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Public Health Informatics: The Importance of COVID-19 Dashboard in KSA

Health Information Sharing and Visualization

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ABSTRACT

The use of technology is enabling businesses, individuals, and governments to combat COVID-19. Containing and measuring global concerns such as Coronavirus will require critically assessing technological developments. This paper evaluates the COVID-19 dashboard developed by the Saudi Ministry of Health (MOH). A scoping review of published and unpublished documents was conducted. The Saudi Arabia MOH provides figures, graphs, and statistics. The researcher found that clicking one button allows access to critical information, enabling individuals to understand how the disease spreads around the country. The Saudi MOH's COVID-19 dashboard provided accurate, reliable, and current information. COVID-19 information is effectively communicated through technology. With the help of data visualization, many citizens can better understand COVID-19. Given their dynamic nature, the evolution of COVID-19 dashboards over time is crucial. A broader range of indicators may assist in better monitoring the impact of COVID-19 on the economy and society. During this crisis, dashboards must include features that facilitate their use by people with disabilities.

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Introduction

Since December 2019, Coronavirus disease 2019 or COVID-19 has spread worldwide [1]. There has been a rapid adaptation of health care systems in these countries due to the increasing demand for health care. The World Health Organization (WHO) has identified digital health solutions as one of the most promising approaches for addressing this challenge in modern societies [2].

Despite the widespread implementation of various intervention measures, from national quarantines to school closings, almost all sectors of society have been negatively affected by the COVID-19 pandemic [3], [4]. Moreover, SARS-CoV-2 has recently circulated multiple new, more transmissible strains worldwide [5]. An increased interest in data sharing has emerged in recent years, especially in healthcare, and it is supported by multiple parties such as the governments and funding programs [6]. The Saudi Arabia government is focused on data sharing in many industries, one of them is healthcare due to its significance. Identifying the strengths and weaknesses of current dashboards is crucial. Data visualizations and dashboards are rarely studied in Saudi Arabia. Hence, this paper investigates the usability and usefulness of data sharing and visualization by examining the COVID-19 dashboard developed by the Saudi Arabian Ministry of Health (MOH).

One of the most critical factors in the success of a website is its accessibility. All Saudi citizens are offered equal access to the COVID-19 dashboard developed by the MOH in Saudi Arabia. The dashboard has been down only a few times since it launched so it can be accessed 24 hours a day, seven days a week. The dashboard does not require any exceptional internet connectivity to access. Moreover, the COVID-19 dashboard by MoH Saudi Arabia is compatible with all browsers, thus making it easy for all users to utilize. It is easy to navigate all data through a simple interface. Since the technical aspects of the dashboard have been simplified, all users, regardless of their level of computer literacy, will be able to access the dashboard [7]. However, assessing these dashboards is critical. The main research questions are:

- What are the benefits of the COVID-19 dashboard during the pandemic?
- What are the benefits of data visualization for delivering information to the public during the COVID-19 pandemic?

Literature Review

It is more important than ever to communicate a public health message during the ongoing COVID-19 pandemic. Data visualization methods have recently been used to provide citizens with critical information through electronic platforms. Using data visualization tools, users can interact with data, interpret it, and make informed decisions [8], [9]. Visualization

techniques are used in public health to communicate information about behavioral health, chronic illness risks, and access to the care [10].

There has been a significant contribution to discoveries and inventions through data visualization over the centuries [11]. Visualization is concerned with exploring data and information [12]. In the earliest stages of data visualization, hand-drawing was used, then photo-etching was used, and now computer technology, such as computer graphics and software, is used [13]. The development of computer software has incredibly advanced data visualization. This allows users to manipulate a significant amount of data for exploration and examination more quickly and inexpensively [14]. Data visualization is typically associated with computer science and technological devices in contemporary society.

While COVID-19 continues ravaging the globe, Saudi Arabia recognizes it as significant human-centered health and major crisis**.** Therefore, Saudi Arabia has implemented many safety measures for all citizens since the beginning of the pandemic, and this pandemic has sparked our government's interest in digitalization. For instance, the Saudi Ministry of Health has developed multiple superb platforms and health applications for the public, including Tawakkalna, Tabaud, and COVID-19 dashboards. Each app and platform serves a unique purpose, especially the COVID-19 dashboard, which effectively visualizes COVID-19 cases in a country. Furthermore, it is assessable to anyone at any time with a continuous regular update of the cases by the Saudi Ministry of Health (MOH).

A. Data Visualization

Data Data Visualization makes it easier for stakeholders to access and understand it. Compared to computational biology, there has been a tenfold increase in the use of visualization in books over the past decade and a fivefold growth in the compilers [15]. The term "data visualization" can be defined in several ways. Most definitions focus on connecting data and computer technology to transform data into a visual or sonic form.

Data visualization is as "the representation and presentation of data that exploits our visual perception abilities to amplify cognition". The visualization technique is for gaining insight into complex and large datasets [16]. Some describe dashboards as visual displays that summarize pertinent information, allowing an observer to monitor and understand the entire operation of a system [17].

Systems, Systems, Formal/Analysis, and Humans represent the theoretical foundations of visualization. As such, there are multiple challenges associated with the theoretical foundations of visualization due to visualization theory foundations drawing on several domains. However, visualization relies significantly on data from other disciplines. There are often few concrete examples from the experience of a few authors in the visualization

literature on which a model or theory is based, and at times even no evidence is provided [18-20]. Various evaluations and concepts used in the visualization literature need to be explained theoretically [21], [22].

Moreover, papers did not explicitly discuss data visualization theories but presented specific theories related to their subjects. With the Elaboration Likelihood Model as an example, Pandey and colleagues described the dual process of how a person interprets stimuli that influence attitude change by taking the central and peripheral routes. An important factor contributing to the process was the individual's ability to process the message without being cognitively burdened [23], [24]. Based on this theory, the authors designed an experiment to examine how persuasive data visualizations are in addressing controversial social issues. Five studies have demonstrated that visual displays assist users in better understanding complex real-world problems by integrating large amounts of information from multiple sources and reducing cognitive burden, resulting in more effective and efficient decision-making based on the information [25].

B. Advantages of Data Visualization

The use of data visualization has a wide range of benefits. For instance, data visualization makes data accessible to a broad audience. Furthermore, detecting relationships that would otherwise remain hidden when visualized becomes easier. Additionally, visualizations facilitate the integration of multiple data sources by bringing together different types and scales of data into a single view. Data integration is vital in many fields, especially public health and health informatics. Moreover, decision-making, learning, and analytical reasoning are all enhanced by visualizations due to their influence on human cognition [26]. Also, A vast amount of data can be displayed instantly, and viewers can discover emerging patterns and properties in the data immediately, resulting in new insights.

Furthermore, It facilitates the comprehension of large and small datasets, regardless of their size [14]. Visualizing data facilitates the construction of hypotheses [27]. Graphical representations of data or concepts are created in visualizing data, facilitating decision-making. Graphs are more effective at persuading audiences and altering their attitudes than tables containing the same information [24]. In scientific disciplines, visual representations are widely acknowledged as effective and efficient methods of communicating information to populations with varying levels of information processing ability. Scientists had developed numerous visualizations to illustrate health status indicators in the scientific community [28]. In multiple studies, traditional data visualization has been demonstrated to have many benefits, and its importance has been emphasized. However, during the researcher's

investigation, only a few studies have examined and addressed the issues associated with data visualization on electronic platforms during pandemics.

C. COVID-19 Dashboard: Saudi Arabia

A recent study illustrated that almost all Saudis have Internet access, and most have their own smartphones [29]. Dashboards enable data visualization and provide a convenient means of analyzing a wide range of data. Therefore, Saudi Arabia's Ministry of Health (MOH) established a dashboard after the spread of COVID-19. It is an effective tool for sharing information about disease cases nationwide through this platform. As a result of the Coronavirus's recent emergence, there is a need to enhance public awareness. Therefore, (MOH) ensures that the COVID-19 dashboard is easy to use and accessible to all citizens with internet access. Globally, COVID-19 has impacted the social, economic, and political spheres. However, there is a significant lack of facts, data, and statistics on the exact impacts on most citizens [30].

MOH has developed the COVID-19 dashboard to bridge this gap and provide critical information and statistics to the public. Few defined dashboard as "a visual display of the most important information needed to achieve one or more objectives" [31]. The public must be informed about the pandemic to prepare for it. With the proliferation of applications and users, user interfaces (UIs) are becoming increasingly important. Even though users avoid uncomfortable or difficult interfaces are less likely to interact with them. When developing applications or websites, it is essential to consider the User Interface since it connects the end-users with the functionality. Platform heterogeneity and user expectations have made the user Interface a pivotal element to consider [32], [33]. When designing an interface, it is vital to consider the users' needs, capabilities, and limitations [34].

The COVID-19 dashboards provide accurate information about new cases, tests, and critical and recovered cases in Saudi Arabia. Using visually appealing charts and statistics makes public instructions easier to understand. Therefore, the (MOH) in Saudi Arabia designed this useful dashboard to make citizens more knowledgeable about the disease effect in the country. Fig. 2 shows that this dashboard offers practical features and an easy-to-use interface. How data are presented has a significant impact on how they are interpreted. Therefore, dashboards displaying information can smoothly scan all the data and determine the necessary information.

The dashboard provides a concise summary of essential information that enables an individual to understand how data trends on COVID-19 in Saudi Arabia are represented. Furthermore, the reports of cases, deaths, and which regions have the most cases have generated considerable concern. Thus, users can easily access the dashboard and identify the

confirmed Coronavirus spread among the country's cities see Figure 5. By displaying which cities have the most disease cases on the dashboard, users can avoid visiting cities with a high rate of new COVID-19 cases see Figure 3. They can protect themselves by taking these preventive measures. This ultramodern era of information technology makes the COVID-19 dashboard ideal for the government to spread public awareness about the pandemic and provide residents with essential information.

The dashboard allows the government to provide citizens with daily information about confirmed cases, deaths, and recovery rates. The availability of this information will facilitate the planning process for people. If the number of confirmed cases flattens, the government and the people can quickly reopen. Additionally, citizens can adjust and prepare for the potential consequences of an increase in COVID-19 positive cases. However, experts concluded that dashboards need more than data visualizations to be practical public health tools. The dashboards should provide resources and patterns to assist resource allocation and behavior modification [35].

The dashboards with map-based communication are necessary to provide a global perspective on this pandemic. Using such tools, authorities can improve data transparency and disseminate information more effectively [36]. There has been unpredictability to the COVID-19 pandemic across the globe[37]. The situation has been similar in Saudi Arabia since the beginning COVID-19 disease. The dashboard can provide valuable information about Coronavirus dynamics at the social, economic, and political levels. In the case of a pandemic such as COVID-19, trends must be monitored continuously.

Methods

Our scoping review followed the guidelines of PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) to achieve the study objective [38].

A. Search Sources

A search was conducted in the following databases: Google Scholar, MEDLINE (via Ovid), PsycINFO (via Ovid), Embase (via Ovid), CINAHL (via EBSCO), ACM Digital Library, and IEEE Xplore. Google Scholar retrieved a massive number of publications, so only the first 100 were considered, and we found that results quickly lost relevance and application beyond the first 100. Using backward reference list screening and forward reference list screening, we identified further studies from the reference lists of the included studies and relevant reviews.

B. Search Terms

The search query for this review was developed after consulting two experts in data visualization and reviewing previous studies in this area. The expanded search query includes terms related to dashboards and data visualization (e.g., health information exchange, COVID-19, data sharing, and effectiveness).

C. Criteria for Study Eligibility

The study included only studies that focused on dashboards or data visualizations. This study focused on digital visualizations, such as those found on mobile phones and personal computers, and excluded non-digital data visualizations. Data visualization and dashboard studies that provide an overview or recommendation were excluded. Only empirical research in English was included in this review. Also included were books, conference proceedings, dissertations, and peer-reviewed articles. Reviews, conference abstracts, ideas, editorials, and commentary were excluded. We did not limit the publication year, the publication nation, the study methodology, the population, or the study results. The study selection process was divided into three stages: (1) removing duplicates from all retrieved studies using Zotero, (2) skimming titles and abstracts, and (3) reviewing the full texts of the studies that passed the first step. The full-text screening process involves reading the entire paper, including all supporting documents, from beginning to end. Two reviewers independently conducted the selection process. Consultation with two more reviewers was conducted at the second and third stages of the review process.

D. Data Extraction

The data extraction form for this review was pilot tested using five studies included in the review. In an independent review, three reviewers used Microsoft Excel to extract data regarding the included studies, dashboards, and data visualizations. Any disagreements among the reviewers were discussed.

E. Data Synthesis

In this study, data extracted from the publications included were synthesized using a narrative synthesis approach. A description of the dashboards and data visualizations used in the included studies was provided, including their name, target condition, purpose, connectivity, interface, genre, type, and platform.

Then, we discussed the purpose, type, size, performance, and features of the dashboards and data visualizations used in the included studies. The data synthesis was managed using Microsoft Excel.

Results and Discussion

According to Fig. 1, Saudi Arabia has a young population, with most residents under 65. Furthermore, studies in Saudi Arabia recently reported that only a tiny fraction of the population is without internet access [29], [39], [40]. We can easily observe that user interfaces have become increasingly important with the increase in users and applications. Although users avoid uncomfortable or difficult interfaces, they are less likely to interact with them. It is apparent from Fig. 2 that the dashboard's interface is simple and has a limited number of buttons, making it extremely easy for users with little computer literacy to navigate. However, in this contemporary, the researcher externally emphasizes the importance of eHealth literacy. Generally, eHealth is sometimes called electronic health and is defined as a new term to describe the combined use of electronic communication and information technology in the health sector. Digital data is used in the health sector –transmitted, stored, and retrieved electronically– for clinical, educational, and administrative purposes at the local site and distance [41].

Overall, there are many definitions of health literacy (HL), but in general, they are skills and competencies that enable a person to interpret health information and apply it to inform health-related decisions. In this digital age, eHealth literacy has become necessary due to the diffusion of knowledge over the World Wide Web (WWW). Furthermore, the term eHealth Literacy (eHL), meaning" the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem" [42]. There is massive misinformation about COVID-19, which comes in various forms from various sources [33]. The explosion of information on the internet requires individuals to possess the analytical skills to make informed decisions. Moreover, the following factors affect eHealth literacy: an individual's presenting health issue, their educational background, their health status at the time of the encounter, their motivation to seek out information, and the technology used.

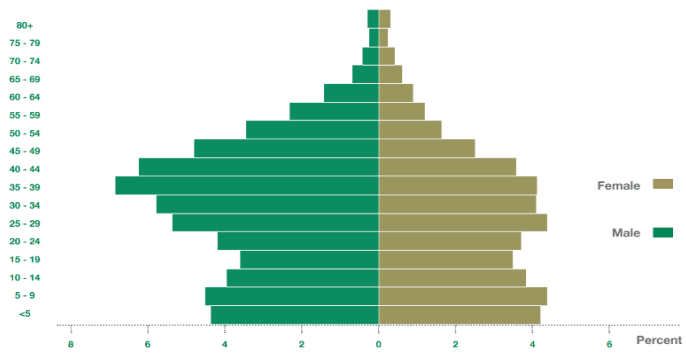


Fig. 1. The Kingdom's Population Pyram

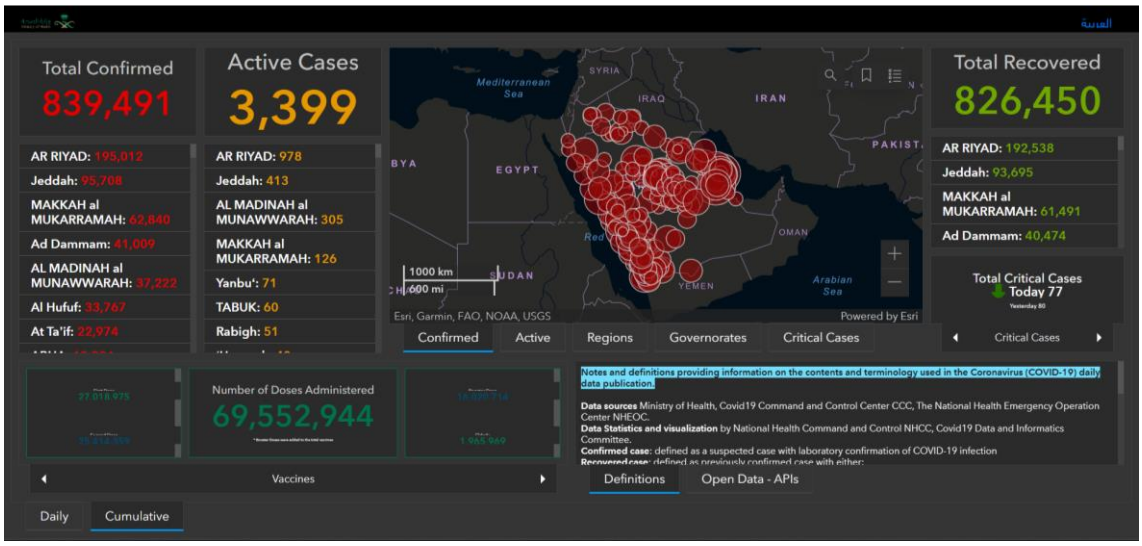


Fig. 2. The COVID-19 Dashboard Interfaces

Fig. 2 illustrates the ease and efficiency with which it is possible to determine the number of confirmed cases of covid 19 and their distribution within the Kingdom of Saudi Arabia. The users can track the instances based on confirmed cases, active regions, governorates, or critical cases. The Circle size indicates the rate of cases and their location. For instance, the smallest circle demonstrates > 5 - 50, whereas the largest for the highest number of cases is> 45,000 - 60,000.

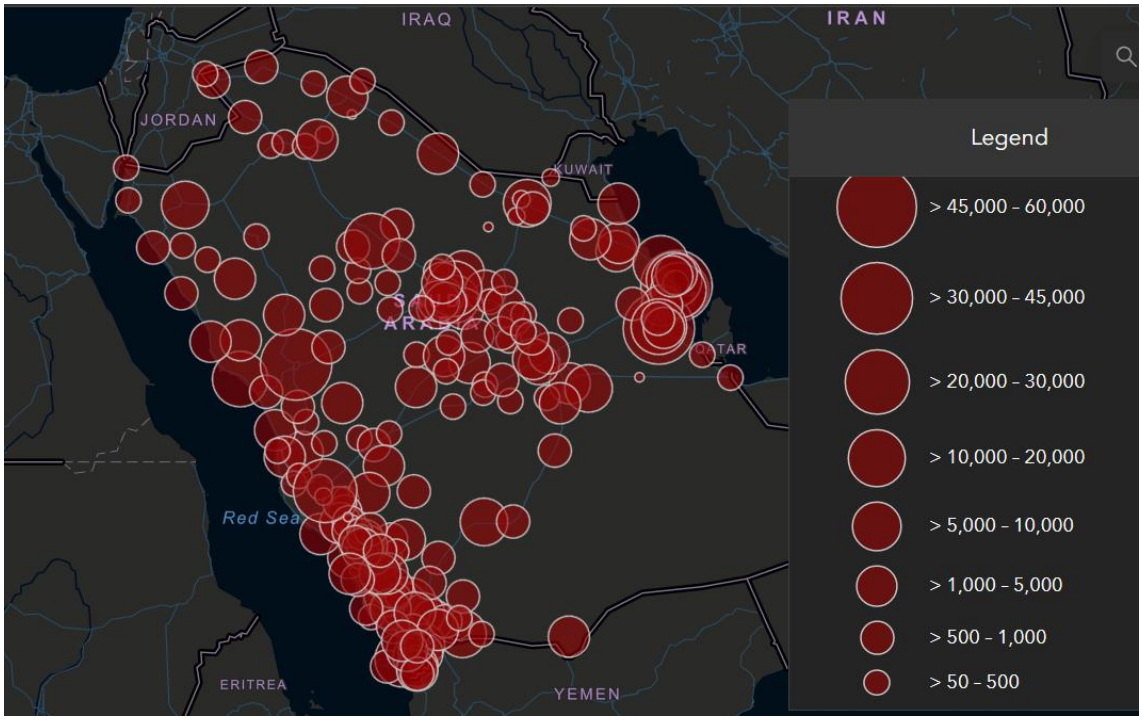


Fig. 3. The confirmed cases

As shown in Fig. 3, new Covid 19 cases reported to the Ministry of Health are reported daily at https://covid19.moh.gov.sa/. Users can switch from daily to cumulative results with just a click. Furthermore, using different mathematical regression models, researchers developed mathematical regression models to predict daily confirmed cases of COVID-19 in Egypt and Saudi Arabia.

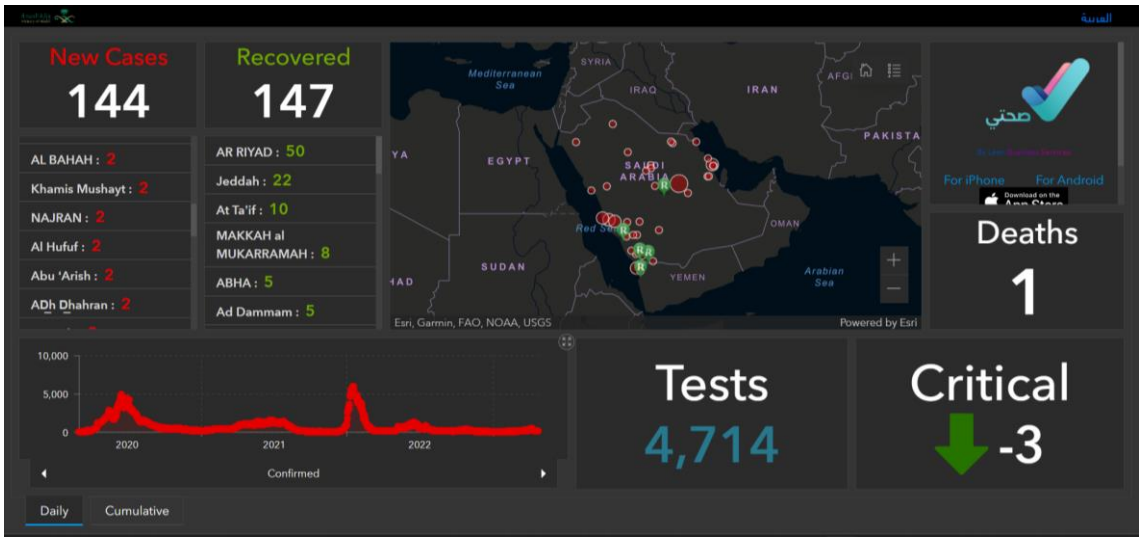


Fig. 4. The Daily New Cases

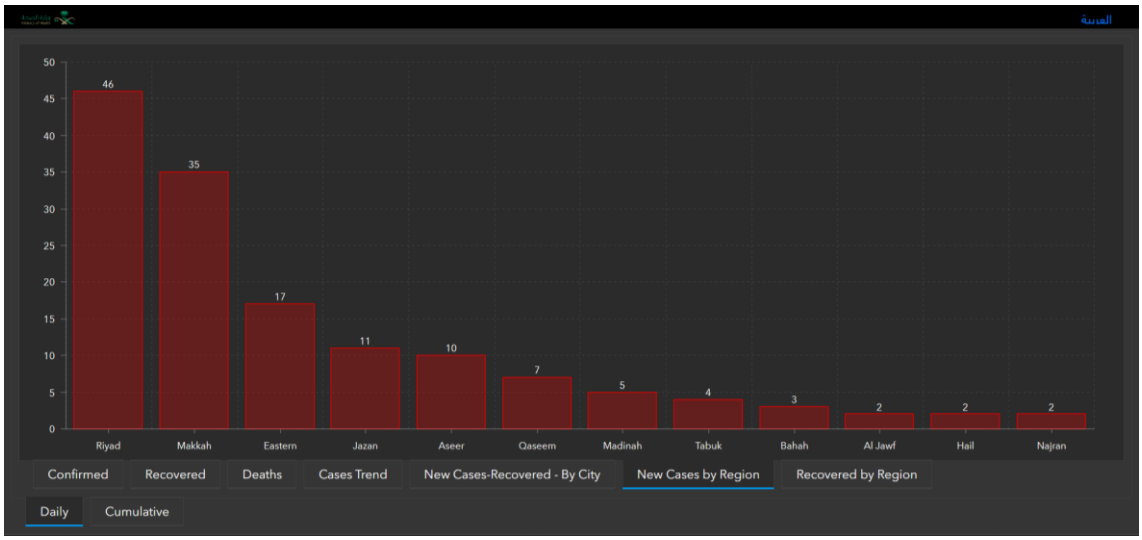


Fig. 5. New cases by region

The concept of line charts is well known in many fields and is also known as line graphs. In this graph, information is presented as a series of connected points. In many situations, line charts are used to visualize trends in data over time intervals, which means that they are used to demonstrate the behaviour of data over a specific period [43].

Saudi Arabia had a fatality rate of 1%, compared with 3.47% worldwide on August 23, 2020. It can be seen from Fig. 6 that the number of critical cases-cumulative was unstable from the beginning of the trend, but in the last months, it has been deficient and approximately steady. Therefore, understanding this type of illustration does not require much effort.

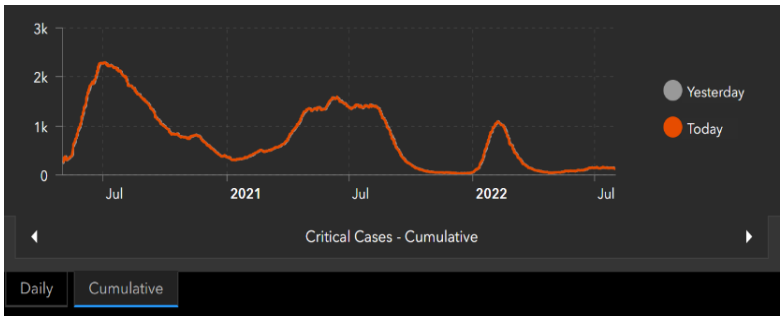


Fig. 6. Critical Cases- Cumulative

Fig. 7 shows information about the case trends in Saudi Arabia from the start of the COVID-19 period in terms of total cases, total recovery, and activity. The below graph lets users quickly determine the cases' trends. Digital dashboards have many advantages and optimization possibilities in public health and clinical practice. Dashboard visualizations of information, for example, may be connected to other systems via interfaces so that data can be automatically transferred. This ensures the accuracy of the displayed information. A color or other visual feature can also draw the viewer's attention to important information [44].

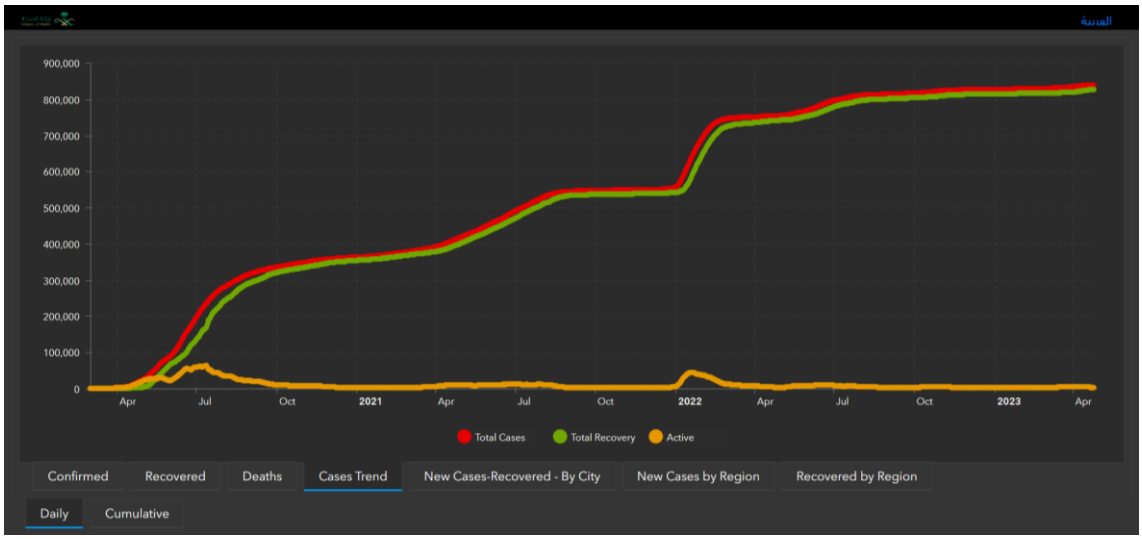


Fig. 7. Cases Trends

Dashboards were successfully used during the COVID-19 pandemic to track cases, deaths, and tests and manage the patient flow [45]. The United States has developed a dashboard for the COVID-19 vaccine so that vaccine safety data may be analyzed timely and disseminated effectively [46]. Fig. 8 shows that the first dose was administered to over

26700,000 people, while the second was to 25,082,132 people. It is estimated that 66,700,629 doses, including booster doses, were given to Saudi citizens on 8/4/2022. In addition, 14,904.575 booster doses were administered, and 1,962,484 elderlies were vaccinated.



Fig. 8. First Dose Applied

The United States has developed a dashboard for the COVID-19 vaccine so that vaccine safety data may be analyzed timely and disseminated effectively [46]. This demonstrates the significance of dashboards worldwide; they were utilized for various purposes.

Some issues were associated with COVID-19 dashboards; for instance, research in 2022 indicated that 28% of COVID-19 dashboards used inappropriate or poorly defined epidemiological variables. 64% of cases did not adhere to standard cartographic principles regarding colors and sizes [47]. Additionally, researchers concluded that actionable dashboards are necessary to facilitate effective audience decision-making. Dashboards are essential for monitoring the COVID-19 pandemic, but maintaining their value requires understanding its stages. Further, there needs to be more proficiency in using communication features effectively. COVID-19 dashboard developers should better utilize public health and communication specialists to ensure data is accessible to the general public [48]. Furthermore, as stated by Hu et al., there are significant differences in the messages and data templates used in producing epidemic surveillance summaries and verified case reports which may have to be updated following pandemics or catastrophic events [49].

In contrast, many studies demonstrated that COVID-19 dashboards and data are highly beneficial and impact a wide range of ways to facilitate our lives. First and foremost, dashboards were successfully used during the COVID-19 pandemic to track cases, deaths, and tests and manage the patient flow process [45]. Researchers, transportation authorities, and the general public can make better-informed decisions using this interactive dashboard [50]. It has been highlighted in other studies that epidemiological studies on COVID-19 heavily rely on confirmed case reports [51], [52]. Furthermore, Reports and data are needed to guide complex policy decisions during the current pandemic [53].

Moreover, reports and data are needed to guide complex policy decisions during the current pandemic[53]. Saudi Arabia COVID-19 and other global dashboards found during the investigation contained summaries of the deaths, active, confirmed cases, and others. Thus, it will be a valuable tool for guiding complex epidemiological studies and making more informed decisions.

Public health emergencies require effective communication and information exchange between all stakeholders to facilitate informed decisions [54]. For instance, data visualization can provide insights into vaccine allocation, scheduling, and prioritization [55]. Consequently, a large number of people are expected to be vaccinated. It is suggested that health officials and policymakers immediately develop dashboards in the case of similar conditions and update the existing dashboards continuously [52]. It has been found in recent studies conducted in the United States that websites must adhere to usability guidelines to be valid [56]. Furthermore, research recently indicated that Chinese city websites must provide information during emergencies, label content categories, properly present information, and address audiences' needs [57]. The pandemic may be reduced by disseminating unbiased and highly accurate information [58].

Several limitations were identified in this study. Firstly, the study examined only one dashboard in the country. Secondly, local information disclosure performance may change over time due to the rapidly evolving COVID-19 situation in different countries. A future study may show how the authorities deal with the pandemic. Official websites and data remain the most authoritative and reliable sources of information. Accordingly, these online dashboards were considered essential public resources for this study. The public may benefit from being kept informed about COVID-19 developments in real-time through the dashboard [59]. As a result, the findings of this study may guide policymakers and data visualizers in the future.

The present research examined the importance of data sharing and visualization, focusing on the COVID-19 dashboard developed by MOH. The COVID-19 virus and its symptoms have been a concern for nations since the pandemic. In response to COVID-19, there was a widespread infodemic, disseminating an enormous amount of misinformation and statistics. However, some countries, such as Saudi Arabia, have introduced web-based communication solutions. Users found up-to-date, accurate, and reliable information about coronavirus cases on the COVID-19 dashboard. Obtaining this information is crucial to the eradication of the virus. Controlling the virus will require accurate and relevant information to be provided to people consistently. Therefore, utilizing technology to communicate with all stakeholders about COVID-19 has proven to be a successful strategy. Individuals interested in using this dashboard can better understand COVID-19 cases using the dashboard. In multiple

future points should be considered. First, since COVID-19 dashboards are highly dynamic, analyzing how they have evolved is necessary. Secondly, a broader range of indicators may enhance the monitoring of COVID-19 and its economic and social impacts. Next, the interoperability of health, social, and economic data sources is essential for better measuring and controlling the epidemic in the future. Lastly, adding additional features to these dashboards is needed to facilitate the use of these dashboards by people with disabilities during such pandemics.

Conflict of Interest

I declare that there is no conflict of interest.

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