**CHAPTER I  
INTRODUCTION**

The usage of digital solutions has proven to be crucial in times of global pandemic crisis. It is unequivocal that the COVID-19 pandemic posed a prominent challenges on the global response and management to control the SARS-CoV-2 virus. Every country was expected to ensure and expand their COVID-19 preparedness, readiness, and response strategies to supress the transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative virus that caused the COVID-19. and thereby, reducing further COVID-19 infection and the impacts on every (World Health Organization, 2016, 2021). Thus, the pandemic have also brought a tremendous need for digital solutions, which fortunately revealed effective use cases such as public health communication, resource consumption and distribution prioritization, population screening, infection tracking, development of specialized interventions, and many more. With that, it progressively compelled governments and communities to persistently address the pandemic through innovation and integration of digital technologies, given the enormous impact it brings and the diversity it can be utilized for different aspects of the pandemic (Golinelli et al., 2020; United Nations, 2020; Vargo et al., 2021). Although it has long been expected prior to the COVID-19 pandemic (Herrmann et al., 2018), it was inevitable for governments to quickly favour, adopt, and integrate digital solutions to their COVID-19 response strategies given the opportunity to strengthen COVID-19 pandemic response strategies (Golinelli et al., 2020).

Digital technology played a crucial role in the facilitation of COVID-19 response strategies. One of the major response strategies that are commonly scoped is the development and improvement of public health communication (Afzal et al., 2021). According to the United Nation, after the declaration of the COVID-19 pandemic, they have found that 110 countries (57%) have already utilized digital technology as a way for public health information communication (United Nations, 2020). A month after, 167 countries have used digital technology to disseminate COVID-19 information and guidance. Moreover, various private and government sectors have come up with ways to integrate and digital technology to improve the COVID-19 information system (Afzal et al., 2021; Whitelaw et al., 2020). One of which is the development of centralized information and the visualization of the epidemiological data through the dashboards (Dixit et al., 2020; Dong et al., 2020; Whitelaw et al., 2020), which would allow the consistent monitoring of the infections and modelling efforts. And it increased the demand for the development of COVID-19 dashboards given the contribution and massive impact it brings to the public health (Dong et al., 2020).

The first development of tracking technology for the COVID-19 pandemic was developed prior to the declaration of the pandemic. On February 17, 2020, the Center for Systems Science and Engineering (CSSE) at John Hopkins University had developed an interactive information system, wherein the outbreak novel coronavirus strain can be visualized and monitored concurrently (Dong et al., 2020). And until now, the JHU CSS COVID-19 data repository for the COVID-19 statistics has been one of the de facto standard for COVID-19 information source. Thereafter, it became a common initiative the application digital technology to allowing the most up-to-date and reliable information to be delivered to the public health (Chehresa, 2020). And so the COVID-19 pandemic presented an unprecedented demand for the integration of digital technology and public health reporting.

The prevalence of COVID-19 information platforms were unprecedented. Almost every country has the tracking and information delivery part of their COVID-19 response strategies. Additionally, by jurisdictions, as the first custodians of COVID-19 information, governments have begun providing statistics such as the aggregate number of cases in a country, overall fatalities, and case reporting (The White House, 2021; United Nations, 2020). Since one of the requirements in the COVID-19 crisis management is the establishment of accessible and reliable COVID-19 information for promoting appropriate public health decision-making (World Health Organization, 2021). So the improvement and development of a robust COVID-19 information system was necessary. However, the COVID-19 pandemic is a turbulent situation, where the effort of response must be actionable and in realtime for it to be impactful and relevant. Thus, the demand of governments, healthcare workers, media, and the citizen for a realtime, reliable, and accessible COVID-19 information was a consequence of the scale and pace of which the situation progressed. Fortunately, the adoption of digital technology allowed the conceptualization of solutions for these demands for COVID-19 response.

The development of COVID-19 information platforms with an unprecedented pace and variety of stakeholders was pervasive. Given the high internet penetration, integration of digital technology with health information systems (Pan American Health Organization, 2020b), and the prevalence of web applications (Galea, 2020). COVID-19 dashboards developed by various international organizations (WHO COVID-19 Dashboard), academics (John Hopkins Coronavirus Resource Center), and industries are instances that go beyond national, regional, and local governments to show the value of data visualization. However, although every COVID-19 dashboard that has been developed has its unique features, it still constitutes the same purpose.

The World Health Organization had released its COVID-19 information dashboard (World Health Organization, 2020b). The dashboard's notable feature is its mobile-friendly responsiveness, minimalistic design, and interactivity that makes complex statistics accessible and available in a convenient way. In the Philippines, the Department of Health had released its Official COVID-19 Tracker. The COVID-19 dashboard was developed by utilizing a dashboard service called "Tableau." Every essential COVID-19 related information is comprehensible and straightforward. It is also interactive, where the users acquire a brief description of each presented data. Various governments have also released its COVID-19 data case bulletin in the regional context. However, it is a significant drawback to adopt case bulletin means of delivering the COVID-19 information because it is laborious to maintain, inefficient, and cannot deliver information in real-time.

COVID-19 information is mainly delivered through the information systems, which is why it plays a crucial part in controlling the COVID-19 pandemic (Pan American Health Organization, 2020a). Moreover, health authorities have developed many approaches to improve the COVID-19 information system and effective public communication. One of the ways healthcare authorities have accomplished effective public health communication is through the adoption of the internet (World Health Organization, 2020b). In such conditions of isolation, the adoption of technology is no coincidence. That is because it conveniently allowed people to have an accessible source of relevant and reliable COVID-19 related information.

COVID-19 information systems are more critical than at any other time for handling data and information at the pace required by the ambiguity of the COVID-19 situation. Information systems allow quick, expeditious, and coordinated information accessibility and sharing, and they promote the prioritization of care, access, and response, particularly for individuals in contexts of susceptibility. With appropriately disaggregated COVID-19 insights, it is feasible to develop a mechanism that minimizes potential health disparities at all levels of care and facilitates the execution of initiatives to tackle such inefficiencies. So, integrating technology to promote advance digital health information became an option for improving a robust health information system. What is needed is an actionable expansion of the present COVID-19 information system to have an effective COVID-19 public communication.

COVID-19 information systems can be expanded by implementing a web-based application, such as platforms and dashboards, which provides COVID-19 insights. It is apparent that COVID-19 platforms are one of the essential ways to communicate the COVID-19 situation to the public effectively. Even though the Government Health Departments already has its COVID-19 data that is publicly accessible, organization and academic-based repositories, such as the JHU CSSE COVID-19 repository, became the de facto standard. Not only that, despite the availability of these data, it needs to be extracted and processed to be displayed through dashboards. That is why a platform that provides real-time dashboard visualization of COVID-19 data became an effective technique to fulfil the public health needs for essential COVID-19-related information.

Dashboards can promptly present actual or real-time data changes, unlike static reporting modalities such as articles or reports. That is why multiple governments and organizations from various nations have developed an accessible dashboard specifically to highlight the situation in their nation. One of the recurring features of these dashboards is that it provides a comprehensible summary of the cumulative data about the COVID-19 cases, deaths, recoveries, and the overview of the COVID-19 vaccination insights, and these numerical data are then visualized. People with no technical knowledge could benefit from a real-time COVID-19 tracking dashboard, which can contain a plethora of information on a web application. Furthermore, this can be meaningfully utilized by individuals in need of COVID-19 related information. Digital dashboards allow COVID-19 epidemiological data to record and report individual data points from various levels, allowing for a more precise assessment of the COVID-19 pandemic context. Consequently, an overview of the scenario is provided in an accessible and convenient way.

However, the one of the identified problems by the researcher in the locality is the lack of COVID-19 dashboards inclusive of the epidemiological insights within the area of Digos city. Despite the rising popularity of COVID-19 dashboards developed by various organizations, such as the COVID-19 Tracker Philippines from DOH, Davao Region COVID-19 Insights of Mindanao, John Hopkins Coronavirus Resource Center, there is a lack of inclusivity for specific insights from the locality. Although the City of Digos government-organized page from Facebook publishes COVID-19 insights, it is published only with long intervals between days, weeks, or even months, which is a major insufficiency for effective COVID-19 public communication. Thus, considering the pace of the COVID-19 situation moves at an exponential rate, the gap will surely incapacitate Digoseños in making the best health-informed decisions. Hence, a real-time web-based COVID-19 dashboard is defined as a solution to the problem.

In ways that are difficult to do conventionally, the utilization of digital technology have certainly proven to in pandemic strategy and response. Therefore, as an independent academic initiative, this research will propose a project that will develop a web-based interactive dashboard, namely COVID Pulse, which is inclusive of the COVID-19 context of Digos City. The web-based application will have data visualization features and track COVID-19 cases, deaths, recoveries, and vaccination at the global, national, regional, and local levels. The objective of this website should be to make COVID-19 related information more mainstream, especially in the locality, and to allow the Digoseños, the citizens of Digos City, for a much more granular assessment of the COVID-19 situation, especially considering the ambiguity of which the situation changes.

This area of study is important since effective public health communication plays a crucial part in controlling the COVID-19 pandemic. As the COVID-19 virus continued to ravage the world, adequate, reliable, timely, and relevant information became a highly essential resource for people to be consistently informed. Fortunately, healthcare authorities could communicate to the public effectively by digitizing information systems (Bernardino & Bacelar Nicolau, 2020). That is why COVID-19 information systems are more critical than at any other time for handling data and information at the pace required by the ambiguity of the COVID-19 situation. Consequently, many have developed approaches to improve and expand the COVID-19 information system and public communication (Clarke et al., 2021; World Health Organization & Others, 2020). Health information systems were expanded at an unprecedented pace due to the urgency of the worldwide need for COVID-19 data and the widespread internet penetration (Ivanković et al., 2021; Max Roser & Ortiz-Ospina, 2022). That is because COVID-19 information systems may support decision-making and help individuals adapt their health behaviors to the crisis.

Contributing to the expanding of the COVID-19 information systems make it easier to prioritize healthcare, access, and response for those most in need by making it possible to access and share data immediately, expeditiously, and in a coordinated manner (World Health Organization, 2020). Another way of expanding the information system is by adopting web-based COVID-19 dashboards as a medium for effective public communication of the data. Accessible web-based dashboards for COVID-19 data have become quite prominent and necessary. It provides essential empirical support for making the most informed decisions feasible and improving awareness of safety measures for Digoseños (World Health Organization, 2020). Hence, the primary rationale for the topic of interest is to provide an exclusive and area-specific data communication for Digoseños since there is a need for expansion of the Digos City COVID-19 Information System. Researching this topic and developing a COVID-19 dashboard that will contribute to the improvement of a robust information system in Digos city is necessary, if not, crucial as part of the effort to control the COVID-19 pandemic.

**Theoretical and Conceptual Framework**

The study that is going to be conducted can be best viewed with the Viewpoint which provided a framework developed by Whitelaw et al. (2020). This framework was developed for the purpose of highlighting the various ways digital technology could be integrated with a pandemic management and response, which in this case, the COVID-19 pandemic. The COVID-19 pandemic had catalyzed efforts in various nations for controlling and mitigation. However, the outcome of the response on the COVID-19 pandemic depends distinctively. Oftentimes, outcomes changes particularly relies on the strategies that were adopted to contain and mitigate the situation. Apart from the quick response, mass testing, contact tracing, and strict imposition of COVID-19 policies various efforts exerted on the COVID-19 pandemic, the framework emphasized that the countries that have successfully flattened the incidence curves and maintained a low mortality rate are usually those who have resorted to adopting digital technology and made it part of their COVID-19 pandemic policy and overall response (Whitelaw et al., 2020).

Additionally, the framework emphasized that there are many ways digital technology can be used as an initiative to pandemic preparedness and response. This can be utilized as a contact tracing, quarantine and self-isolation, screening for infection, clinical management, planning and tracking, and medical supplies, with each having its functions, advantages, and disadvantages. The research project is implementing the Tracking technology wherein the COVID-19 Pulse, the digital technology that is integrated for the purpose of COVID-19 pandemic response, is aimed to provide epidemiological insights and monitor the COVID-19 situation in real-time.

With this, the research had acknowledged the framework postulate that tracking technology may be advantages since it paves the way for an actionable and reliable COVID-19 information, visualization of the COVID-19 virus and pandemic, guides and resource allocation, and dissemination of COVID-19 forecasts. However, the framework also asserted that although tracking technology is advantageous, it is without its disadvantages. One highlighted disadvantage of integrating dashboard technology as part of the COVID-19 pandemic response is the high costs and demand for maintainability. Nevertheless, it will be considered on the pre-development feasibility analysis. Hence, countries with successful outcomes on the COVID-19 response and mitigation strategies are mostly those who have digital applications integrated in their COVID-19 strategic plans. This framework was chosen specifically since it clearly supports the rationale for the development of COVID Pulse project. Moreover, the importance of digital applications has been emphasized as one of the key strategies in appropriately controlling the COVID-19 situation, which further renders the project relevant and necessary.

This research will also provide a rationalization for the development process of COVID Pulse project based on the theoretical model called Input-Process-Output-Outcome (IPOO) model (Brown & Svenson, 1988). This framework is an extended version of the conventional Input-Process-Output (IPO) model that is often used in system analysis and computer programming as a way for characterizing the architecture of a software application and perhaps other systems. The IPO is one of the simplest way to explain the protocol of a project. Nevertheless, the IPOO model is a variant of the IPO and will be based on the deterministic system, but has been extended with the outcome stage. According to the IPOO model, the process for the COVID Pulse project can divided into four categories: input, process, output, and the outcome, as shown in Figure x.

The input stage will contain many of the requirement from the environment, in this case, the Research Problem, Review of Related Literature (RRL), Review of Related System (RRS), Programming Knowledge, Software Requirements, and Hardware Requirements. The process stage will technically be the activity that will occur in the COVID Pulse project itself. In other words, this is where the components of the input stage will be processed into outputs. This process or activity can also be the research process, proposal writing, and each of the development life cycle of the COVID Pulse project such as planning and analysis, designing, development, testing, and deployment process.

For the output, this stage will deliver the results of the processing of the input. The output stage is essential since it reflects the overall product of the input and output process, which is the COVID Pulse web application. Lastly, for the outcome stage, this reflects the expected behaviour and upshot of the COVID Pulse web application. The outcome stage components are produced after the implementation, utilization, and maintenance of the COVID Pulse web application is accomplished. Additionally, it can also be extended with an impact stage, where it can contain the implementation of border restrictions as an impact and proactive COVID-19 response.

Output

COVID Pulse

Implementation

Utilization

Maintenance

Input

Research Problem Identification

Review of Related Literature (RRL)

Review of Related  
System (RRS)

Programming Knowledge

Software Requirements

Hardware Requirements

Process

Software Development Life Cycle (SDLC)

Planning and Analysis

Designing

Development

Testing

Deployment

COVID Pulse System Response Contribution

Outcome

Visual Depiction and Tracking of the COVID-19 Situation

Administers Border Restrictions

COVID-19 Information Resource Categorization

Provides COVID-19 Updates and Forewarns

***Figure x.*** The IPOO Model Conceptual Framework  
of the COVID Pulse Web-based Application.

**Objectives of the Study**

This research project aims to expand the COVID-19 information system of Digos City through the development of a real-time tracking COVID-19 web-based dashboard called "COVID Pulse" for Digoseños to ensure that they are prioritized by enabling it to be feasible for them to retrieve updated COVID-19 information in real-time. Specifically, the project objectives of the study are following:

1. To gather the necessary requirements and its method to be employed in developing the COVID Pulse web-based application.
2. To develop the COVID Pulse web application frontend, middleware, and backend.
3. To embed and visualize the COVID-19 data from COVID-19APIs and resources.
4. To develop an accessible Digos City COVID-19 web-based application that provides:
   1. A dynamic and real-time comprehensible epidemiological indicators
   2. A user-friendly interactive user experience and interface
   3. Brief narratives to summarize and interpret displayed data
   4. Relevant news updates related to COVID-19 situation

**Significance of the Study**

COVID Pulse will be developed for the general public and can be accessible through the internet. However, the significance of this project will directly benefit the following:

**Public Health Authorities.** Public health authorities, especially in the locality, need to be proposed with a real-time COVID-19 tracking dashboard to communicate the epidemiological insights in Digos City. Disseminating COVID-19 insights through social media lacks actionable and real-time qualities, rendering the COVID-19 information system for public communication insufficient. Therefore, public health authorities need a complementary means of effectively communicating the COVID-19 epidemiological data to the public. One of the ways it can be done is by developing a real-time COVID-19 dashboard that includes the context of the locality. It is through the proposal of a COVID-19 web-based dashboard that allows the public health authorities to disseminate the essential COVID-19 insights to the public.

**Digoseños.** The lack of access to real-time COVID-19 insights incapacitate the health-decision making of Digoseños in the context of the COVID-19 situation. Therefore, a real-time dashboard visualization of the COVID-19 data proposal is a useful approach to address the general public of Digos City's need for comprehensive, timely, and accurate COVID-19 related information, which will allow them to make critical health-informed decisions.

**Researchers.** Although it is improbable that this study will be published, researchers hereafter who have the same research of interest, that is the adoption of technology for pandemic response, can benefit from this research study. That is because the development journey and activity taken will provide further insights, recommendations, and implications. Furthermore, the study can also be anchored for their studies to further synthesize and support their upcoming studies. Lastly, they can also utilize this study to develop a much better methodology in developing a real-time COVID-19 dashboard prototype.

**Open-Source Community.** The will benefit the open-source community since the repository for COVID-19 Pulse will be published on GitHub, which is version-control and collaboration online platform for developers. Hence, every aspect of the project from the frontend, middleware, and backend source code as well as the manuscript and documentation will be publicly available. With that, anyone can contribute or even fork the project for further improvement of the COVID Pulse. Lastly, even though the project will be available publicly, there will be certain limitations and restrictions when it comes to the distribution and modification of the COVID Pulse project.

**Scope and Limitation of the Study**

The study will mainly focus on the contribution of expanding the COVID-19 information system of Digos city through the development of a COVID-19 web-application called COVID-19 Pulse. The researcher will ensure that the designed and developed prototype will meet all the designed and devised requirements. In other words, it must at least be barely functional as well as provide answers in the statement of the problem. Additionally, the researcher will consider the feasibility in terms of technical, economic, legal, and scheduling feasibility aspects of the project. This will be further analyzed in the pre-development feasibility analysis stage. Strictly speaking, the project will only adopt available technologies that is also technically and economically feasible and possible for the researcher to deal during the development of the COVID Pulse. Nevertheless, the researcher will also consider limiting the project to develop a prototype given the time constraints. Since given that the project with a scope of deploying a perfect web-application that is an efficient, accurate and error-free will make it unfeasible to conduct. Especially in the frontend development where the consensus has attested that it is an arduous process. Lastly, the researcher will set a timeframe for the development process from February 2022 to May 2022.

**Definition of Terms**

**COVID-19 PULSE.** It is the opted web application name of the COVID-19 realtime web-based application. The name was inspired by the Official School Publication of Cor Jesu College Basic Education Department called “Pulse”.

**REALTIME.** It refers to the feature of the COVID Pulse web application that delivers information in the time during it was requested. In other words, it can be describe as a mechanism of the system where it is available and immediately provides the necessary COVID-19 related information. This could also mean that the information that is delivered is up-to-date according to the COVID-19 dataset reports. So COVID Pulse can be called realtime if it delivered the data relative to the newly reported data from the primary source.

**WEB-BASED APPLICATION.** It refers to the type of which the COVID Pulse application program was designed. Unlike the software applications where it is stored in the client’s device, COVID Pulse is designed to be accessed through the internet and stored in a remote server, and can be used using a web browser.

**INCLUSIVE.** It refers to the main aspect of the COVID Pulse web-based application where it also delivers COVID-19 information and insights relative to the locality for Digoseños. Unlike the other COVID-19 web applications where it either is abstract, excludes, or lacks the coverage of the necessary and relevant COVID-19 data in the locality.

**DIGOS CITY.** It refers to the aimed locality of which the COVID Pulse will be specifically deployed. The City of Digos is located in Davao Del Sur, Philippines, and the demonym for the citizens living in the city are called Digoseño.

**COVID-19 INFORMATION.** It refers to the information that is related to the COVID-19 pandemic situation, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), Coronavirus Disease 2019 (COVID-19), COVID-19 Vaccination, COVID-19 Policies, and many other COVID-19 related information that is relevant and timely. Additionally, these information can come in a form of news articles, updates, and epidemiological insights.

**CATALOG.** It refers to the feature of categorization of the COVID-19 information that will be provided on the end-users of COVID Pulse web application.

**TRACKING.** It refers to the feature of the COVID Pulse web application that provides a realtime and up-to-date monitor of the COVID-19 active cases, recoveries, deaths, vaccination, and the overall situation of the COVID-19 pandemic.