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Covid-19 data visualization using tableau

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ABSTRACT

The COVID-19 pandemic crisis resulted in the accumulation of extensive epidemiological data that demanded the implementation of advanced visualization techniques to support community health surveillance systems. This research adopts the Tableau platform in the development of a dynamic dashboard for a holistic examination of COVID-19 data. A quantitative-descriptive methodological approach was applied using secondary databases from global repositories covering parameters of cases, fatalities, morbidity, and territorial distribution. The construction of the dashboard consolidates chronological-geographical visualization, predictive analytics, and assessment of vaccination efficiency. The findings indicate the superior capability of Tableau in processing epidemiological big data with optimal performance metrics. Temporal investigation identified recurring patterns with different wave characteristics, while geographical mapping exposed the epicenters of transmission and propagation paths. The forecasting model achieved high precision at near-term horizons (MAPE 8.45% for 7-day prediction). Vaccination evaluation displayed a constructive correlation between coverage levels and the suppression of incidence. Analysis of user experience confirmed preferences for an interface that is user-friendly with sophisticated analytical capabilities. This study contributes academically by enriching the literature on health data visualization and practically by offering a dashboard model that supports real-time public health decision-making.

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1. INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) pandemic, which began at the end of 2019, has fundamentally transformed the global landscape, creating wide-ranging impacts on health, economic, and social systems worldwide. The World Health Organization (WHO) recorded that as of October 2021, there were more than 245 million confirmed cases with nearly 5 million deaths recorded globally, accompanied by severe social, economic, and health impacts (Tasrif, 2020). The rapidly developing digital era has enabled the collection of health data on an unprecedented scale, resulting in a very large volume of information regarding the spread of the virus, mortality rates, recovery rates, and vaccine effectiveness across various geographical regions. The complexity and volume of COVID-19 data available create unique challenges in terms of interpretation and communication of information to various stakeholders, ranging from policymakers, medical personnel, to the general public. The need for in-depth data analysis and effective communication

has become very crucial in the context of evidence-based decision-making to control the spread of the pandemic. Data visualization has proven to be a very important tool in transforming raw data into information that can be understood and used to support timely and accurate decision-making processes (Nuraini & Romadhoni, 2025).

Research shows that COVID-19 data visualization has a significant impact on public risk perception of the pandemic. Communities around the world use SARS-CoV-2 visualizations to make life-and-death decisions about pandemic risk, making it very important to understand how these visualizations affect risk perception in order to improve pandemic communication (M. Syam et al., 2021). Effective visualization not only helps in understanding trends and patterns of virus transmission, but also plays a role in building public awareness of the importance of health protocols and preventive policies implemented by the government. In the context of data analysis and visualization, various platforms and tools have been developed to facilitate a better understanding of the dynamics of the COVID-19 pandemic. Previous studies using Tableau were often limited to specific indicators or single-country analyses. This study fills that gap by integrating temporal, spatial, predictive, and vaccination perspectives into one comprehensive dashboard. Tableau was selected over other visualization tools because of its stronger interoperability with diverse data sources, advanced forecasting features, and interactive dashboard design. In the context of big data epidemiology, these advantages allow Tableau to process large and heterogeneous datasets in real-time, thereby strengthening health risk communication by delivering timely, accurate, and easily interpretable information to the public. Tableau, as one of the leading data visualization platforms, has proven its capability in analyzing and visualizing COVID-19 data in a comprehensive and easily understandable way. This platform provides the ability to integrate various data sources, conduct complex statistical analyses, and create interactive dashboards that allow users to explore data from various perspectives and temporal dimensions (Mujahidah et al., 2025).

The application of Tableau in the context of COVID-19 data visualization has shown very promising results in various previous studies. Research conducted by (Nugraha et al., 2023) demonstrated how Tableau can be used to conduct a comprehensive analysis of COVID-19 data in India, with an emphasis on key metrics such as daily case rates, mortality rates, recovery rates, and geographical distribution of cases. The study showed that visualizations created using Tableau were able to identify important patterns in virus transmission, geographic hotspots, and temporal trends that can be used to support public health intervention strategies. Tableau's ability to integrate real-time data and create interactive dashboards provides significant added value in the context of monitoring and surveillance of the COVID-19 pandemic. This platform allows the creation of visualizations that can be automatically updated when new data becomes available, thereby allowing stakeholders to always have access to the latest information. The advanced analytics features available in Tableau also enable users to perform forecasting, trend analysis, and statistical modeling that can help predict the future development of the pandemic (Novany et al., 2023).

In addition, a participatory approach in the design of data visualization tools for monitoring the COVID-19 pandemic has shown the importance of involving various stakeholders in the development process of visualization systems. (Novany et al., 2023), in their research, used a Web-Delphi participatory approach to inform the design of COVID-19 data visualization tools in Portugal, emphasizing the importance of considering end-user needs and preferences in selecting the appropriate visualization format. This approach resulted in valuable recommendations for choosing the appropriate visualizations, both in terms of technical feasibility and user experience. The development of data visualization technology in the era of the COVID-19 pandemic has also experienced significant acceleration, with the emergence of various innovations in spatial and temporal data visualization for mass dissemination. The digital era has enabled unprecedented public consumption of spatial and temporal disease data, which can increase government transparency and accountability to the public. This creates new opportunities for

democratic participation in public health decision-making, where communities have better access to the information they need to make informed decisions (Novany et al., 2023).

However, challenges in COVID-19 data visualization also cannot be ignored (Tasbi et al., 2025). The complexity of data involving multiple variables, uncertainty in data reporting, and the need for real-time updates create technical challenges that must be addressed in the development of effective visualization systems. In addition, differences in literacy levels and technical backgrounds among end-users require a thoughtful approach in user interface and user experience design to ensure that information can be accessed and understood by diverse audiences.

This study aims to explore and analyze the use of Tableau as a platform for COVID-19 data visualization, with a focus on the development of interactive dashboards that can provide deep insights into various aspects of the pandemic. Through a systematic quantitative approach, this research will evaluate the effectiveness of various visualization techniques in presenting COVID-19 information, analyze trends and patterns emerging from the data, and identify best practices in the use of Tableau for public health data visualization. The results of this study are expected to contribute to the body of knowledge in the field of health informatics and data visualization, while also providing practical guidance for practitioners and researchers interested in applying business intelligence tools for public health data analysis.

2. RESEARCH METHOD

This study employs a quantitative approach with a descriptive-analytical design to evaluate the implementation of COVID-19 data visualization using the Tableau platform. The quantitative method was chosen as it enables systematic analysis of extensive numerical COVID-19 data and objective measurement of the effectiveness of the visualization techniques applied. A cross-sectional design was implemented to analyze the COVID-19 dataset within a specific time frame, utilizing secondary data analysis techniques obtained from reliable sources such as the World Health Organization (WHO), Johns Hopkins University, and national government data repositories.

The dataset used in this study includes key variables such as the number of daily and cumulative confirmed cases, mortality rates, recovery rates, vaccination rates, and the geographical distribution of COVID-19 cases. Data were collected from multiple countries with a comprehensive time span, enabling temporal trend analysis and cross-regional comparisons. A preprocessing procedure was carried out to ensure dataset consistency, accuracy, and completeness, which included the removal of anomalies, handling of missing values, and standardization of data formats in accordance with the requirements of the Tableau platform.

The sampling technique applied was purposive sampling, with inclusion criteria consisting of complete data availability for the key variables, consistent data reporting, and adequate geographical representativeness. The sample size was determined based on data completeness considerations and the computational capacity of the Tableau platform to process large datasets. A cross-sectional design was chosen to capture a consistent temporal snapshot of the pandemic across regions. Country selection was based on complete and reliable reporting, covering the period from late 2019 to October 2021. Purposive sampling was applied by including only regions with consistent daily records, while data consistency across sources was maintained through triangulation, normalization, and removal of anomalies. Data validation was performed through source triangulation and cross-verification with official publications from international health organizations to ensure the reliability and validity of the dataset used (Saadah et al., 2022).

The implementation of data visualization utilized the latest version of Tableau Desktop, leveraging various advanced analytics features such as trend analysis, forecasting, and statistical modeling. The visualization development process followed a systematic design framework, beginning with initial data exploration, identification of significant patterns, selection of appropriate visualization types, and optimization of the dashboard for an optimal user experience. The visualization techniques employed included time series charts for temporal trend analysis,

geographical maps for spatial distribution, bar charts and pie charts for categorical comparisons, and scatter plots for correlation analysis between variables (Ramadhan & Voutama, 2025).

Descriptive statistical analysis was applied to describe the dataset characteristics and identify key patterns within the COVID-19 data. Exploratory analysis techniques were used to uncover insights not immediately apparent from raw data, including the identification of outliers, seasonal patterns, and correlation patterns between variables. The validation of analysis results was conducted through comparison with findings from previous studies and verification by domain experts in epidemiology and public health informatics. This comprehensive quantitative approach enabled the study to produce robust and reliable findings in the context of developing public health data visualization systems (Inonu & Magda, 2025).

3. RESULTS AND DISCUSSIONS

COVID-19 Dashboard Implementation Using the Tableau Platform

The implementation of the COVID-19 data visualization dashboard using the Tableau platform has produced a comprehensive interactive interface for monitoring and analyzing the spread of the pandemic across various geographical regions. The developed dashboard integrates diverse data sources with a user-friendly display, enabling stakeholders to access real-time information regarding the progression of COVID-19 cases. Based on the implementation analysis conducted, the Tableau platform demonstrates superior capability in processing large datasets with optimal performance, in line with the findings of (Elfrida Wunu & Yulian Pamuji, 2023), which emphasize the effectiveness of Tableau in visualizing COVID-19 data in Indonesia through various types of charts such as maps, line charts, bar charts, and tree maps.

The implemented dashboard consists of several main components, including geographical mapping for spatial visualization of case distribution, time series analysis for tracking temporal trends, inter-regional comparison analysis, as well as predictive modeling for forecasting future case developments. The interactive features provided enable users to conduct in-depth analysis, filtering based on specific criteria, and adjustment of the display according to analytical needs. The overall implementation shows that Tableau is capable of providing a robust solution for complex data visualization requirements in the context of public health surveillance (Novany et al., 2023).

Analysis of Temporal Patterns and Spatial Distribution of COVID-19 Cases

The temporal analysis of COVID-19 data revealed significant patterns in the spread of the virus during the research period. The generated time series visualizations show the existence of seasonal patterns with peak periods that correlate with external factors such as community mobility, government policies, and weather conditions. The data indicate that there are recurring patterns in the spread of the virus at certain intervals, where each wave has different characteristics in terms of magnitude and duration.

Table 1. Distribution of COVID-19 Cases Based on Time Period

Period	Daily New Cases (Average)	Peak Cases	Growth Rate (%)	Wave Duration (Days)
Q1 2020	1,245	3,456	15.6	45
Q2 2020	2,891	8,934	23.4	62
Q3 2020	4,567	12,789	18.9	58
Q4 2020	6,234	15,678	12.3	71
Q1 2021	3,789	9,456	-8.7	39

Source: Secondary data, processed from the COVID-19 Task Force

Spatial distribution analysis identified geographic hotspots that showed the highest concentration of cases, with spread patterns following major transportation routes and population density. Geographical visualization using heat maps and choropleth maps provided in-depth insights into how the virus spread across regions, enabling the identification of early warning areas and priority resource allocation. These findings are consistent with the study of Pang et al. (2021), which utilized spatio-temporal visualization for global COVID-19 surveillance, where bubble charts were used to integrate various epidemiological indicators within regional and temporal contexts.

Table 2. Top 10 Provinces with the Highest Cases

Province	Total Cases	Active Cases	Recovery Rate (%)	Mortality Rate (%)	Population
DKI Jakarta	847,256	12,456	94.2	2.8	10,562,088
Jawa Barat	623,789	8,934	95.1	2.1	48,274,162
Jawa Tengah	478,123	6,789	96.3	2.4	34,257,565
Jawa Timur	445,678	7,234	94.8	3.2	39,293,191
Sumatera Utara	287,456	4,567	93.7	2.9	14,799,361
Banten	234,789	3,891	95.4	2.3	11,904,562
Sulawesi Selatan	198,567	2,945	94.6	3.1	8,618,940
Kalimantan	167,234	2,156	96.1	2.7	3,688,232
Timur	145,890	1,789	95.8	2.5	5,534,472
Sumatera Barat	134,567	1,567	94.9	2.8	6,394,087
Riau					

Source: Secondary data, processed from the COVID-19 Task Force

Evaluation of Vaccination Policy Effectiveness Through Data Visualization

Data visualization analysis shows a significant relationship between the implementation of vaccination programs and the decline in COVID-19 cases across various regions. The developed dashboard enables real-time tracking of vaccination coverage and its impact on epidemiological indicators. Data indicate that regions with high vaccination rates experienced a more substantial reduction in new cases, hospitalization rates, and mortality. These findings support the study of (Mustikaningsih, 2023), which examined vaccination policies using big data analysis and found that high vaccination participation rates were able to significantly suppress new COVID-19 cases.

Comparative visualization analysis shows that the effectiveness of vaccination is not only influenced by the level of coverage but also by other factors such as the type of vaccine used, demographic characteristics of the target population, and the timing of program implementation. The dashboard enables multidimensional analysis that integrates vaccination data with other indicators such as mobility data, compliance with health protocols, and socio-economic factors. This analysis provides valuable insights for policymakers in optimizing vaccination strategies and resource allocation.

Predictive Analytics and Forecasting of Pandemic Development

The implementation of predictive analytics using Tableau has produced a forecasting model capable of predicting the development of COVID-19 cases with a reasonable level of accuracy. The developed model integrates historical data patterns with external variables to generate short- and medium-term projections. Forecasting analysis shows that the model is able to identify potential surge periods with sufficient lead time for the implementation of preventive measures. These results are consistent with the study of (Novany et al., 2023), which used forecasting methods in COVID-19 data visualization analysis in North Sumatra and successfully optimized decision-making based on the predictions generated.

Table 3. Forecasting Model Accuracy Based on Time Horizon

Prediction Horizon	MAPE (%)	RMSE	MAE	R-squared	Confidence Interval(%)
7 days	8.45	1,234	987	0.923	95
14 days	12.67	1,789	1,345	0.887	90
30 days	18.93	2,456	1,892	0.834	85
60 days	26.78	3,567	2,678	0.756	80
90 days	34.52	4,789	3,456	0.678	75

Source: Secondary data, processed from the COVID-19 Task Force

The forecasting model developed uses a hybrid approach that combines various algorithms to improve the robustness and reliability of predictions. Model validation was carried out using cross-validation techniques and backtesting procedures to ensure the generalization of results. The forecasting dashboard provides intuitive visualizations with uncertainty bands and confidence intervals, enabling decision-makers to understand the range of possible outcomes and associated risks.

Comparison of Visualization Techniques Effectiveness and User Experience Analysis

Evaluation of various visualization techniques implemented in the dashboard shows that each type of visualization has its own specific strengths and limitations. Geographical visualizations such as choropleth maps and heat maps proved highly effective for spatial analysis and hotspot identification, but less optimal for temporal trend analysis. Conversely, time series graphs and area charts provide superior clarity for tracking temporal patterns but are limited in representing spatial context. These findings are consistent with the analysis by Clarkson (2023), who conducted a survey of web-based COVID-19 dashboards in the United States and identified that variations in design and visualization quality can affect data interpretation and potentially mislead viewers.

User experience analysis shows that interactivity features such as drill-down capabilities, filtering options, and cross-filtering among visualizations provide significant added value in terms of user engagement and the effectiveness of data exploration. Dashboards with clean design and intuitive navigation yielded higher user satisfaction scores compared to interfaces that were complex and cluttered. Usability evaluation through expert review and user testing indicated that simplicity in design, combined with strong analytical capabilities, is a key success factor in dashboard development. Performance metrics analysis shows that the developed dashboard is capable of handling large datasets with acceptable response times and minimal memory usage. Scalability testing confirmed that the system can accommodate increasing data volumes without significant degradation in performance. Integration with real-time data sources enables automatic updates and ensures that users always have access to the latest information, consistent with findings from Pala et al. (2022), who developed the PERISCOPE Atlas as an interactive tool for COVID-19 data visualization and analysis. Compared to other visualization platforms, Tableau demonstrates stronger capabilities in integrating diverse datasets and generating predictive analytics, which are essential for epidemiological analysis. The dashboard findings are directly useful for policymakers by providing real-time insights to support vaccination planning, mobility regulation, and resource allocation.

4. CONCLUSION

The application of Tableau technology in the development of the COVID-19 data visualization system demonstrates the advantages of business intelligence solutions in transforming the complexity of epidemiological datasets into accessible and dynamic graphical representations. This investigation validates the quantitative-descriptive methodological approach in examining the temporal-spatial characteristics of pathogen distribution, where cartographic representations successfully identified case aggregations and primary diffusion pathways. The construction of predictive models produced forecasting algorithms with maximum precision within a 1–2 week timeframe (MAPE 8.45%–12.67%), providing a reliable early warning system for the formulation of responsive strategies. Comparative assessment revealed a substantial relationship between population vaccination penetration and prevalence reduction, confirming the validity of immunization strategies as a fundamental mitigation measure. User experience analysis indicated a preference for streamlined interfaces with extensive investigative capabilities, maximizing information penetration for diversified stakeholders in the domain of health informatics. Future research could extend the dashboard with additional data sources and adapt it for broader disease monitoring, ensuring its sustainability as a long-term public health surveillance tool beyond the COVID-19 pandemic.

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