest route calculation steps using random users

R1–4 stops
R2–5 stops
R3–5 stops
R4–6 stops

From the above data, it is clear that "R1" will be the best and shortest route possible between the specified source and destination. Thus, route R1 will be allotted to "A."

3.2 Fare Calculation

While finding the shortest route we will be keeping a track of the number of stops between the source and destination along a particular route. This same data will be re-utilized by us in calculating the fare incurred on the user. We have decided on a standard rate for traversing between two stops, that is, 10 rupees per stop, and based on this the final price will be displayed to the user. For instance, let us consider the above case again where "A" wants to go from pin code "1" to "5." We have already found that the "R1" route will be allotted to "A" so the fare corresponding to that will be (Price per stop) * (Number of Stops to be traversed) = 4X10 = 40/−. Thus, "A" will have to pay 40 rupees to take up the journey.

3.3 Unique Ticket Number Generation

In order to avoid reusing the same ticket twice or sharing the ticket by users, our application will generate a unique ticket number to uniquely identify each journey. The uniqueness of every ticket is ensured by using a combination of source and destination pin code, alphabets, and a series of random numbers generated using the random() function. The pattern of each ticket number has been designed in a way such that it can directly indicate the source, destination, and username of the user. For example, the ticket number niniTNBF1T50.387 indicates the user name "nini", the source pin code as "1," and the destination pin code as "5".

3.4 Ticket Validation Through Mask Detection

Every ticket generated has to be validated based on the provided details and mask detection technique. This extra step in the process of booking tickets has been introduced to ensure that the user is complying with the guidelines given by the government. The validation has been implemented using a flask app. For the validation, the user will be required to upload their recent photo from their device, which will be verified by IBM visual recognition either as "Masked" or "Without mask." This page has to be shown by the user while boarding the transport, failing which the user will not be allowed to enter the bus.

We have planned an alternative and more effective method to impose the guidelines as well. If we are able to install cameras in every public transport, then we can use OpenCV (Open Source Computer Vision Library), an open-source computer vision and machine learning software library of python, to distinguish between people who are not wearing and those who are not wearing a mask properly, so that required action can be taken against such people.

3.5 Security Features

Our application ensures security in all respects either for user authentication or for ticket generation in the following ways:

(a) While signing up the user is required to enter their "AAdhaar Card Number" for authentication. Aadhaar is an initiative by the Unique Identification Authority of India laid down by "Targeted Delivery of Financial and Other Subsidies, Benefits and Services Act, 2016 (Aadhaar Act 2016)".
(b) As discussed in the previous section, every journey will be associated with a unique ticket number to ensure that there is no fraudulent use of the ticket generated.

(c) We constantly urge the user to keep changing their passwords and choose strong passwords with special characters and length greater than eight characters to reduce the risk of getting hacked.

3.6 Imposing Guidelines

(a) We have designed our application in such a way that the users can get the option for booking tickets at the end of the guidelines page. This will force the user to go through the guidelines at least once before going to book the tickets. We know that some people will just scroll through the points without reading but people are becoming self-aware nowadays so even if some people keep the points in mind, it will prove beneficial to society.
(b) The most powerful feature of our application is that even when the ticket is generated for a particular user, it has to be validated to allow the user to take up the journey. This validation will be based on image recognition and only properly masked images will only get validated.
(c) We have planned to reduce the bus occupancy by 50%. This will allow the passengers to maintain social distancing even inside the bus. We are also planning to impose a penalty on people who will not be abiding by the rules specified by the government.
(d) As we have seen already that route allocation will be based on the shortest path, this will reduce the time spent in public transport by the user thus reducing exposure and eventually reducing the risk of infection.
(e) We are also promoting digital methods of payment in order to ensure a contactless money transaction.

3.7 Customer-First Approach

Our application has been built keeping the customer as a priority. As we have discussed earlier, that shortest path will be allocated to the user which will reduce the time of travel, will be pocket friendly, and owing to minimum exposure will reduce the risk of people getting affected with COVID-19. The ticket allocation is done on a priority basis, giving doctors and health workers the highest priority, thus ensuring their availability at required places on time.

Also, we would ensure 50% occupancy of transports in order to provide our users with ample space to follow social distancing. This feature will result in more number of buses to be scheduled at regular intervals of time, but the lives of the users cannot be negotiated with. Lastly, the application has been made extremely user friendly, thus making booking, canceling tickets, and updating information easier.

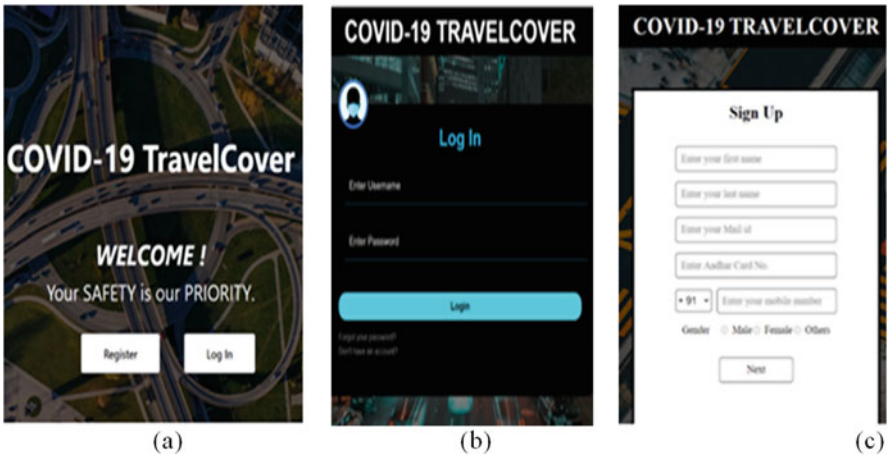


Fig. 4 User Interface of COVID-19 TravelCover: (**a**) Welcome Page, (**b**) Login page, (**c**) Sign Up page

3.8 User Interface (UI)

In this section, we have explained and presented each page of the application along with a brief description**.** All the main pages of and interface used in the application such as HOME page, Login Page, Ticket Booking, etc. are visualized with their steps to be used. Figure 4 shows the user interface of (a) Cover page, (b) Login page, and (c) Registration page, respectively.

Cover Page It is the welcome or cover page of the application which will guide the user to follow the initial steps.

Login Page Those who already have an account here on our website can LOG IN directly by entering the username and password. If a person has forgotten his/her password, then they can click on the Forgot your Password option, or if a person does not have an account can click on the Don't have an account option.

Registration Page If a person does not have an account can directly go to the registration page. On this SIGN-UP page, the user needs to enter First Name, Last Name, Email Address, Mobile Number, and Gender. Click on the Next button to complete his/her registration form. On the next page, you need to enter Username, confirm the email, enter the password of your choice, and re-enter the password.

Home Address In this home address page, the user can save the address of theirs so they can easily choose home rather than entering the address of their home every time. In this box, the user needs to fill up their Username, Address of their home, Choose the State, Pin Code, and then click on the SUBMIT button.

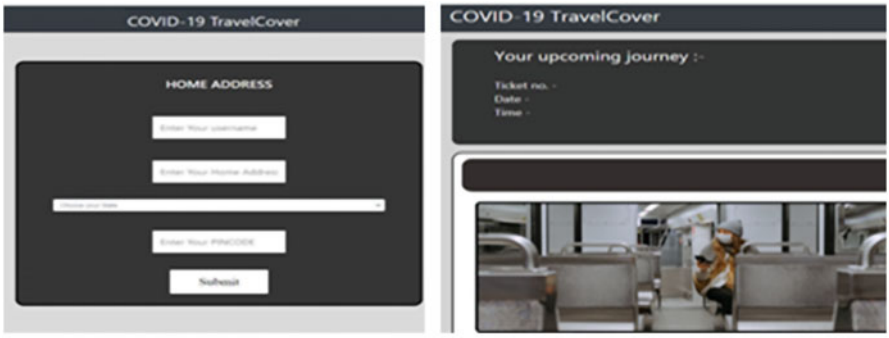


Fig. 5 User Interface of COVID-19 TravelCover: (**d**) Home Address Page, (**e**) Dashboard page

Dashboard An informative page about the user's upcoming journey and this page also has a blog. This page also has a Cancel Your Ticket button (for the user to cancel his/her ticket). And from now, on every page, there will be a hamburger menu to toggle between pages. The home address page and Dashboard page visualization have been shown in Fig. 5.

Guidelines This page provides users with a set of general instructions that are essential to be followed in public places and transport. We have followed guidelines issued by the Ministry of Health & Family Welfare-Government of India for domestic travel [15].

Time Table On this page, the timetable shown, which is dynamic, changes as per the user's details. The changes in the time of the buses will get updated as soon as the database gets updated. UI of Guidelines page and Time table page has been shown in Fig. 6.

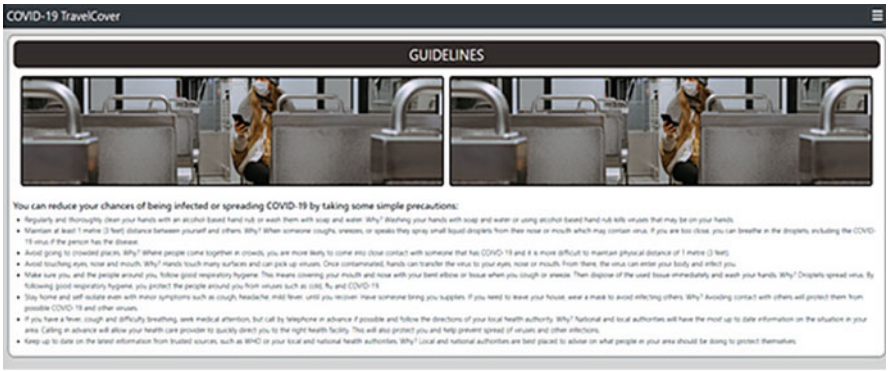
Ticket-Booking This box appears for the booking of the ticket; here, the user needs to:

(a) Enter the source pin code (from where he/she will start his/her journey).
(b) Enter the destination pin code (where he/she will end his/her journey).
(c) Enter the purpose for which the user wants to move from one place to another (this purpose entry will help to define the priority of one's work).
(d) Enter the date (day, month, and year) and time.

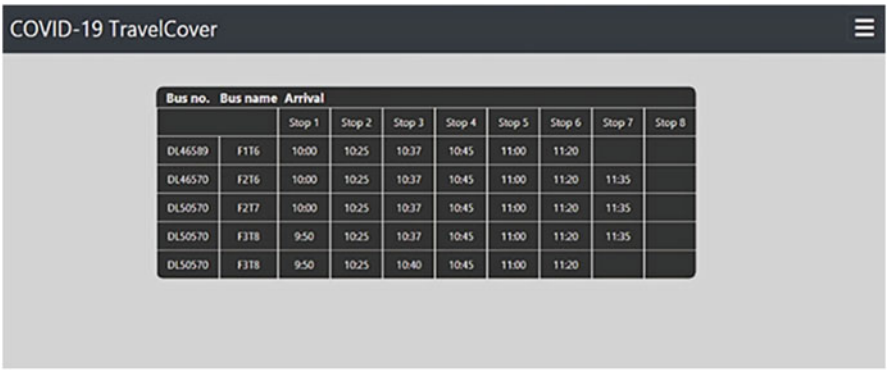
After the completion of the box, the user needs to click on the Proceed button, Fig. 7 visualizes the ticket booking page and cancelation page, respectively.

Cancelation Page

1. After clicking on the "Cancel your ticket" button on the dashboard page, this cancelation page will appear, the user needs to enter his/her ticket number, then will click on the "Cancel Request" button.



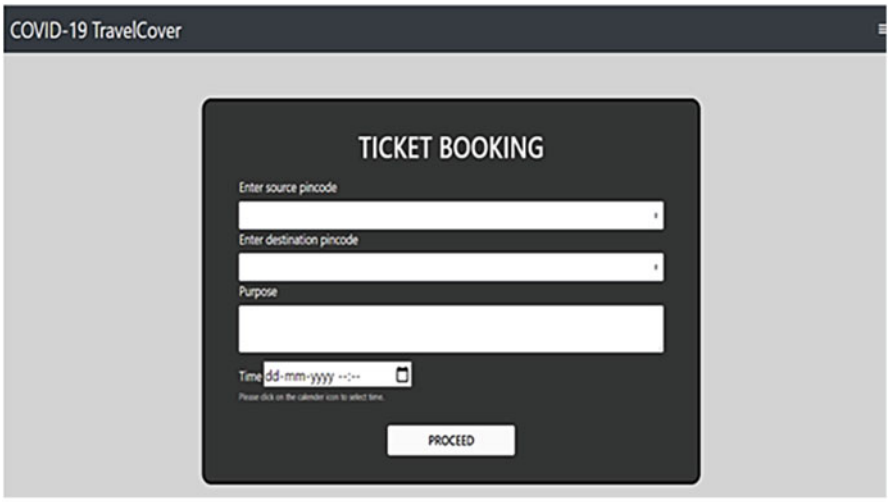
(f)



(g)

(h)

Fig. 6 User Interface of COVID-19 TravelCover: **(f)** Guidelines page, **(g)** Time Table page, **(h)** blog page



(i)

(j)

Fig. 7 User Interface of COVID-19 TravelCover: **(i)** Ticket Booking Page, **(j)** Cancelation page

2. As soon as the user clicks on the "Cancel Request" button, a prompt pops up where the user needs to enter his/her password and then needs to click on the OK button.
3. After clicking on the previous prompt's OK button, another prompt will pop up which will ask the user for his/her cancelation's confirmation.
4. As soon as the user confirms his/her cancelation, another prompt will appear with the confirmation of the user's ticket's cancelation.

Mask Detection System This system is made to detect the user is wearing a mask or not. The user needs to upload his/her picture and will get detected by our app.

Forgot Password Here on this page the user can change their password, if they forgot it by entering specified details such as New Password, Confirm New

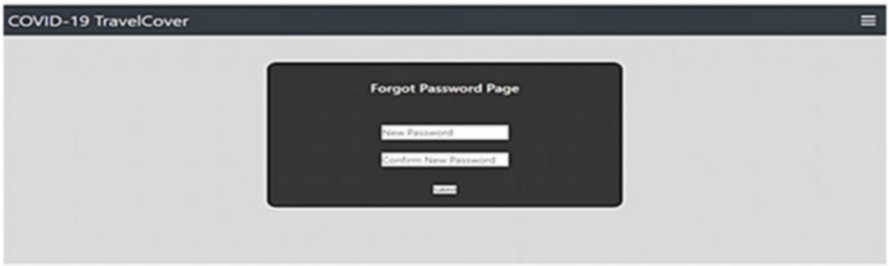


Fig. 8 User Interface of COVID-19 TravelCover Forgot Password Page

Password, and then click on the SUBMIT button. Figure 8 shows the user interface of the Forgot password page and Mask detection system, respectively.

4 Result and Discussion

The proposed method for the smart transport management system has been tested on a real-time database collected through the application "COVID-19 TravelCover". We have randomly collected 100 real-time data using the application and based on this we have verified the system validity. The system efficiency of our work is determined based on the dynamic fare calculation, validation, and generation of tickets (mask detection) and dynamic time table generation. The fare calculation system and ticket validation system have been explained based on some real-time data.

4.1 Fare Calculation

We have explained the fare calculation method with the help of an example and taken a few real-time data from the system for briefing purposes. Let us take an example and check whether the price generated is correct or not, where the price per stop is 10/- rupees.

We have used a very simple and user-friendly technique to calculate the fare of individual users. After receiving the inputs from the user for source and destination, respectively, we will refer to the "route details" table (shown above in the second picture). First, we will find the routes which consist of both the source pin code and destination pin code as its stops and create an array at the backend with a list of such routes present in the table. Then we will calculate the number of stops between source and destination in each of these routes and will find the minimum value among them. This minimum value will represent the number of stops between the source and the destination. Thus, now we just have to multiply 10 with the

Table 2 Real-time users' ticket details and fare calculation table

UNAME	S_PIN	D_PIN	DTIME	PRICE	TNO	PRIORITY
Nini	1	5	2020-07-07 T12:57	50	niniTNBF1T50.387	1
Kaju	1	8	2020-07-04 T12:49	30	kajuTNBF1T80.139	

minimum value received and that will be the price incurred upon the user to take up the journey.

Table 2 provides the individual user's ticket details consisting of username (UNMAE), source PIN(S_PIN), Destination PIN(D_PIN), Date and Time (DTIME), Price Calculated(PRICE), Ticket Number(TNO), and priority(**PRIORITY**). The bus or vehicle route details are charted in Table 2, where we have considered four routes (R1 to R4) and nine bus stops represented by S1 to S9. Based on Tables 1 and 2, we have explained two cases for automatically calculating the fare of the ticket of every individual user.

Case 1 For username "nini", we can see in Table 2 that the price calculated is Rs 50/- between pin code "1" and "5," which has been allocated according to "R1." Since all four routes consist of the stops 1 and 5, hence based on shortest routes determination it has opted route 1 which has only 5 stops difference, hence the price calculated is 50.

Case 2 For username "kaju", the price calculated is 30/- between pin codes "1" and "8", which has been allocated according to "R2", because route R2 provides the shortest path between stops 1 and 8.

4.2 Validation of Tickets

As mentioned earlier in the chapter, the ticket validation system is implemented through a python-based flask app. We have used the "Visual Recognition" service provided by IBM for this purpose. We have used supervised learning methodology to initially train the model to make it reliable. The model is trained to differentiate between masked and unmasked images using a large dataset of 100 images among which 50 images were masked and the rest of them were unmasked ones. The visual recognition service has allowed us to design a customized layout to implement the machine learning model. Only after a rigorous test of the trained model, the model has been incorporated within the project.

After a unique ticket generation is done for a particular journey, the user will see a button called "Click to validate", clicking on which the user will be redirected to the validation page. On the validation page, the user is required to upload an image by browsing through their device. After uploading the image as soon as the "Predict" button will be clicked, the assessment result will be displayed below the image uploaded by the user. Only if the user is able to show this validation page to

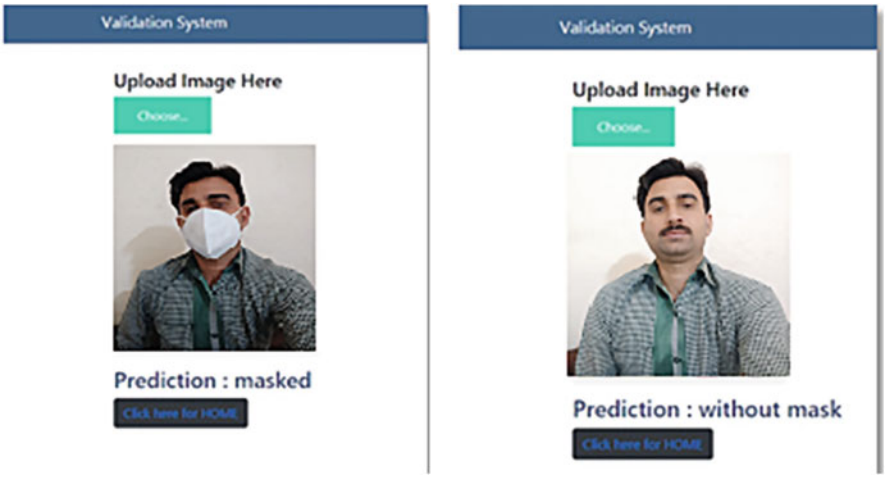


Fig. 9 Ticket validation using mask detection, masked (left) and unmasked image (right)

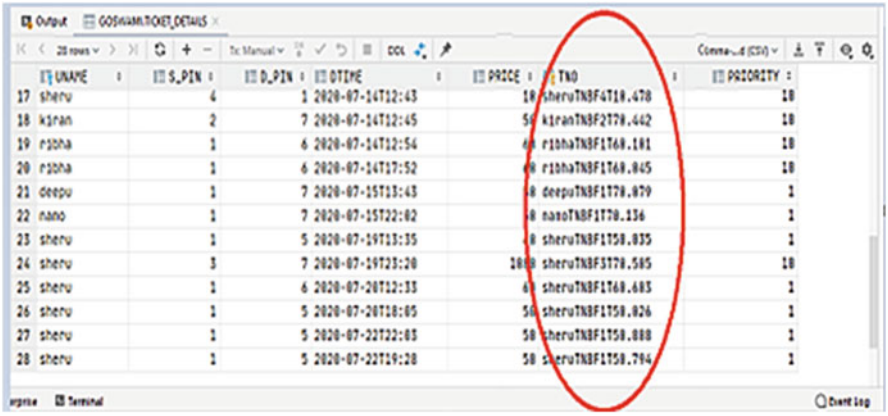
the regulation authority at the time of boarding the bus, will he/she be allowed to take up their journey? Figure 9 shows that the flask app is able to detect the masked and unmasked images pretty well.

4.3 Security Features

Our application ensures security as well as authenticity in a way that every different journey will be associated with a unique ticket number. A unique ticket number will not only help us in distinguishing different users and keeping a track of them but also would avoid the risk of double-spending (i.e. using the same ticket to travel twice), thus enhancing the authenticity of our application. Figure 10 shows the ticket details table of our database and we can see in the "TNO" column (marked with a red circle) that each and every ticket number is unique.

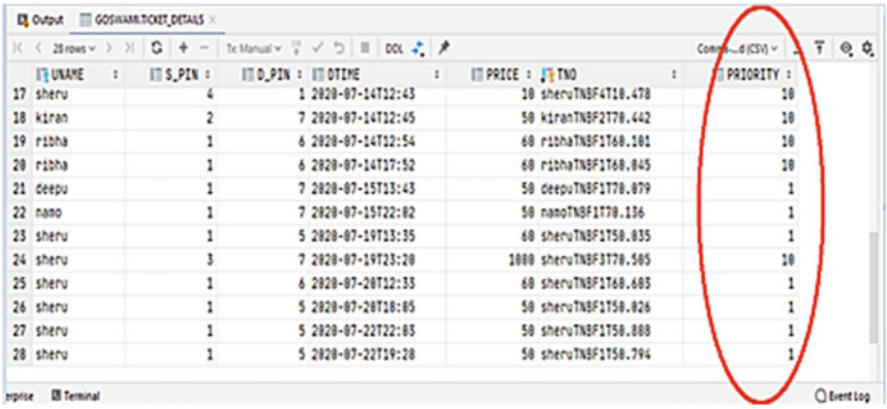
4.4 Priority

One of the topmost concerns that the world is facing nowadays is safety related to health. In such a scenario, the demand for health officials is quite high as compared to the actual health workers available. Thus, efficient time management has become very necessary for health workers. Through our application, we put forward an effort to help the health officials. This will be ensured with the help of maintaining priority. The health workers and patients will be given the highest priority (=1, according to



	UNAME	S_PIN	D_PIN	DTIME	PRICE	TNO	PRIORITY
17	sheru	4	1	2020-07-14T12:43	10	sheruTNBF4T10.478	10
18	kiran	2	7	2020-07-14T12:45	50	kiranTNBF2T70.442	10
19	ridha	1	6	2020-07-14T12:54	60	ridhaTNBF1T60.101	10
20	ridha	1	6	2020-07-14T17:52	60	ridhaTNBF1T60.845	10
21	deepu	1	7	2020-07-15T13:43	50	deepuTNBF1T70.879	1
22	nano	1	7	2020-07-15T22:02	50	nanoTNBF1T70.136	1
23	sheru	1	5	2020-07-19T13:35	60	sheruTNBF1T50.835	1
24	sheru	3	7	2020-07-19T23:20	1000	sheruTNBF3T70.505	10
25	sheru	1	6	2020-07-20T12:33	60	sheruTNBF1T60.685	1
26	sheru	1	5	2020-07-20T18:05	50	sheruTNBF1T50.026	1
27	sheru	1	5	2020-07-22T22:03	50	sheruTNBF1T50.888	1
28	sheru	1	5	2020-07-22T19:28	50	sheruTNBF1T50.794	1

Fig. 10 COVID-19 TravelCover ticket details table with unique ticket number



	UNAME	S_PIN	D_PIN	DTIME	PRICE	TNO	PRIORITY
17	sheru	4	1	2020-07-14T12:43	10	sheruTNBF4T10.478	10
18	kiran	2	7	2020-07-14T12:45	50	kiranTNBF2T70.442	10
19	ridha	1	6	2020-07-14T12:54	60	ridhaTNBF1T60.101	10
20	ridha	1	6	2020-07-14T17:52	60	ridhaTNBF1T60.845	10
21	deepu	1	7	2020-07-15T13:43	50	deepuTNBF1T70.879	1
22	nano	1	7	2020-07-15T22:02	50	nanoTNBF1T70.136	1
23	sheru	1	5	2020-07-19T13:35	60	sheruTNBF1T50.835	1
24	sheru	3	7	2020-07-19T23:20	1000	sheruTNBF3T70.505	10
25	sheru	1	6	2020-07-20T12:33	60	sheruTNBF1T60.685	1
26	sheru	1	5	2020-07-20T18:05	50	sheruTNBF1T50.026	1
27	sheru	1	5	2020-07-22T22:03	50	sheruTNBF1T50.888	1
28	sheru	1	5	2020-07-22T19:28	50	sheruTNBF1T50.794	1

Fig. 11 COVID-19 TravelCover ticket details database with user's priority

our application). Figure 11 shows the priority of the users during ticket allocation itself where each user will be associated with some priority of the purpose entered by them, based on which the sequence of allocation will be determined.

We performed a small survey with our friends, family, and other acquaintances. In that survey, we asked each individual a few questions related to our application. Some of the questions were, "Are you satisfied with the management of transportation prevalent nowadays in terms of safety?", "Will you prefer an application which will allow you to book buses based on your source and destination, online?", "What do you think of the idea of ticket allocation on the basis of priority?". After carefully analyzing the results we found that around 60% of the people were willing to associate with an application as ours, thus indicating the need and success of our application.

We have also compared our work with various similar work or applications based on Social Distancing, Mask Detection, Location Record, Shortest Route, Priority Assignment, and Simplicity. From Table 3, it is observed that no application or work includes all the features except our proposed COVID-19 TravelCover, whereas almost all the application are user friendly and simple to use.

MOOVIT[6] is capable of finding the shortest path as well as location tracking, whereas TRANSIT [17] and GoTo (Harsh Vardhan [9]) only able to record the location. SOCIAL DISTANCING APP [24] and Coready [24] are developed for maintaining the social distancing very efficiently along with location tracking. Among all applications, MASK DETECTOR [1] is only capable of detecting the face mask. But our proposed application has all the features like social distancing, mask detection, location tracking, priority assignment, and also user friendly. Hence, our developed application is far superior as compared to all applications presented in Table 3.

5 Conclusion and Future Scope

This chapter has provided a dependable solution to tackle the growth of infections of COVID-19 and would facilitate proper public transportation management post lockdown. Once the lockdown ends, there needs to be elaborate planning to manage all the people using public transport as offices, factories, etc. will start functioning. So, to ensure everyone's well-being and safety, we are introducing an intelligent post-lockdown management system for public transport which will help in avoiding over occupancy of public transport and will help people to maintain social distancing which will lower their risk of getting infected by COVID-19. In our application, we will have ticket allocation based on the urgency of the purpose of travel; this will help the doctors and other health workers get to their destination in time as in tough times of the COVID-19 pandemic, these people hold the highest priority. Through our ticket booking system, we will try to reduce the transit time for users as much as possible thus saving time and comparatively reducing the risk of the individual getting infected. We will also strive to avoid over-occupancy of the public vehicles and ensure social distancing by allowing the commuters to board only the allowed seats as available seats would be arranged in a pattern to facilitate social distancing. All the money transactions would be done through e-currency, thus reducing the chances of infection being spread through physical currency. We also have a strong ticket validation system aligning with the basic guidelines to allow only people with precautions to board the bus.

In the future scope, we will implement the neural network, reinforcement learning, on this platform to automatically categorize the type of passengers.

Table 3 Comparison of the proposed COVID-19 TravelCover with the state-of-art methods

Applications	Parameters					
	Social distancing	Mask detection	Location record	Shortest route	Priority assignment	Simplicity
MOOVIT [6]	NA	NA	√	√	NA	√
TRANSIT [17]	NA	NA	√	NA	NA	√
GoTo [9]	NA	NA	√	NA	NA	√
SOCIAL DISTANCING APP [23]	√	NA	√	NA	NA	√
MASK DETECTOR [1]	NA	√	NA	NA	NA	√
Coready [24]	√	NA	√	NA	NA	√
COVID-19 TravelCover	√	√	√	√	√	√

Acknowledgments We would like to acknowledge the "IBM Hack Challenge 2020" for providing the platform and cloud services and also for providing a problem statement for implementing this idea. This project is selected and implemented under the mentor's supervision in the hackathon and we strive to come up with better ways of practical implementation of our idea, thus promising a broader future scope.

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