

Interactive dashboard to monitor the COVID-19 outbreak

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Abstract

As of September 20th, 2021, 221 countries and territories are infected by the COVID-19 worldwide pandemic. Dashboards are the most often used visualization method for visualizing COVID-19 data and informing the public. The main objective of this study is to identify different features, visualization methods & improvements that should be occurred by exploring the existing dashboards and to develop a dashbored to visualize COVID-19 outbreak in Sri Lanka. We explored 15 different dashboards. The most commonly used visualization methods in dashboard development are bar charts, line charts, and interactive maps. Dashboards that fit on a single screen are preferable than others.

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

1 Introduction

The COVID-19 pandemic is a global coronavirus illness outbreak that began in 2019 and is being caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) virus. In December 2019, the first COVID-19-infected patient was discovered in Wuhan, China. According to Worldmeter data, there were 229835231 confirmed cases, 206515718 recovered cases, 18605877 active cases, and 4713636 deaths worldwide as of September 20, 2021. Currently, 99.5 percent of active patients are in a mild state, while 0.5 percent are in a critical state.

Dashboards are one of the greatest visual interpretation methods for tracking the COVID-19 pandemic's spread and communication. 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 in 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 visualized COVID-19 outbreak in Sri Lanka.

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2 Literature Review

Initially 15 dashboards were compared to determine which data types are most frequently shown in dashboards. The 15 dashboards we used in the study are listed below (Table 1).

Table 01: Labeled 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)
10	Italy COVID-19 dashboard	“COVID-19 integrated surveillance data in Italy – EpiCentro” (2022)

No	Name of the Dashboard	Reference
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)

2.0.1 Summary of data representation on dashboards

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	✓	✓	✓	✓	✓	
15	German	✓	✓	✓	✓		

As shown in table 02 all dashboards which are considered in this paper represent the data related to COVID-19 confirmed cases, recovered cases & deaths. There have been contained vaccination details, 8 dashboards out of 15 dashboards. In almost each & every dashboard, value boxes have been used to represent these total figures. Bar charts & line charts (trend lines) are most frequently used to visualize

these data (confirmed cases, recovered cases, deaths & vaccination details) with respect to time. A Majority of dashboards presented data by daily or weekly. The mapping is used to track the spatial distribution of COVID-19 cases by country/ provincial/ regional etc. When visualizing the data by map color code system & circles with respect to the size of the cases have been used to visualize the variation in size. The considerable number of dashboards has been used doughnut shape pie charts to represent total COVID-19 confirmed cases, recovered cases, active cases & deaths as a percentage. Also, region, gender, age group & ethnicity can be identified as common breakdowns of COVID-19 cases. In some dashboard has been added data tables for representing cases distribution by province/region. Only very few dashboards have been visualized in COVID-19 test details. Only 6 dashboards have been compared to global situations. In addition, fatality rate, incidence rate, ICU beds, stage of the patients & hospitalize details have been contained in the several dashboards. These are the most common data types that have been contained in the dashboards. The main tools that have been used for different purpose can be shown in the following table.

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	✓	✓				✓	✓

2.0.2 2.2 Comparison of Dashboards

Before developing a dashboard, it is necessary to think about which visualization tools & features that should be contained in the dashboards. What are the most suitable plots, how many panels in the dashboard, what data should be included, how to fit dashboard on a screen, colors & is it real time updated or not are the common things that should be considered before develop the dashboards. In table 02 has been compared these visualization tools & features under the following categories.

- Number of panels - How many panels which are included in the dashboard.
- Visualization tools – what are the graphical representations of data which are contained in the dashboards.
- 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).
- 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).
- Dark background – background color of the dashboard is dark or light.
- Data available – whether users can be downloaded/available the data set which has been visualized on the dashboard.

- Real time updated – whether the dashboard is updated daily/ specific time (live dashboard) or not.

Table 04: Comparison of visualization tools & features of dashboard

Name of the Dash-board	Number of panels	Visualization tools	Fitted on a single screen	Color theme	Dark back-ground	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		✓			✓
8	3	Line chart Bar chart Data table Interactive map			✓		✓

Name of the Dash-board	Number of panels	Visualization tools	Fitted on a single screen	Color theme	Dark back-ground	Data available	Real time updated
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		✓			✓
14	2	Line chart Bar chart Interactive Country map		✓		✓	✓

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

As shown in table 04 almost each & every dashboard, line charts & bar charts have been used to visualize the data. Heat map & dot plot has been used only one dashboard. Only four dashboards have been fitted with a single screen. The majority of dashboards have used color theme on the whole dashboard. That is, dashboards have been applied different colors for different type of data (i.e. One specific color for confirmed cases, another color for deaths, etc.) in the whole dashboard. The data set & related links have available on some dashboards & users can download these data sets. There are 6 dashboards with dark background while others have been used light background. Last updated time & date of the latest available data has been reported at the top or bottom of the first panel in the dashboard. Like, half of dashboards included all data in one panel.

3 Methodology

3.1 Data

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

3.2 Software

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).

3.3 Data visualization

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
Daily COVID-19 recovered cases by time	Time series plots
Daily COVID-19 death cases by time	Time series plots

Data	Type of graphics
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	Tile 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

4 Results

The “Sri Lanka COVID-19 Dashboard” provides an overview of the COVID-19 pandemic for Sri Lanka. This dashboard has eight panels as follows.

Table 6: Description of the panels

Name of the Panel	Description of the Panel
Overview	Total count of COVID-19 confirmed, recovered, deaths, active cases & total vaccine doses administered. Provide an overview of daily COVID-19 confirmed, recovered & deaths by plots.
Cases by Wave	There are three tabs in this panel. * 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

Name of the Panel	Description of the Panel
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
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
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). 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 (The data has been pulled from WHO)
Global Comparison	<p>Compare the total confirmed & deaths in Sri Lanka with top 10 countries in Global & Asia. There are two tabs.</p> <ul style="list-style-type: none"> * 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
Global Map	Visualize the distribution of confirmed, recovered & deaths in the world by world map.
About	This panel contains the details about the dashboard.

In order, to compare patterns across districts min-max transformation is used to normalize data into 0-1 scale.

5 Discussion and Further research

Bar charts & line charts are the most frequently used tools for the visualization of total cases, daily cases & comparisons with respect to time. Some dashboards contained doughnut shape pie charts to summarize the total figures. In almost each and every dashboard, value boxes have been used to represent total figures. Some dashboards contained interactive maps & data tables to visualize the distribution of cases by country, province, region or state. All dashboards are daily updating real time dashboards. Gender, age groups and ethnicity can be identified as common breakdowns. The data sets & related links are available on most of the dashboards & can be downloaded. It can be seen that it is very easy, clear and user friendly to

identify confirmed, recovered and deceased cases in dashboards which include one color theme for the whole dashboard. Dashboards with the dark background are more comfortable to the eyes than dashboards with light background & light colors. Also, it is better if the dashboard can be fitted on a single screen rather than adjusting through a grid overlay.

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7 Appendix: Overview of reviewed dashboard

Real time updated COVID-19 dashboard created by the John Hopkins University Center for Systems Science & Engineering (JHU CSSE) has included total confirmed cases & total deaths by country, province/region/state (not for all countries)[6]. Weekly & daily global confirmed cases, deaths & vaccine doses have been visualized using bar plots related to the date in the side panels. Also, an interactive world map has included in the dashboard to represent total confirmed cases, incidence rate, fatality ratio & vaccine doses administered by country & state of US. All the links related to the data sets has been included in the dashboard. In this dashboard red, white, green colors has been used to indicate confirmed cases, deaths & vaccine doses respectively. The dashboard has fitted on a single screen.



Figure 1: Johns Hopkins University COVID-19 Dashboard

Live updated “WHO COVID-19 dashboard” contained four panels. The interactive world map in the dashboard has visualized the distribution of COVID-19 confirmed cases, deaths & vaccination by country [15]. Line chart & bar charts have been used as visualization plots. Blue, red, green colors have been used to represent confirmed cases, deaths & vaccination respectively. The links related to the underlying data was available in the dashboard. The dashboard was not fitted on a single screen.

The “COVID-19 surveillance dashboard” created by the University of Virginia in collaboration with Bio complexity Institute has included interactive world map with a time slide to visualize the confirmed cases, recovered cases, deaths, active cases & vaccine details [7]. Line charts, bar charts & data tables have been visualized in the dashboard. Red, blue, green & yellow colors have been used to identify confirmed, deceased, recovered & active cases respectively. The data behind the dashboard also available on the dashboard & can be downloaded. The dashboard has fitted on a single screen.

Corona cases (COVID-19) per municipality in Belgium dashboard has included interactive map for distribution of total confirmed cases per municipality, bar chart for number of cases per province, line charts for number of cases per day by region & municipality, dodge bar chart for deaths per region, per age & pie chart for deaths per age as visualization methods[3]. Also it included several value boxes for total cases, total deaths & hospital situations. There was no specific color theme used in this dashboard. This dashboard also fitted on a single screen.

The COVID-19 dashboard for England created by NHS providers included daily totals, daily changes & weekly changes in new cases, hospital admission, patients in hospital, and patients in ICU beds, deaths &

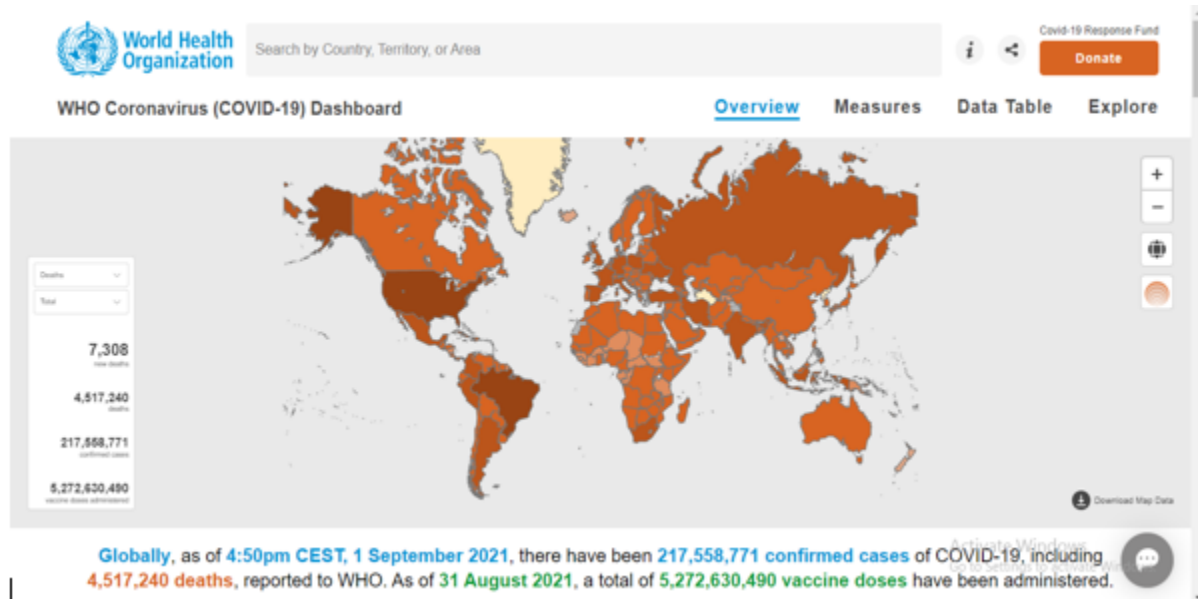


Figure 2: WHO COVID-19 Dashboard

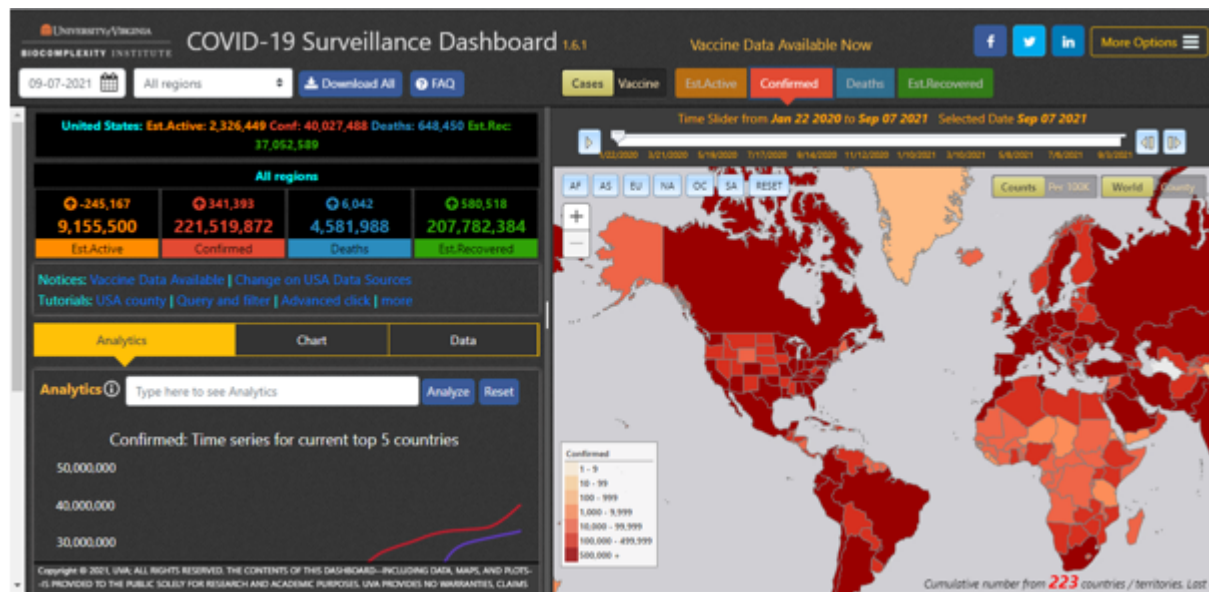


Figure 3: COVID-19 Surveillance Dashboard

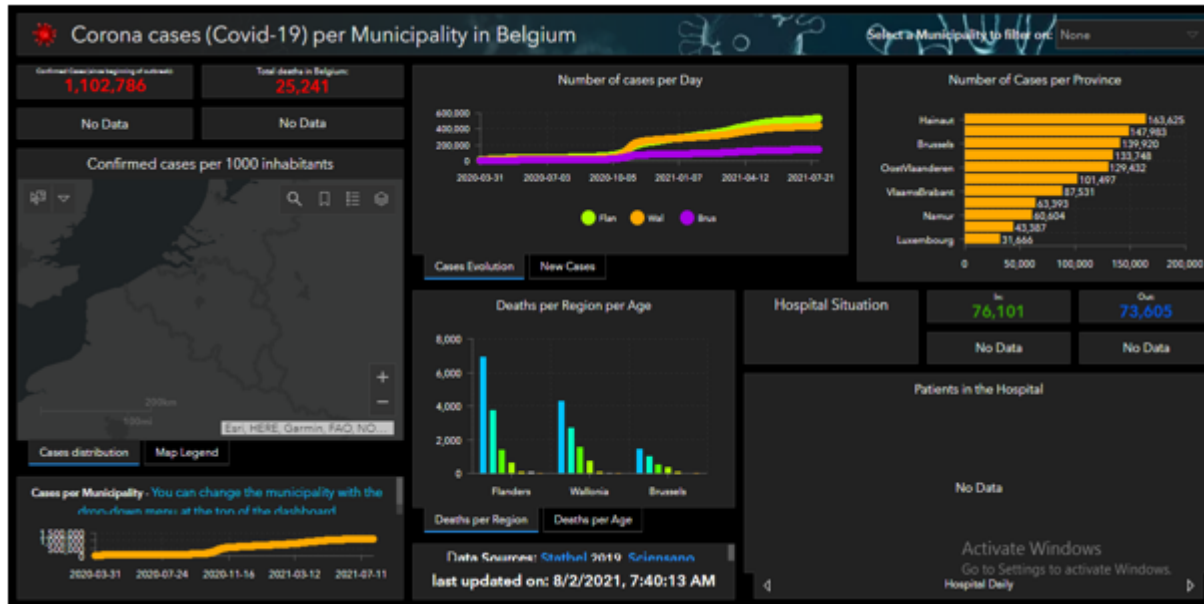


Figure 4: Corona cases per Municipality in Belgium Dashboard

vaccinations in England as counts [2]. Bar plots for daily new cases, hospital admissions & deaths for last 30 days have been added in this dashboard. Also it has included data table for total count, daily changes (as increase or decrease), weekly changes (as increase or decrease) of new cases & hospital admission by region. It can be seen that, three different colors have been used in bar plot as orange for new cases, green for hospital admissions & red for deaths. These plots were not interactive plots & there was only one panel. The dashboard was not fitted on a single screen.

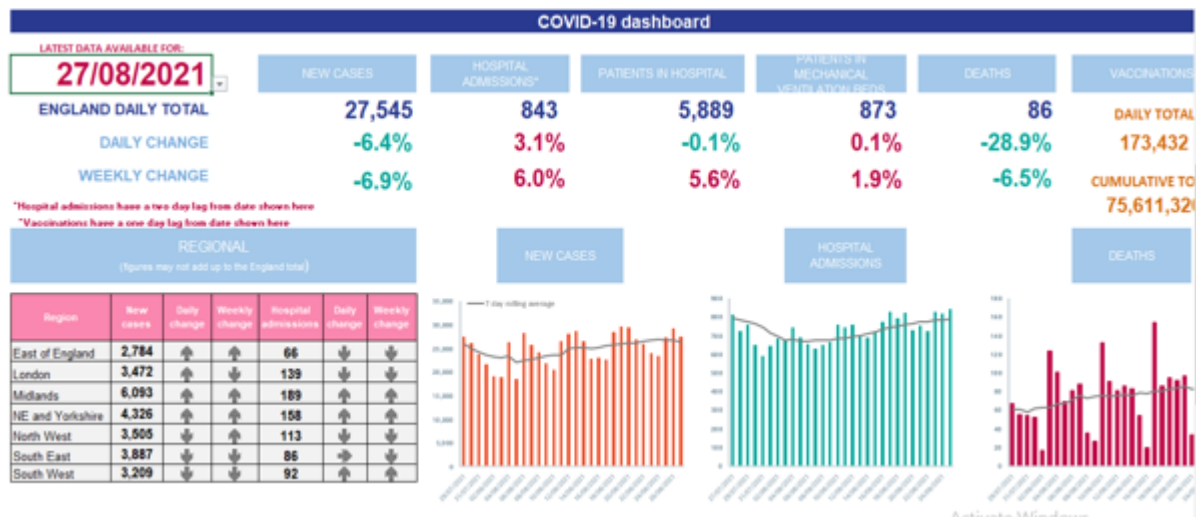


Figure 5: COVID-19 dashboard for England

The Environmental Science and Research Institute COVID-19 dashboard for New Zealand (was developed & is maintained in collaboration with Epi-interactive Ltd) contained five panels as overview, outbreak, source, international & ESR reports [10]. In this real time updated dashboard, they have included value boxes for total confirmed cases, recovered cases, deaths & interactive map has been added for distribution of confirmed & probable cases as incidence & count. Also they have included bar charts for confirmed cases distribution

by gender, age group, & line charts for confirmed & deaths as daily & cumulative. The dashboard has not fitted on a single screen.

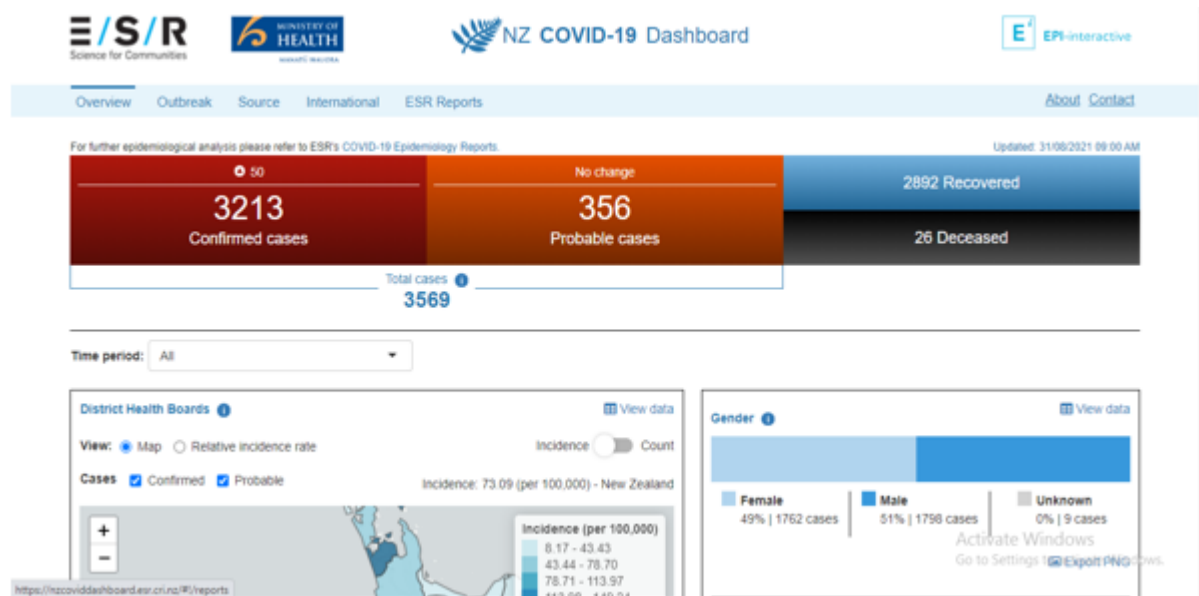


Figure 6: New Zealand COVID-19 Dashboard

Pakistan's official COVID-19 dashboard is a real time updated dashboard with one panel. This dashboard contains value boxes for total confirmed cases, active cases, deaths, recovered cases by country. Province wise cases have been represented by map & data table [11]. Line charts & bar charts have been added to visualize the distribution of cases related to time & province. In the value boxes blue, orange, pink & green colors have been applied for confirmed cases, active cases, deaths & recoveries respectively, but there was no specific color theme used when plotting the graphs. The dashboard cannot be seen on a single screen without grid overlay.

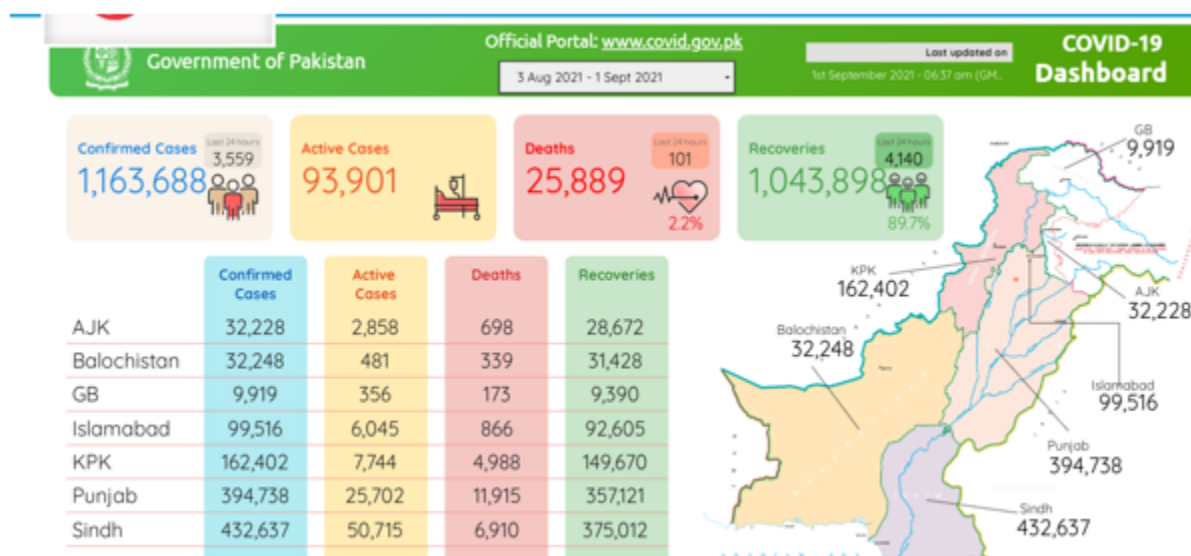


Figure 7: COVID-19 Dashboard for Pakistan

COVID-19 Canada live dashboard has been developed with three panels for provincial data, hospital resources & projections [14]. This dashboard contained interactive map for represented total reported cases & deaths

by province. Data tables, line charts, bar charts were the most frequently used visualization types of this dashboard. More details were presented on this dashboard by province like ventilator counts, hospital beds per 100 residents, resource capacity based on critical case rate, effect of social distance, forecast of deaths & cases. There was no specific color theme applied for plotting the graphs. The dashboard also was not fitted on a single screen.

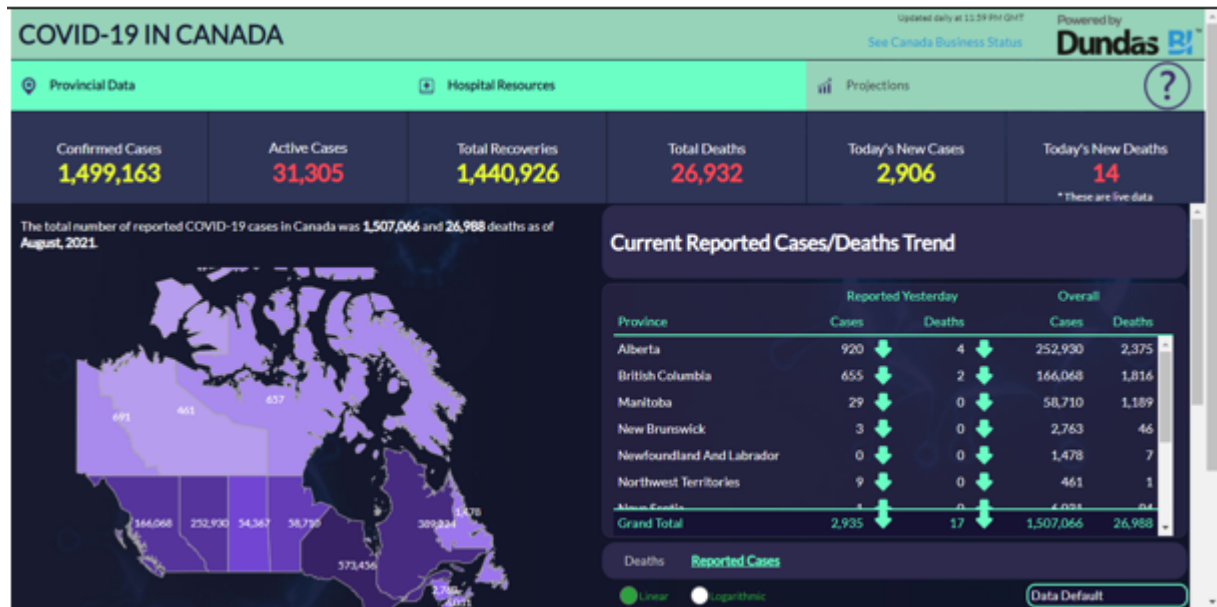


Figure 8: COVID-19 in Canada dashboard

“Zoho analytics COVID-19 live dashboard” for India contained three panels as insight by state, trend analysis & vaccination [1]. Interactive country map has been used to visualize the distribution of confirmed cases, active cases, deaths, recovered cases & vaccination by states in India. Line charts, bar charts & doughnut shape pie charts have been used as other visualization tools. Also this dashboard contained data table for overview of COVID-19 in India. This dashboard also was not fitted on a single screen.

Italy COVID-19 dashboard created by the COVID-19 task force of the department of infection diseases and the IT service Istituto Superiore Sanita, contained interactive map, bar charts, doughnut shape pie charts & heat maps as visualization tools [4]. It provides data related to COVID-19 cases, cases distribution by age, clinical status, and weekly number of cases notified in Italy by region/province. This dashboard also was not fitted on a single screen.

Live COVID-19 dashboard developed & contributed by an amber innovations for the government of Jamaica has added interactive country map & data table to represent the COVID- 19 cases by parish [9]. Line charts & bar charts have been added to the dashboard for cumulative & daily COVID-19 cases. Yellow, green & red colors have been used to represent confirmed, recovered & deaths respectively. Doughnut shape pie chart has been added to represent the distribution of recovered, confirmed & deaths by age group. This dashboard was not fitted on a single screen.

The GCI COVID-19 dashboard for Russia includes an interactive map, bar charts & line charts to visualize the COVID-19 data [13]. Yellow, green, red & blue colors have been added to identify the confirmed, recovered, deaths & active case respectively in plotting the charts.

COVID-19 live situation analysis dashboard of Sri Lanka contains total & daily figures in Sri Lanka as counts [5]. Total cases & active cases have been visualized by using a line chart. Bar charts have been used to summarize the daily confirmed cases and recovered cases. As well fatality rate, recovery rate & daily investigations using PCR tests & rapid antigen tests have been compared by using the bar charts. Doughnut shape pie chart has been used to summarize the total cases. Blue, green & red colors have been applied to active, recovered & deaths respectively. This dashboard was also not fitted on a single screen.

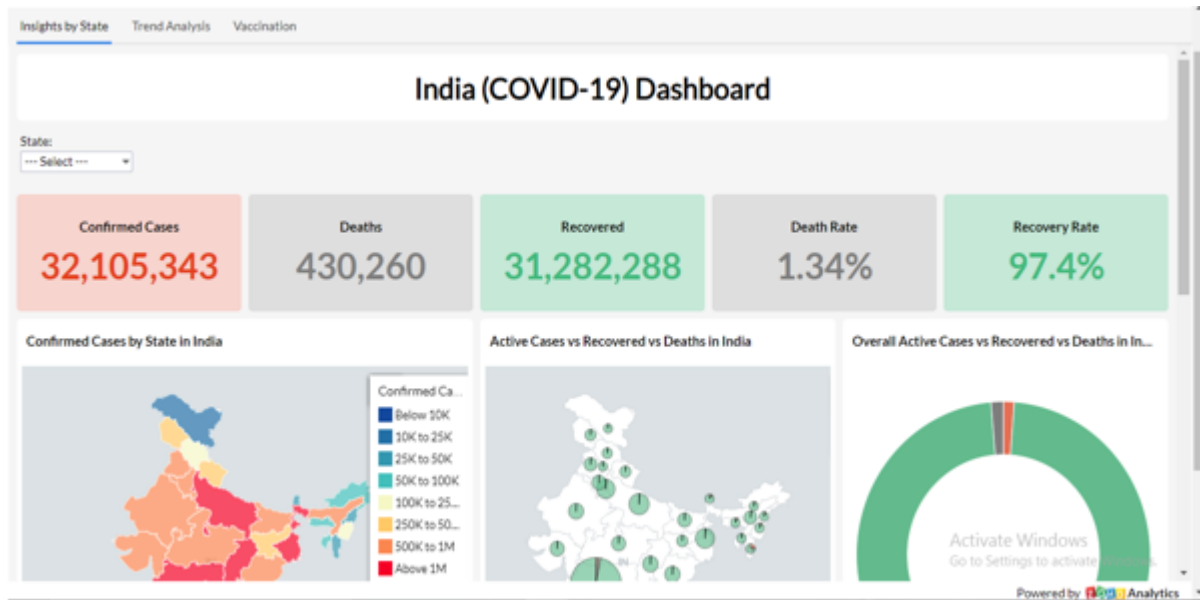


Figure 9: India COVID-19 Dashboard

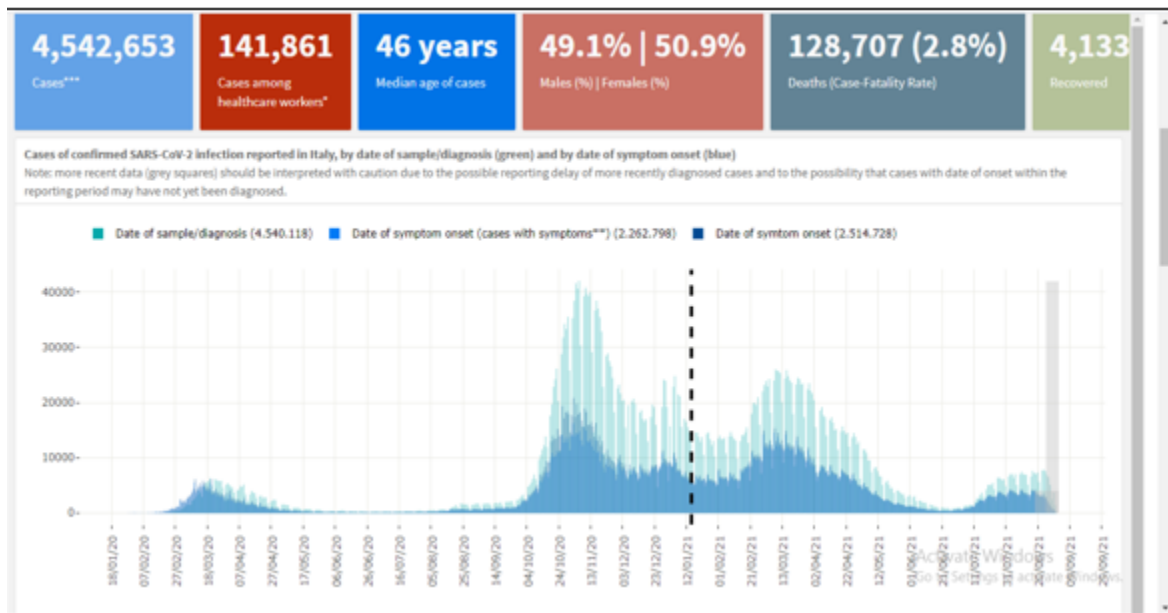


Figure 10: Italy COVID-19 Dashboard

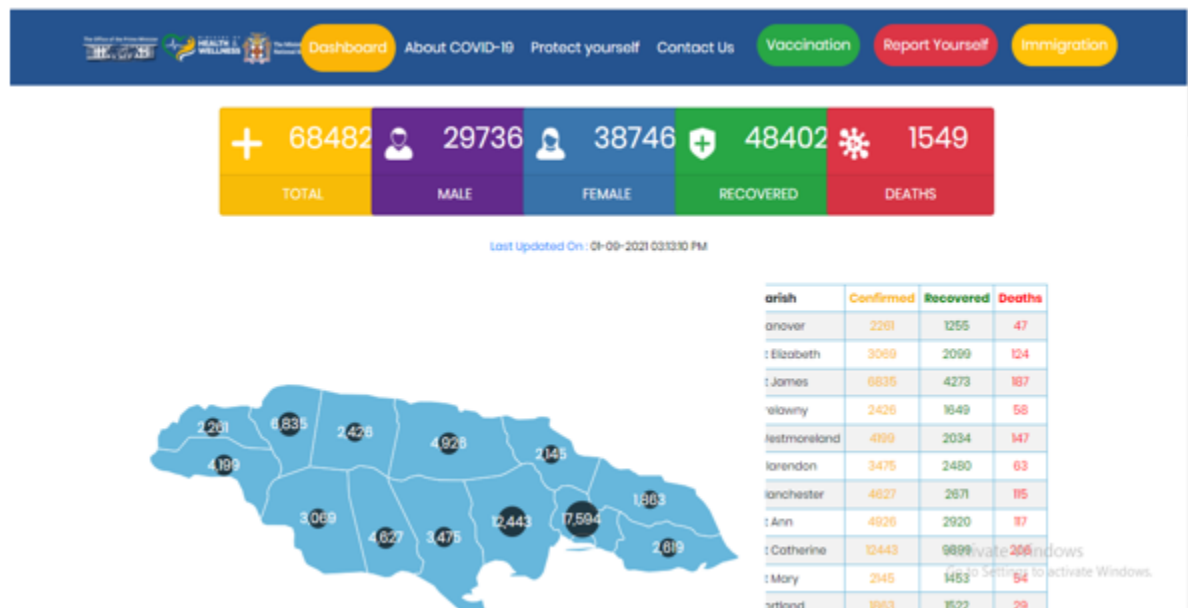


Figure 11: Jamaica COVID-19 Dashboard



Figure 12: GCI COVID-19 Dashboard for Russia

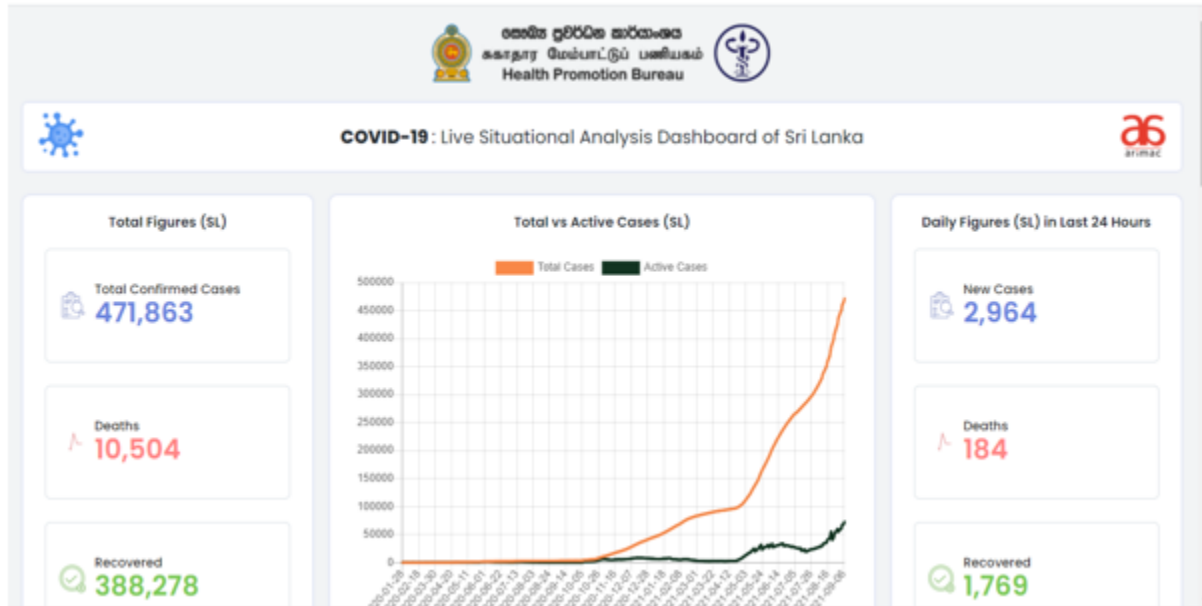


Figure 13: COVID-19 Live Situational Analysis Dashboard of Sri Lanka

COVID-19 live situation analysis dashboard of Sri Lanka contains total & daily figures in Sri Lanka as counts [5]. Total cases & active cases have been visualized by using a line chart. Bar charts have been used to summarize the daily confirmed cases and recovered cases. As well fatality rate, recovery rate & daily investigations using PCR tests & rapid antigen tests have been compared by using the bar charts. Doughnut shape pie chart has been used to summarize the total cases. Blue, green & red colors have been applied to active, recovered & deaths respectively. This dashboard was also not fitted on a single screen.

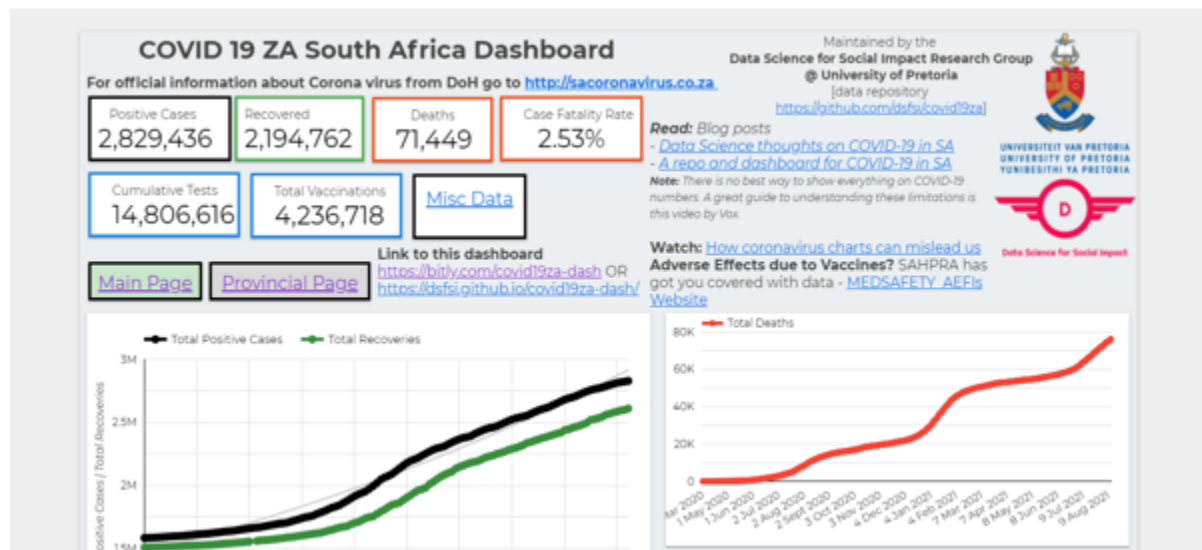


Figure 14: COVID 19 ZA South Africa Dashboard

Robert Koch-Institute COVID-19 dashboard for German contains interactive map, line charts & bar charts as visualization tools of COVID-19 data [12]. The dashboard has been fitted on a single screen. This dashboard format is similar to the John Hopkins dashboard.

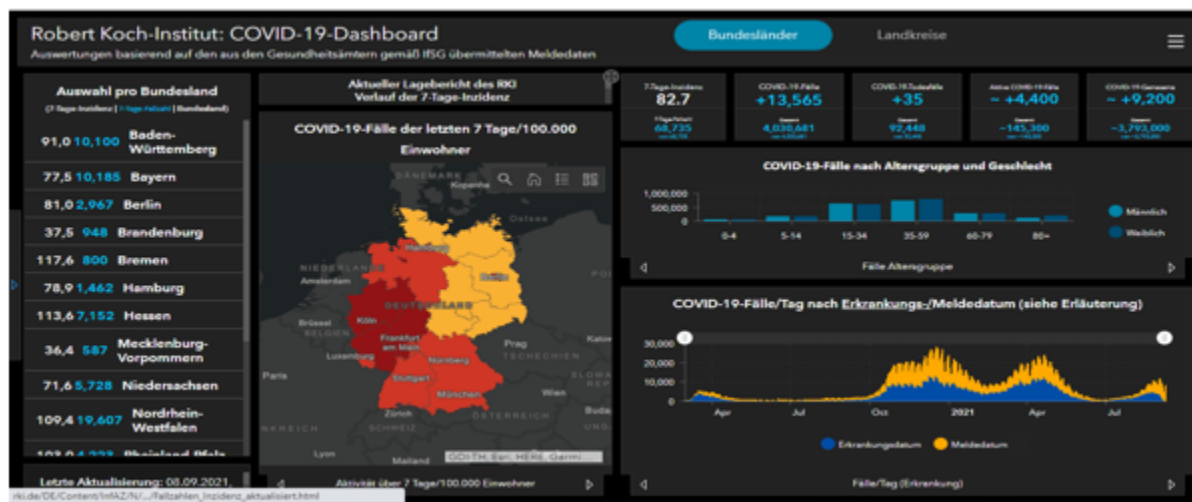


Figure 15: Robert Koch-Institute COVID-19 dashboard for German