

Interactive Dashboard to Monitor the COVID-19 Outbreak and Vaccine Administration

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Abstract

Dashboards are the most common visualization method for displaying COVID-19 data and informing the public. We examined 15 different dashboards to see how various visualization techniques were used. This paper describes the creation and implementation of a dashboard for COVID-19 epidemic and vaccination administration data in Sri Lanka.

Keywords: Visualization, multiple time series, heatmap, COVID-19 vaccine, flexdashboard

1 Introduction

COVID-19 has expanded over the globe, having a significant impact on our daily lives and work. Early responses and timely decisions and actions are critical to saving communities and economies worldwide. Data is essential in order to make effective decisions. Data-driven information guides the decision-making process and also evaluates the effectiveness of strategies taken.

Massive amounts of data are being generated in the response to the COVID-19 pandemic. Given this available data, it is critical to create tools for exploratory analysis for policymakers, health officials, and the general public. Dashboards are one of the greatest visual interpretation methods for tracking the COVID-19 pandemic's spread and vaccine administration. Dashboards allow users to quickly interact with a combination of exploratory visualizations and gain a quick overview of the data. This paper describes the development and implementation of a dashboard for the COVID-19 outbreak and vaccine administration data in Sri Lanka.

There are a plethora of COVID-19 visualization dashboards that have been designed to visualize the pandemic's global and local status. Different software can be used to generate dashboards. We explored 15 dashboards designed to visualize COVID-19 data at the global and country levels. First, dashboards were compared to identify the various features, visualization approaches, and enhancements that should be implemented. Next, we developed an interactive dashboard to visualize the COVID-19 outbreak and vaccination information in Sri Lanka. This dashboard provides front-line health officers a situational awareness of the spread of COVID-19 and the status of the vaccination program.

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The rest of the paper is organized as follows: Section 2 of dashboards created using data related to the COVID-19 pandemic. Section 3 presents the methodology and basic design concept; Section 4 presents the results; and Section 5 concludes.

2 Literature Review

Dashboards are one of the best visual interpretation methods for tracking the spread and communication of the COVID-19 pandemic. The 15 dashboards we used in the literature survey are listed in Table 1. We compared dashboards to identify data types, plotting techniques, colour themes, and other features such as interactivity on plots and panel numbers.

Table 01: Labels of the dashboards

No	Name of the Dashboard	Reference
1	COVID-19 dashboard created by the John Hopkins University Center for Systems Science & Engineering (JHU CSSE)	“COVID-19 Map – Johns Hopkins Coronavirus Resource Center” (2022)
2	WHO COVID-19 Dashboard	“WHO Coronavirus (COVID-19) Dashboard” (2021)
3	COVID-19 surveillance dashboard created by the University of Virginia	“COVID-19 Surveillance Dashboard – NSSAC Research” (2022)
4	Corona cases (COVID-19) per municipality in Belgium dashboard	“COVID 19 Dashboard – Belgium” (2022)
5	COVID-19 dashboard for England created by NHS providers	“COVID 19 Dashboard – NHS providers” (2022)
6	NZ COVID-19 Dashboard	“New Zealand COVID-19 Surveillance Dashboard” (2021)
7	Pakistan’s official COVID-19 dashboard	“Pakistan’s Official COVID-19 Dashboard – Shifa International Hospitals Ltd” (2021)
8	COVID-19 Canada live dashboard	“Track COVID-19 Across Canada Using Our Interactive Dashboards” (2021)
9	India (COVID-19) Dashboard	“COVID 19 Dashboard India – ZOHO Analytics – ZOHO” (2022)

No	Name of the Dashboard	Reference
10	Italy COVID-19 dashboard	“COVID-19 integrated surveillance data in Italy – EpiCentro” (2022)
11	Jamaica COVID-19 Dashboard	“COVID-19 Jamaica - Ministry of Health and Wellness” (2021)
12	GCI COVID-19 dashboard for Russia	“The Global COVId-19 Index (GCI) – Russia Dashboard – PEMANDU Associates” (2021)
13	COVID-19 live situation analysis dashboard of Sri Lanka	“COVID-19: Live situational Analysis Dashboard of Sri Lanka” (2022)
14	COVID 19 ZA South Africa Dashboard	“COVID-19 ZA Dashboard - Data Studio” (2021)
15	COVID-19 dashboard for Germany	“RKI COVID-19 Germany – ArcGIS Experience” (2021)

Table 02 summarizes the data types that are most frequently shown in dashboards. As shown in Table 02, all dashboards which are considered in this paper represent the data related to COVID-19 confirmed cases, recovered cases, and deaths. There were 8 dashboards out of 15 dashboards that contained vaccination details.

Table 02: Summary of data represent in the dashboards

Name of the Dashboard	Location (Represented)	Confirmed Cases	Recovered Cases	Deaths	Vaccination Details	Tests	Global Comparison
1	Global	✓	✓	✓	✓		✓
2	Global	✓	✓	✓	✓		✓
3	Global	✓	✓	✓		✓	
4	Belgium	✓	✓	✓			
5	England	✓	✓	✓	✓		
6	New Zealand	✓	✓	✓			✓
7	Pakistan	✓	✓	✓		✓	
8	Canada	✓	✓	✓			
9	India	✓	✓	✓	✓		✓
10	Italy	✓	✓	✓		✓	
11	Jamaica	✓	✓	✓	✓		
12	Russia	✓	✓	✓			
13	Sri Lanka	✓	✓	✓		✓	✓
14	South Africa	✓	✓	✓	✓	✓	

Name of the Dashboard	Location (Represented)	Confirmed Cases	Recovered Cases	Deaths	Vaccination Details	Tests	Global Comparison
15	German	✓	✓	✓	✓		

Table 03 highlights the dashboard visualization techniques. Value boxes have been utilized to display total figures on practically every dashboard. The most common ways of visualizing confirmed cases, recovered cases, deaths, and immunization details are bar charts and line charts (trend lines). The majority of dashboards displayed data on a daily or weekly basis. The spatial distribution of COVID-19 cases by country, province, regional, and other factors is tracked using choropleth maps. When visualizing the data by the map color code system, circles with respect to the size of the cases have been used to visualize the variation in size. Several dashboards use doughnut-shaped pie charts to indicate total COVID-19 confirmed cases, recovered cases, active cases, and deaths as a proportion. Furthermore, region, gender, age group, and ethnicity can be identified as common breakdowns of COVID-19 cases. Data tables for representing cases' distribution by province/region have been added to some dashboards. Very few dashboards have been visualized in the COVID-19 test details. Only 6 dashboards have been compared to global situations. In addition, the fatality rate, incidence rate, ICU beds, stage of the patients, and hospitalized details have been contained in the several dashboards.

Table 03: Summary of tools which are used for different purpose

Purpose	Bar chart	Line chart	Pie chart	Dot plot	Heat map	Mapping	Data table
COVID-19 confirmed cases	✓	✓		✓		✓	✓
COVID-19 deaths	✓	✓				✓	✓
COVID-19 recovered cases	✓	✓				✓	✓
COVID-19 vaccination		✓				✓	✓
COVID-19 test conducted	✓	✓					
Clinical status	✓						
Cases distribution by age	✓		✓				
Cases distribution by gender	✓						
Cases distribution by area (Province/state/region)	✓	✓			✓	✓	✓
To compare the cases				✓			
Global comparison	✓	✓				✓	✓

2.1 Comparison of Dashboards

Before developing a dashboard, it is necessary to think about which visualization tools and features should be contained in the dashboard. What are the most suitable plots, how many panels in the dashboard, what data should be included, how to fit the dashboard on a screen, colors, and is it real time updated or not are the common things that should be considered before developing the dashboards. Table 4 summarizes information under the following categories:

- i. Number of panels - How many panels are included in the dashboard.
- ii. Visualization tools – what are the graphical representations of data.

- iii. Fitted on a single screen – whether the dashboard fits on a single screen or not (users can see the whole dashboard on a single screen without adjusting through grid overlay or not).
- iv. Color theme – is there a unique color used for one data type in the whole dashboard (i.e.: one color scale for one data type everywhere on the dashboard).
- v. Dark background – the background color of the dashboard is dark or light.
- vi. Data available – whether users can download or whether data is available to reproduce the results.
- vii. Real time updated – whether the dashboard is updated daily/ specific time (live dashboard) or not.

Table 04: Comparison of visualization tools and features of dashboard

Name of the Dashboard	Number of panels	Visualization tools	Fitted on a single screen	Color theme	Dark background	Data available	Real time updated
1	1	Bar chart Interactive map	✓	✓	✓	✓	✓
2	4	Line chart Interactive map Data table		✓		✓	✓
3	2	Line chart Bar chart Interactive map Data table	✓	✓	✓	✓	✓
4	1	Line chart Bar chart Pie chart Interactive map	✓		✓	✓	✓
5	1	Line chart Bar chart Data table		✓		✓	✓
6	5	Line chart Bar chart Dot plot Interactive country map				✓	✓
7	1	Line chart Bar chart Country map Data table		✓			✓

Name of the Dashboard	Number of panels	Visualization tools	Fitted on a single screen	Color theme	Dark background	Data available	Real time updated
8	3	Line chart Bar chart Data table Interactive map			✓		✓
9	3	Line chart Bar chart Doughnut shape pie chart Data table Interactive country map		✓		✓	✓
10	2	Bar chart Doughnut shape pie chart Heat map Interactive country map					✓
11	1	Line chart Bar chart Doughnut shape pie chart Data table Interactive country map		✓			✓
12	1	Line chart Bar chart Interactive map		✓	✓		✓
13	1	Line chart Bar chart Doughnut shape pie chart		✓			✓

Name of the Dashboard	Number of panels	Visualization tools	Fitted on a single screen	Color theme	Dark background	Data available	Real time updated
14	2	Line chart Bar chart Interactive Country map		✓		✓	✓
15	1	Line chart Bar chart Data table Interactive map	✓	✓	✓		✓

As listed in Table 4, on almost each and every dashboard, line charts and bar charts have been used to visualize the data. The heat map and dot plot were only used on one dashboard. Only four dashboards have been fitted with a single screen. The majority of dashboards use a color theme on the whole dashboard. That is, dashboards have been applied with different colors for different types of data (i.e., one specific color for confirmed cases, another color for deaths, etc.) across the whole dashboard. The data set and related links are available on some dashboards, and users can download these data sets. There are 6 dashboards with a dark background, while others have a light background. The last updated time and date of the latest available data has been reported at the top or bottom of the first panel in the dashboard. Half of the dashboards included all the information in a single panel.

3 Methodology

3.1 Data

We obtained data from COVID-19 situation reports published by the Epidemiology Unit, Ministry of Health Sri Lanka. The data includes the number of death cases, number of hospitalized cases, number of recovered cases, and COVID-19 vaccinated counts in Sri Lanka. The data is made available through an open-source R package covid19srilanka (Talagala 2021).

3.2 Design and development

R software was used for data cleaning and analysis. The flexdashboard (Iannone, Allaire, and Borges 2020) package was used to build the data visualization dashboard. The initial layout for the dashboard was prepared based on Krispin (2021). Data visualizations are generated using the ggplot2 ([ggplot2?](#)) and plotly (Sievert 2020) packages in R. We used color-blind friendly color palettes for the graphics. A diverging colour palette was used to represent qualitative data, and to represent numeric variables, a sequential colour theme was used. Table 5 provides an overview of methods that have been used to visualize data.

Table 5: Data visualization approaches used to visualize data

Data	Type of graphics
Daily COVID-19 confirmed	Time series plots

Data	Type of graphics
Daily COVID-19 recovered cases by time	Time series plots
Daily COVID-19 death cases by time	Time series plots
Total COVID-19 confirmed cases by time and wave	Time series plots annotated with vertical lines to denote significant milestones
Total COVID-19 death cases by time and wave	Histogram
Distribution of COVID-19 patients by districts	Tree map, Choropleth maps, Dorling Cartogram, heatmaps
Total vaccination by first dose and second dose	Time series plot
Total administrated does by vaccine name	Stacked bar chart
Total administrated does by vaccine name	Stacked bar chart
Total administrated does by vaccine name	Stacked bar chart
Comparison of cases with in Sri Lanka with Top 10 countries	Cummulative cases by time, Log of cummulative cases by time, stacked bar chart
Spread of COVID-19 around the world	Choropleth maps

We now describe the novel visualization approaches we included in our dashboard. To effectively distribute the vaccine and to support situational awareness and inform policymakers' decision-making, it is important to know the district-wise spread of COVID-19 cases. We have daily COVID-19 data related to confirmed cases in all 25 districts in Sri Lanka. This structure generates a multiple time series collection. Visualizing this time series data is useful to identify similarities and dissimilarities between districts and their general trends. There are two approaches to visualizing these time series: (i) creating individual time series plots for each district (as shown in Figure 1-A), and (ii) plotting all time series on a single panel at the same time (as shown in Figure 1-B). Plotting all time series simultaneously is also not possible due to overlapping time series and scale differences. Plotting separate panels for each district is not effective. The reason is that it is hard to compare across 25 different panels at once. In order to overcome these problems in multiple time series visualization, we use heat maps (Peng (2008)) to visualize global and local similarities and dissimilarities across districts. The associated results are shown in Figure 2. Here, two heatmaps are used to show the global variations (Figure 2: A) and local variations (Figure 2: B) in the time series collection. Figure 2-A cell colours represent the actual counts of the COVID-19 confirmed cases. This is useful to get an idea of the differences in absolute values. Figure 2-B cell colors represent the normalized values created by applying the min-max transformation. A Min-max transformation is applied to each district's time series by using the corresponding district's minimum and maximum value. This helps us to get an idea about patterns within districts. For example, according to Figure 2A, we can see that in Colombo, Gampaha, and Kalutara districts, COVID-19 cases are significantly higher than in other districts. According to Figure 2B, all districts show an increasing trend pattern as the right-hand side of the cells are lighter than the left-hand side cells in the heat map. Furthermore, according to Figure 2B, all districts reported a high number of cases on August 19, 24, and 29, 2021. Figure 3B is useful for identifying these local outlying behaviors. As shown in Figure 4, we also use a Choropleth map and Dorling cartogram to visualize the spatial distribution of COVID-19 cases. The vaccination information is visualized through interactive time series plots and bar charts.

The source code to reproduce the results are available in a public GitHub repository and can be accessed

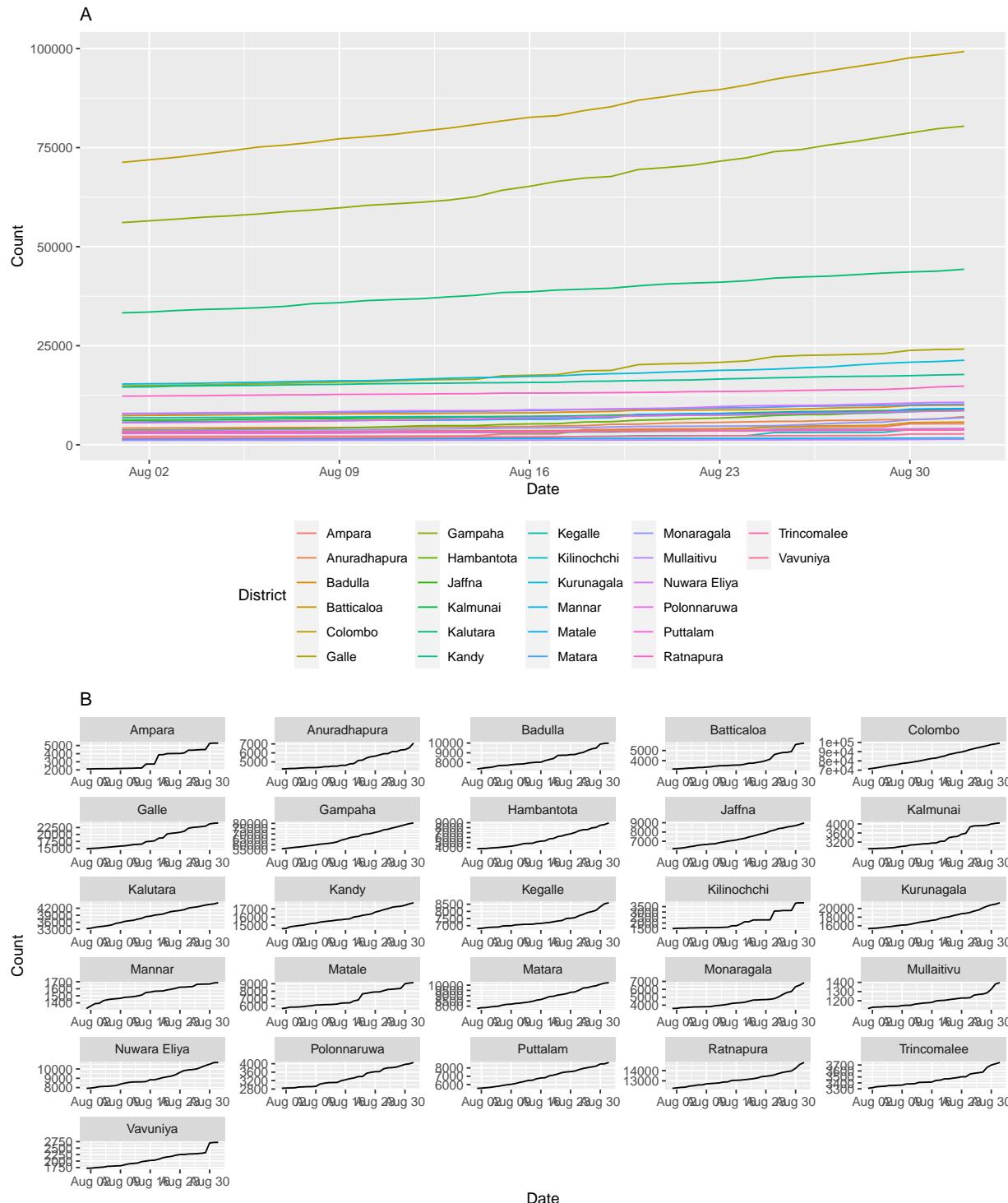


Figure 1: Distribution of COVID-19 cases by districts: (A) Plotted on a single panel, (B) Plotted on separate panels.

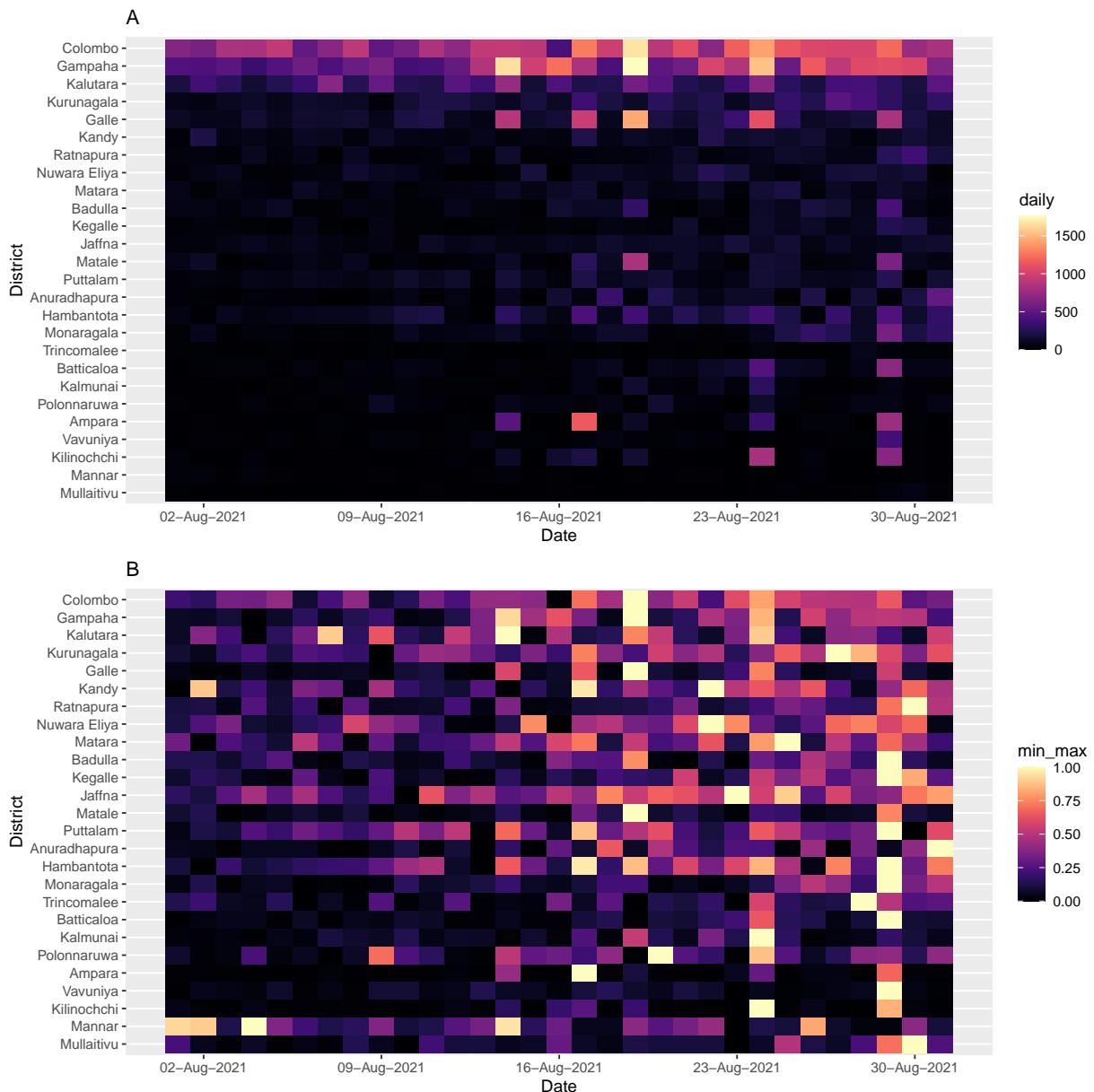
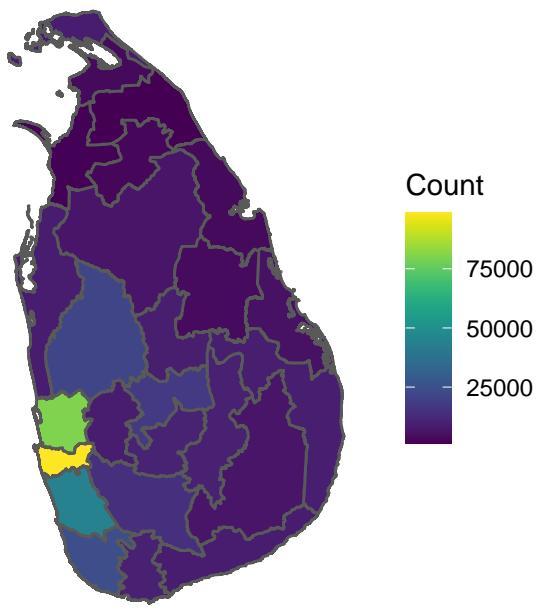


Figure 2: (A) Global view of distribution of COVID-19 cases by districts, (B) Local view of distribution of COVID-19 cases by districts

A: Choropleth map



B: Dorling cartogram

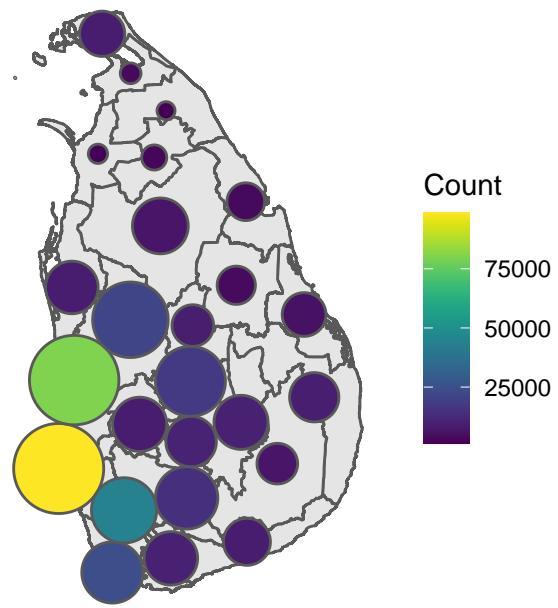


Figure 3: Spatial distribution of COVID1-19 cases by districts

4 Results

The “Sri Lanka COVID-19 Dashboard” provides an overview of the COVID-19 pandemic and administration of vaccine information in Sri Lanka. This dashboard has eight panels as listed in Table 6.

Table 6: Description of the panels

Name of the Panel	Description of the Panel	Figure
Overview	<p>Total count of COVID-19 confirmed, recovered, deaths, active cases and total vaccine doses administered.</p> <p>Provide an overview of daily COVID-19 confirmed, recovered & deaths by plots.</p>	Figure 4
Cases by Wave	<p>There are three tabs in this panel.</p> <ul style="list-style-type: none"> * Total COVID-19 confirmed cases - Cumulative count of COVID-19 confirmed cases with specific dates * COVID-19 Cases Distribution by Wave - Daily confirmed cases by wave * COVID-19 Deaths Distribution by Wave - Daily deaths by wave 	Figure 5
COVID-19 Patients Distribution	<p>Provide an overview of confirmed cases district wise distribution. There are four tabs in this panel.</p> <ul style="list-style-type: none"> * Total COVID-19 Patients Distribution in Sri Lanka - Total confirmed counts for each district is represented by tree map * Country Map - Total confirmed cases in each district represented by Sri Lanka country map * Distribution of Daily COVID-19 Patients for Last 30 Days - Visualize the daily confirmed cases distribution by districts in last 30 days * By Applying Min-Max Transformation - Visualize the details in the third tab by applying min-max transformation for each district 	Figure 6
Vaccination Details	<p>Provide an overview of COVID-19 vaccination in Sri Lanka. There are two tabs.</p> <ul style="list-style-type: none"> * Total Vaccine Doses - Visualize the administered vaccine doses as first dose only & fully vaccinated * Total Administered Doses by Vaccine Name - Visualize the vaccination by vaccine names 	Figure 7
Top 10 Countries	<p>In this panel, compare the Sri Lanka confirmed & deaths with top 10 countries in the world (top 10 countries - The countries which have been reported highest number of confirmed cases as 31st of August 2021).</p> <p>There are two tabs.</p> <ul style="list-style-type: none"> * Comparison of Cumulative Cases in Sri Lanka with Top 10 Countries - Compare the confirmed and deaths in Sri Lanka with top 10 countries by cumulative time series plots * Comparison of Log of Cumulative Cases in Sri Lanka with Top 10 Countries - Compare the confirmed and deaths in Sri Lanka with top 10 countries by log cumulative time series plots <p>(The data has been pulled from WHO)</p>	Figure 8

Name of the Panel	Description of the Panel	Figure
Global Comparison	Compare the total confirmed & deaths in Sri Lanka with top 10 countries in Global & Asia. There are two tabs. * Comparison of the Sri Lanka with Top 10 Countries Reporting the Most COVID-19 Cases in the World - Compare the total confirmed & deaths in Sri Lanka with top 10 countries in the world & compare the case fatality ratios * Comparison of the Sri Lanka with Top 10 Countries Reporting the Most COVID-19 Cases in the Asia - Compare the total confirmed & deaths in Sri Lanka with top 10 countries in the Asia & compare the case fatality ratios	Figure 9
Global Map	Visualize the distribution of confirmed, recovered & deaths in the world by world map.	Figure 10
About	This panel contains the details about the dashboard.	Figure 11

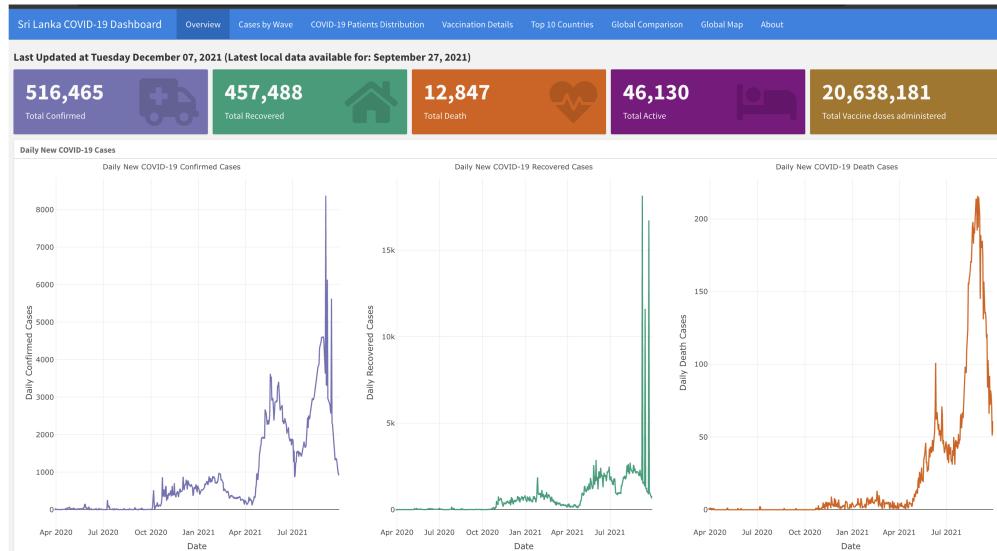


Figure 4: Screenshot of panel 1: Overview

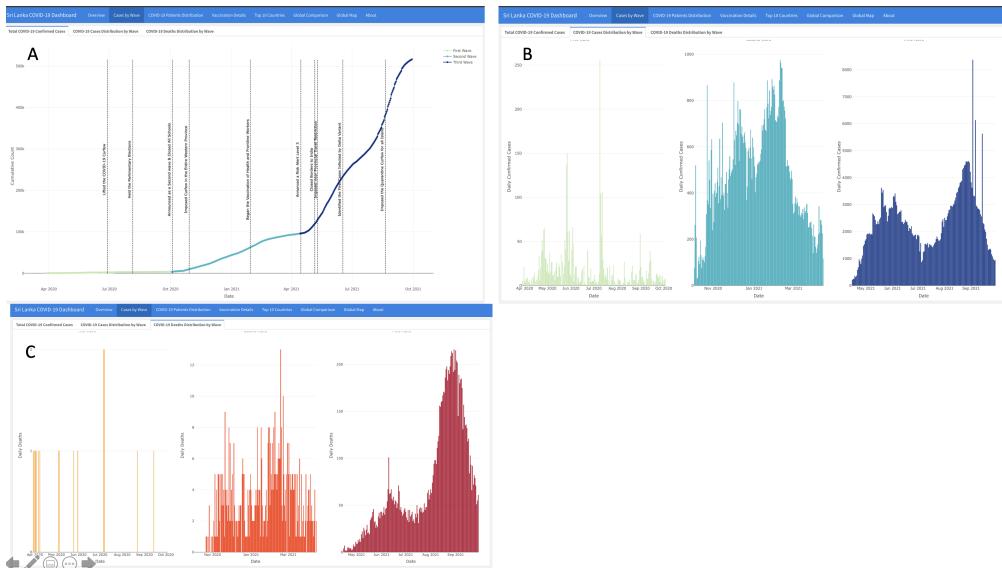


Figure 5: Screenshot of panel 2: Cases by Wave



Figure 6: Screenshot of panel 3: Distribution of COVID-19 Patients

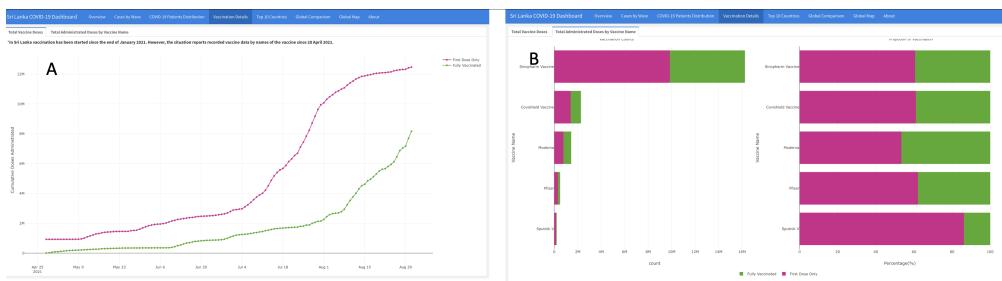


Figure 7: Screenshot of panel 4: Vaccination Details

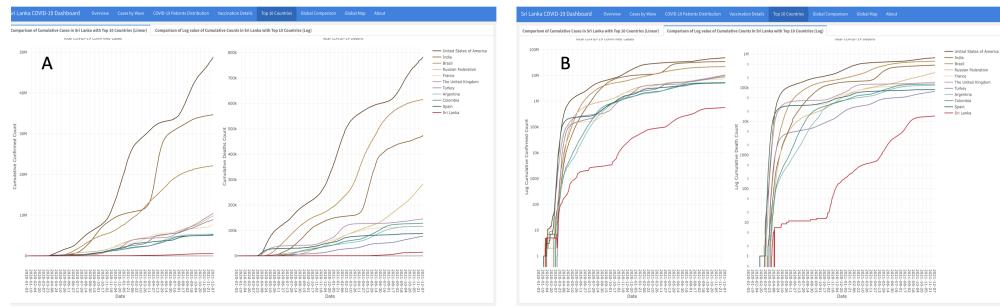


Figure 8: Screenshot of panel 5: Comparison with Top 10 Countries

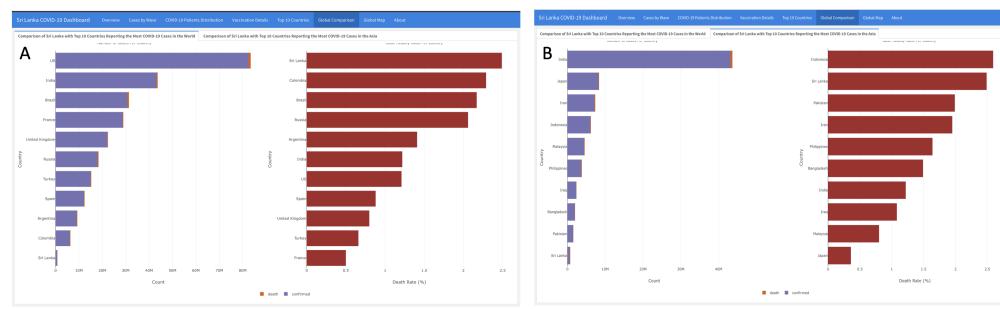


Figure 9: Screenshot of Panel 6: Global comparison

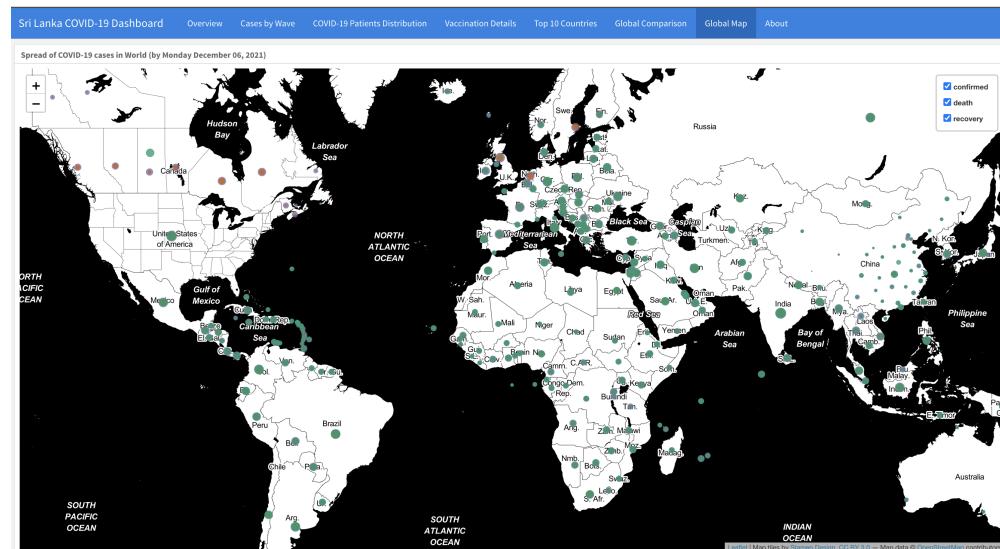


Figure 10: Screenshot of panel 7: World Map

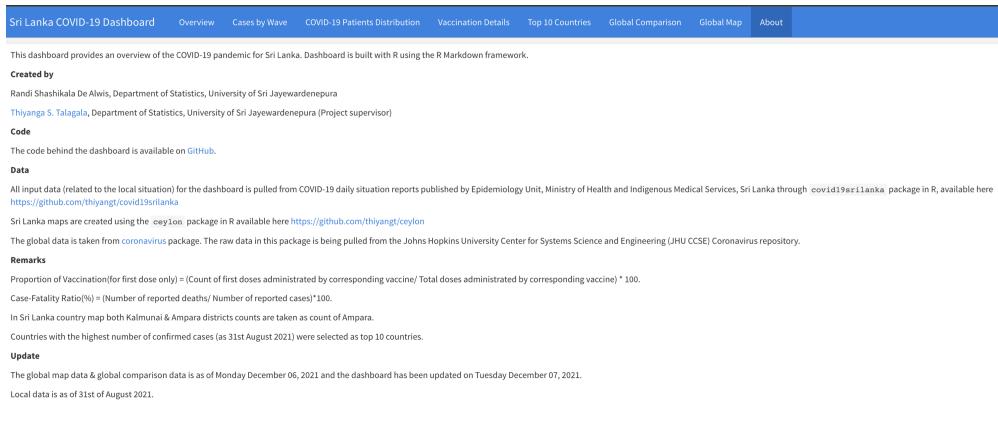


Figure 11: Screenshot of panel 8: About

5 Discussion and Further research

Bar charts and line charts are the most frequently used tools for the visualization of total cases, daily cases, and weekly cases. and comparisons with respect to time. Some dashboards contained doughnut-shaped pie charts to summarize the total figures. In almost every dashboard, value boxes have been used to represent total figures. Some dashboards contained interactive maps and data tables to visualize the distribution of cases by country, province, region, or state. All dashboards are updated daily in real time. Gender, age groups, and ethnicity can be identified as common breakdowns. Most data sets and related links are available.

We used a color-blind-friendly theme when creating our dashboard. The dashboard includes both static and interactive charts that can be used for explanation, exploration, and display. The data speaks to us, but it is not always easy to understand in what language they are doing it. Hence, we examine the same data under different angles using different types of plots. We do not have district-wise vaccination details. We do not have vaccination information per district. We'll save this for later. Our dashboard is completely replicable. The source code for reproducing the results is accessible in a public GitHub repository at <https://github.com/thiyangt/covid19srilanka>.

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