

Interactive COVID-19 Dashboard: Case Trends, Vaccination Progress & Forecasting Using R

Shridevi Jeevan Kamble¹, Ravi Shankar D², Nayana Hegde³, Aryalekshmi B N⁴, Deepthi Murthy T S⁵, Anitha Kumari R D⁶

¹Assistant Professor, REVA University, Bangalore India, Email: shridevi.havanoor@gmail.com, Orcid Id: 0009-0002-9435-3888

²Assistant Professor, REVA University, Bangalore India, Email: ravishankard@reva.edu.in, Orcid Id: 0000-0002-5713-7169

³Assistant Professor, REVA University, Bangalore India, Email: nayana.srikanth@gmail.com, Orcid Id: 0000-0001-7467-2553

⁴Associate Professor, HKBK College of Engineering, Bangalore India, Email: aryalks88@gmail.com, Orcid Id: 0000-0003-1823-0237

⁵Associate Professor, REVA University, Bangalore India, Email: deepthiresearch1983@gmail.com, Orcid Id:

⁶Assistant Professor, REVA University, Bangalore India, Email: anithakumari.rd@reva.edu.in

HOW TO CITE:

Shridevi Jeevan Kamble, Ravi Shankar D, Nayana Hegde, Aryalekshmi B N, Deepthi Murthy T S, Anitha Kumari R D, (2026) Interactive COVID-19 Dashboard: Case Trends, Vaccination Progress & Forecasting Using R. International Journal of Special Education, 41(25s), 746-754

COPYRIGHT STATEMENT:

Copyright: © 2026 Authors.
Open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).

ABSTRACT:

The COVID-19 pandemic has highlighted the importance of data monitoring, visualization, and forecasting in supporting public health awareness and decision-making. This study presents an interactive COVID-19 dashboard developed using R to analyse confirmed cases, deaths, and vaccination progress across different countries and regions. Publicly available datasets from Our World in Data (OWID) were used for data preprocessing, exploratory analysis, and visualization. R packages, including tidyverse, ggplot2, plotly, and shiny, were used to develop interactive charts and a user-friendly dashboard. Time-series forecasting was performed using the Autoregressive Integrated Moving Average (ARIMA) model to generate short-term predictions of COVID-19 case trends. The dashboard enables users to explore historical patterns, compare vaccination progress, and examine forecasting results through interactive visualizations. The proposed system demonstrates the application of R-based data analytics and predictive modelling to improve the accessibility and interpretation of public health information. **Keywords:** peacekeeping education; higher education strategy; DEMATEL; analytic network process; mixed methods; defence diplomacy; Indonesia

Keywords: COVID-19 Dashboard; R Programming; Vaccination Analysis; ARIMA; Prophet; Public Health Informatics; Data Visualization; Predictive Modeling; Shiny App; Interactive Analytics

I. Introduction

The COVID-19 pandemic has presented an unprecedented global health challenge, highlighting the importance of effective data

monitoring, analysis, and visualization. Data Science and interactive visualization tools play a significant role in helping researchers, health care professionals and policymakers understand

pandemic trends and support the informed decision-making. The study focuses on developing an interactive dashboard using R to analyse COVID-19 case trend, vaccination progress, and short-term forecast-based on historical data.

The R programming Language, widely used for statistical computing and data visualization, provides a flexible environment for developing interactive analytical applications. The proposed dashboard integrates COVID-19 case statistics and vaccination data to present complex information in an accessible and user-friendly format. It enables user to explore historical trends, compare vaccination progress across regions, and examine potential relationships between vaccination coverage and reported COVID-19 cases. Additionally, time-series forecasting techniques, including the Autoregressive Integrated Moving Average (ARIMA) model, are used to generate short-term predictions of COVID-19 case trends.

Previous studies have demonstrated the importance of interactive dashboards and data visualisation in COVID-19 monitoring and public health decision-making. Marvel et al. [1] developed the Pandemic Vulnerability Index (PVI) Dashboard, integrating multiple indicators with statistical modelling and machine learning to assess COVID-19 vulnerabilities across geographical regions. Similarly, Dixon et al. [2] demonstrated how data visualisation and health information exchange systems can support COVID-19 surveillance and public health responses. These studies highlight the importance of combining data analytics, statistical modelling, and visualisation for pandemic monitoring. Building upon these approaches, the present study integrates COVID-19 case trends, vaccination progress, and ARIMA-based short-term forecasting within an interactive R-based dashboard.

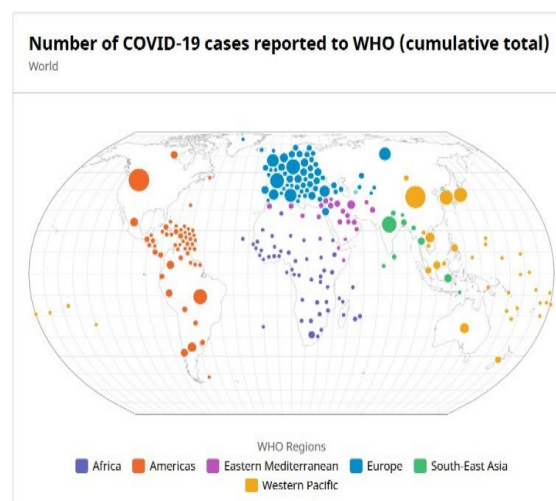


Fig. 1: COVID-19 cases reported to WHO

Figure 1 illustrates the global distribution of cumulative COVID-19 cases reported to the World Health Organization (WHO) across different regions of the world. The bubble map visually represents the severity of the pandemic in various geographical locations, where the size of the bubble corresponds to the total number of reported cases, and the color represents the respective WHO region. Regions such as the Americas and Europe exhibit significantly larger bubbles, indicating a higher cumulative cases burden, while smaller bubbles are observed in regions including Africa and parts of South-East Asia. The visualization highlights geographical variations in reported COVID-19 cases and provides an overview of the pandemic's global distribution. Such geographical representations support the identification of regional differences and help researchers and public health professionals interpret patterns in reported infections.

A. Main R Packages Used

The proposed COVID-19 dashboard was developed using several R Packages that support data preprocessing, statistical analysis, Visualization, forecasting and interactive application development. These packages provide the necessary functionality for processing historical COVID-19 datasets, analysing trends, generating short-term forecasts, and presenting results through an interactive dashboard.

i. tidyverse

the tidyverse is collection of R packages designed for data manipulation, cleaning and visualization. Includes the packages such as dplyr, readr, tidyr, and ggplot2, which support for data cleaning, wrangling, and preparation. Makes data workflows more readable and efficient.

ii. ggplot2

The ggplot2 package is used to create static data visualisations in R. It supports the development of line charts, bar charts, and scatter plots to illustrate COVID-19 case trends, mortality statistics, and vaccination progress over time.

iii. Plotly

The plotly package enables the creation of interactive visualisations with features such as zooming, panning, and hover-based information. It enhances user interaction and facilitates detailed exploration of COVID-19 trends.

iv. Shiny

The shiny package provides a framework for developing interactive web applications using R. It enables the integration of user interface components, reactive programming, and dynamic visual outputs, allowing users to explore COVID-19 data through interactive dashboards.

v. Forecast

The forecast package provides statistical methods for analysing and forecasting time-series data. In this project, the auto.arima() function is used to automatically select an appropriate ARIMA model based on historical COVID-19 case data and generate short-term forecasts of reported cases.

vi. Prophet (optional, complementary to forecast)

Developed by Facebook, prophet is user-friendly and robust for time series forecasting. Handles seasonality and holidays well, making it suitable for epidemic trend modeling.

Purpose and Outcome:**Purpose and Outcome**

The proposed COVID-19 dashboard provides an interactive analytical platform for examining historical trends in confirmed cases, deaths, and vaccination coverage across different countries and regions. It enables users to explore variations in COVID-19 case trends, compare vaccination progress, and investigate potential relationships between vaccination coverage and reported case numbers. The dashboard also incorporates short-term forecasting using the AutoRegressive Integrated Moving Average (ARIMA) model to estimate future trends in reported COVID-19 cases.

By integrating data preprocessing, statistical analysis, interactive visualisation, and time-series forecasting, the proposed system transforms historical COVID-19 datasets into accessible graphical representations and analytical insights. The dashboard supports the interpretation of pandemic trends, facilitates comparisons across regions, and demonstrates the potential application of R-based analytical tools in public health monitoring and data-informed decision-making.

II. Literature Survey

Several studies have explored the application of interactive dashboards and predictive analytics to monitor COVID-19 trends and support public health decision-making. These, study demonstrate the importance of integrating data visualization with analytical techniques to improve the interpretation of pandemic-related information.

Kenigsberg et al. [1] discuss the development of a near real-time COVID-19 vaccine safety surveillance dashboard as part of the U.S. Vaccine Safety Datalink (VSD). The system aggregates weekly health data, including vaccine uptake and adverse effects, across multiple sites. Developed using Tableau and SAS, the dashboard facilitates timely evaluation of over 1,000 statistical analyses weekly. It is designed primarily for internal use by the centers for Disease Control and Prevention (CDC) to monitor safety outcomes and vaccine

coverage with a high degree of granularity.

Zhou and Li [2] introduce an epidemiological forecasting model for predicting the COVID-19 vaccine uptake rate in the United States. Their approach integrates autoregressive models such as ARIMA for clinical data and machine learning techniques—including random forest and support vector machines—for web-based data like Google Trends. The most accurate results were obtained using a stacked regression model combining both data types, demonstrating the value of hybrid forecasting systems in public health planning.

Clement et al. [3] designed an interactive COVID-19 dashboard that integrates trend visualization, analytics, and forecasting using Python libraries like Dash, Plotly, and Pandas. Unlike many existing dashboards that provide static visual summaries, this solution allows dynamic exploration of global and Canada-specific data. It includes forecasting via SARIMAX models and supports real-time updates, highlighting the importance of performance and usability in public dashboards.

Marvel et al. [4] developed the Pandemic Vulnerability Index (PVI) Dashboard to visualize county-level COVID-19 vulnerabilities across the United States. It integrates 12 key indicators ranging from infection rates to healthcare capacity using the ToxPi framework and offers predictive modeling for cases and deaths via Bayesian spatiotemporal models. This work emphasizes the utility of composite indices in identifying at-risk populations and enabling localized interventions.

Dixon et al. [5] leveraged Indiana's statewide health information exchange to develop public and private COVID-19 dashboards tailored for public health agencies. The dashboards integrate data from over 117 hospitals and multiple public health organizations, providing detailed surveillance capabilities. Key metrics include testing positivity rates, estimated recovery, and localized outbreak detection. This initiative underscores the importance of interoperability and collaboration in effective public health

informatics.

Collectively, these studies highlight the importance of interactive visualisation, statistical analysis, and predictive modelling in understanding COVID-19 trends. Building upon the existing literature, the present study focuses on developing an interactive dashboard using R that integrates confirmed case trends, vaccination progress, and ARIMA-based short-term forecasting within a single analytical platform.

III. DESIGN OF PROPOSED SYSTEM

The proposed system is an interactive COVID-19 dashboard developed using the R programming language to visualize and forecast pandemic case trends and vaccination progress in COVID-19. The system follows a modular a layered architecture, consisting of four primary components: data acquisition, processing, visualization, and forecasting, which together enables efficient data handling, real time visualization and predictive analytics. It incorporates time-series forecasting using the AutoRegressive Integrated Moving Average (ARIMA) model to generate short-term predictions of reported COVID-19 cases. The system follows a modular architecture consisting of four primary components: data acquisition, data processing, visualisation, and forecasting Figure 2 shows system Architecture flow chart.

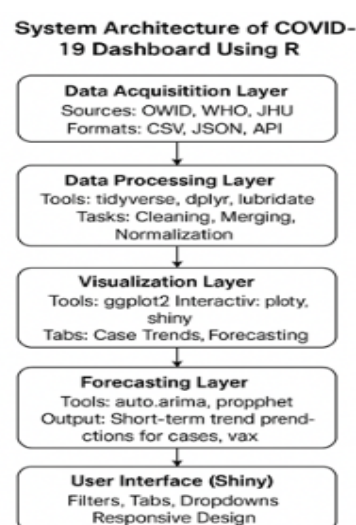


Fig.2: System Architecture Flowchart

A. System Architecture

The system architecture is composed of the following functional layers:

i. Data Acquisition Layer

This layer collects COVID-19 cases and vaccination data from publicly available and reliable sources such as the World Health Organization (WHO), Our World in Data (OWID), and Johns Hopkins University. The datasets are obtained in structured formats including CSV, JSON, or via APIs streams, and are periodically updated to ensure near real-time data availability and accuracy.

ii. Data Processing Layer

In this layer, data processing is performed using R Packages such as tidyverse, dplyr, and lubridate. Key operations include handling missing values, standardizing data formats, filtering country specific data, and restructuring datasets into analysing formats, ensuring consistency and reliability for future analysis.

iii. Visualization Layer

This layer supports both static and interactive visualizations. ggplot2 is utilized to generate high-quality static plots while plotly and shiny enables interactive visual analytics. The dashboard interface employs a tabbed navigation, allowing users to seamlessly explore case statistics, vaccination data, forecasting, and correlation analysis.

iv. Forecasting Layer

Time-series forecasting is implemented using auto.arima() from the forecast package and the prophet library. These models are trained on historical COVID-19 data to generate short-term predictions for confirmed cases and vaccination trends, Supporting proactive public health planning and trends anticipation.

B. Dashboard Features

The interactive dashboard provides the following key functional features:

i. Global Overview Tab

Presents summary statistics such as total confirmed cases, recoveries, deaths, and vaccination rates. Interactive maps and line plots visualize regional distributions and trends.

ii. Vaccination Progress Tab

Displays comparative vaccination statistics across countries using bar charts and scatter plots. This section allows users to analyse the pace of vaccine rollout and its relationship with case reductions.

iii. Case Trends & Forecast Tab

Provides time-series visualizations and forecasting models. Users can select specific regions and customize forecast windows to view predicted trends.

iv. Correlation Analysis Tab

Illustrates statistical relationships between vaccination rates and case trends. Correlation coefficients such as Pearson and Spearman are calculated and displayed alongside interpretive graphs.

C. User Interface Design

The user interface is developed using the shiny framework in R. It includes drop-down menus for country selection, date range filters, and toggle switches for metrics display. The layout is responsive and optimized for both desktop and tablet devices.

D. Performance and Scalability

To maintain high responsiveness, the application leverages Shiny's reactive programming model and data caching techniques. The codebase is modular, enabling easy integration of new features, datasets, or visual elements as required.

IV. IMPLEMENTATION

This chapter describes the practical steps followed to implement the project titled "Interactive COVID-19 Dashboard: Case Trends, Vaccination Progress & Forecasting Using R". The implementation process involves acquiring real-world COVID-19 data, cleaning and processing it, performing exploratory analysis, applying forecasting techniques, and

finally developing an interactive dashboard to present the results. Each step is carefully designed to offer a clear and informative visualization of the pandemic's trends and the impact of vaccination programs.

The proposed COVID-19 dashboard was implemented using R Programming language and a combination of data preprocessing, Visualization, forecasting, and interactive dashboard development tools. Table1. Summarises the major technologies used and their respective roles in the implementation process.

Table1. Summary of Tools, Technologies, and their Applications in the Proposed COVID-19 Dashboard

S. No.	Tools / Technologies	Purpose	Application in the Project
1	R Programming	Data analysis and statistical computing	Processing COVID-19 data and implementing analytical models
2	RStudio	Development environment	Writing, executing, and debugging R scripts
3	Our World in Data (OWID)	Data source	Obtaining historical COVID-19 case, death, and vaccination data
4	tidyverse, dplyr	Data preprocessing	Cleaning, filtering, transforming, and organising datasets
5	readr, lubridate	Data import and date handling	Importing CSV files and processing date variables
6	ggplot2	Static data visualisation	Displaying trends in confirmed cases, deaths, and vaccinations
7	plotly	Interactive visualisation	Developing interactive

			charts with zoom and hover features
8	forecast – ARIMA	Time-series forecasting	Predicting future COVID-19 case and vaccination trends
9	prophet	Time-series forecasting	Modelling historical trends and generating short-term predictions
10	MAE	Model evaluation	Measuring forecasting errors against observed values
11	shiny, shinyWidgets	Dashboard development	Creating interactive filters, navigation, and visual outputs

i. Tools and Technologies Used

The work was entirely implemented in R using the RStudio IDE. Several powerful R packages were used for different purposes: tidyverse and dplyr for data manipulation, ggplot2 and plotly for static and interactive visualizations respectively, forecast and prophet for time-series modeling, and shiny for creating the interactive dashboard interface. Other supportive libraries like lubridate, readr, and shinyWidgets were also used to enhance functionality and user experience.

ii. Dataset Description

The data used in this project was obtained from the publicly available repository maintained by Our World in Data (OWID). The datasets contain detailed daily records of COVID-19 confirmed cases, deaths, recoveries, and vaccinations for various countries. Key columns in the dataset include date, location, total cases, total deaths, total vaccinations, people vaccinated, and new vaccinations. These CSV files were loaded into R for processing and analysis.

iii. Data Preprocessing

Before analysis, data preprocessing was performed to ensure accuracy and consistency. The datasets were imported using the `read_csv()` function, and date columns were converted to date format using `lubridate`. Missing values were handled through imputation or removal, depending on context. Country-specific data was filtered and the vaccination dataset was merged with the case dataset based on the location and date fields. The resulting dataset formed a clean base for further exploration and modeling.

iv. Data Analysis

Exploratory Data Analysis (EDA) was carried out to extract meaningful insights. The data was grouped by country and date to calculate daily and cumulative trends. Metrics such as the daily increase in cases, vaccination progress, and death rates were computed. Relationships between rising vaccination rates and declining case numbers were also investigated. This phase was essential for identifying patterns, seasonal trends, and outliers in the data.

v. Visualization

Visualization played a key role in presenting the findings effectively. Line graphs were created using `ggplot2` to show trends over time for total cases, deaths, and vaccinations. For a more interactive user experience, `plotly` was used to build zoomable and hoverable plots. Geographic visualizations were optionally developed using the `leaflet` library to show case and vaccination distributions across countries on a world map.

vi. Forecasting

To predict future trends in COVID-19 cases and vaccination coverage, time-series forecasting models were implemented. Both ARIMA and Prophet models were trained on historical data. These models were used to forecast daily new cases and estimate future vaccine distribution trends. The models were evaluated visually and using error metrics such as Mean Absolute Error (MAE) to ensure reliability.

vii. Dashboard Development

An interactive dashboard was developed using shiny, allowing users to explore the data dynamically. Features such as country selection, date range filtering, and tabs for different types of analysis were implemented. The dashboard displayed real-time visualizations of cases, deaths, vaccinations, and forecasts. This made it possible for users without programming knowledge to engage with the data in an informative and user-friendly environment.

V. Result

The outcomes from the implementation of the interactive COVID-19 dashboard developed using R. The dashboard integrates graphical representations and interactive features to facilitate the exploration of pandemic-related data across different regions and time periods. The results are presented in the following subsections.

A. Case Trends Visualization

The dashboard presents both daily and cumulative COVID-19 cases using interactive visualizations developed using R Packages such as `ggplot2`, `Plotly`, and `leaflet`. A significant increase in cases during the mid-2021 wave was observed across all regions. Users could select multiple regions for comparison using dropdown filters. Daily new cases and deaths were also visualized for better analysis of patterns and severity over time. Figure. 3, presents the historical trends in reported COVID-19 cases for the selected dataset.

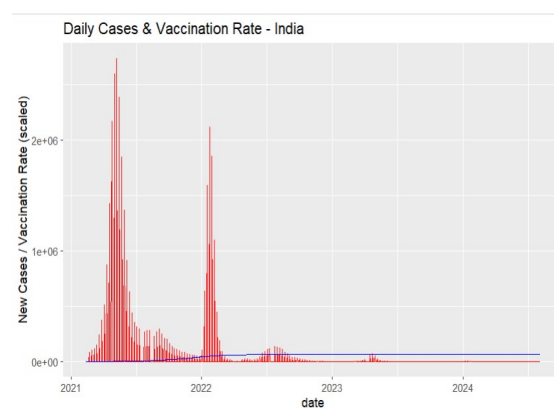


Fig. 3: Historical Trends in Reported COVID-19 Cases

B. Vaccination Progress

Vaccination data was visualized using bar charts and time-series plots, as shown in figure 5. The dashboard showed the growth of vaccination over time and enabled comparison between different regions. Disparities in vaccination coverage were highlighted using a color-coded choropleth map, which displayed the percentage of population vaccinated per region. Figure 4. Shows the historical trends represented by the selected COVID-19 indicator, while Figure 5 presents changes in vaccination coverage over time.

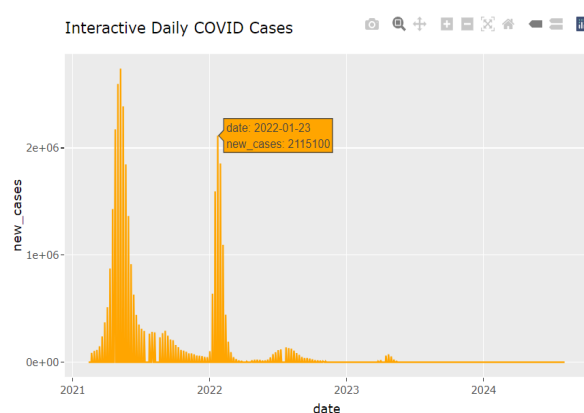


Fig. 4: Historical Trend of the Selected COVID-19 Indicator

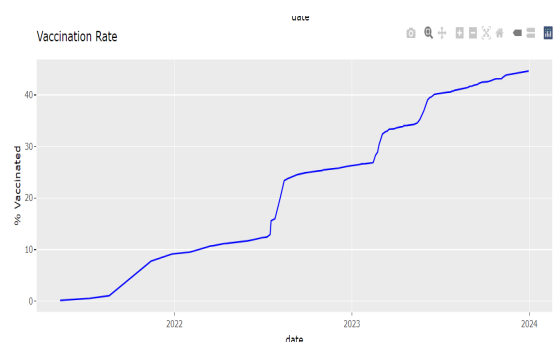


Fig. 5: Trend in the Percentage of Population Vaccinated Over Time

C. Forecasting of COVID-19 Cases

Short-term forecasting was performed using ARIMA models via the forecast package in R. The dashboard displayed 14-day projections of case counts along with 95% confidence intervals. These forecasts aligned closely with actual trends during validation. Figure 6 presents the ARIMA-based forecasting results for the selected COVID-19 time series.

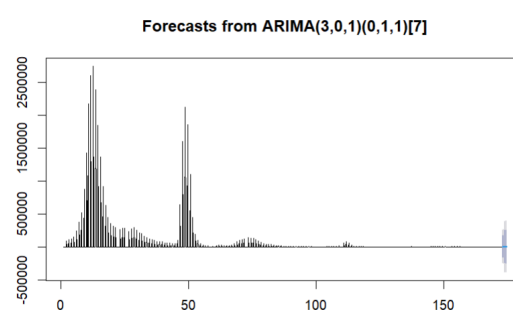


Fig. 6: ARIMA-Based Forecast of COVID-19 Cases

Interactive Dashboard Functionality

The dashboard supported interactive filters for region, time range, and metrics such as confirmed cases, recoveries, and deaths. The UI was implemented using the Shiny package, enabling reactive visual updates based on user input. A CSV download feature was included for further offline analysis.

A screenshot of the dashboard interface is presented in Figure. 7.

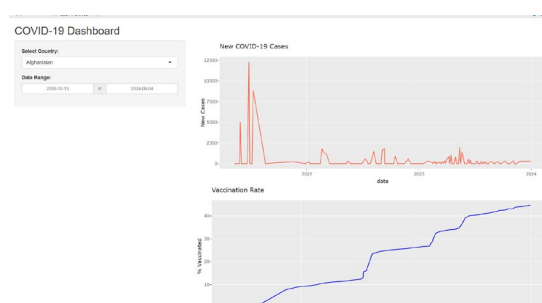


Fig. 7: Main interface of the COVID-19 dashboard

Performance and Usability Feedback

The dashboard integrates data processing, graphical visualisation, and forecasting within a single R-based application. The use of Shiny's reactive programming framework enables visual outputs to respond to user interactions. The interface is designed to support the exploration and interpretation of COVID-19 statistics without requiring users to write R code. Further performance and usability evaluation would be required to quantify application responsiveness and user satisfaction.

Vi. Conclusion

The study presents the development of an interactive COVID-19 dashboard using R programming language to analyse and visualize the historical pandemic trend, Vaccination process and short-term forecasts. By integrating data preprocessing, exploratory data analysis, statistical forecasting, and user interaction visualization technique. The proposed system provides a accessible platform for examining COVID-19 statistics across different countries and regions.

The dashboard provides a comprehensive and intuitive platform for analysing confirmed cases, deaths, recoveries, and vaccination coverage across various regions. Utilizing R packages such as shiny, ggplot2, plotly, and forecast, the system supports both exploratory data analysis and predictive modeling through techniques like ARIMA and Prophet. The dashboard's modular structure ensures flexibility, allowing for regular updates with new datasets and analytical features. Moreover, the correlation analysis between vaccination rates and case trends offers valuable indicators of public health intervention efficacy.

The study demonstrates the potential of combining interactive data visualisation and time-series forecasting to support the interpretation of public health information. However, the accuracy of forecasts depends on the quality of historical data, reporting consistency, and changing epidemiological conditions. Future work could incorporate additional forecasting models, such as Prophet, compare model performance using quantitative evaluation metrics, and extend the dashboard to support automated data updates and additional public health indicators.

Overall, the proposed work on R-based dashboard provides a foundation for exploring COVID-19 trends and demonstrates how statistical analysis and interactive visualisation can contribute to data-informed public health monitoring and research.

Acknowledgment

The authors would like to express their sincere gratitude to REVA University for providing constant support, encouragement, and valuable insights throughout this project. The guidance and resources made available played a crucial role in the successful completion of this work.

References

- A. Kenigsberg et al., "Dashboard development for near real-time visualization of COVID-19 vaccine safety surveillance data in the Vaccine Safety Datalink," *Vaccine*, vol. 40, no. 22, pp. 3064–3071, 2022. doi: 10.1016/j.vaccine.2022.04.010
- X. Zhou and Y. Li, "Forecasting the COVID-19 vaccine uptake rate: an infodemiological study in the US," *Human Vaccines & Immunotherapeutics*, vol. 18, no. 1, pp. e2017216, 2022. doi: 10.1080/21645515.2021.2017216
- F. Clement, A. Kaur, M. Sedghi, D. Krishnaswamy, and K. Punithakumar, "Interactive Data Driven Visualization for COVID-19 with Trends, Analytics and Forecasting," in *Proc. 24th Int. Conf. Information Visualisation (IV)*, 2020, pp. 593–600. doi: 10.1109/IV51561.2020.00101
- S. W. Marvel et al., "The COVID-19 Pandemic Vulnerability Index (PVI) Dashboard: Monitoring County-Level Vulnerability Using Visualization, Statistical Modeling, and Machine Learning," *Environmental Health Perspectives*, vol. 129, no. 1, 2021. doi: 10.1289/EHP8690
- B. E. Dixon et al., "Leveraging data visualization and a statewide health information exchange to support COVID-19 surveillance and response: Application of public health informatics," *J. Am. Med. Inform. Assoc.*, vol. 28, no. 7, pp. 1363–1373, 2021. doi: 10.1093/jamia/ocab004