# Integrated Disease Surveillance and Response System for the Metro Manila Center for Health Development

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**Abstract:** The Metro Manila Center for Health Development (MMCHD) under the Department of Health (DOH) is responsible for ensuring continuous improvement of health status in Metro Manila by providing an effective yet quality health care system. More specifically, they handle disease reporting and surveillance through their partially paper-based process with multiple medical and government units. This causes delays and inconsistencies in data collection, eventually resulting in inaccurate and untimely data and reports. With an objective in incorporating technology and public health, the Integrated Disease Surveillance and Response System (IDSRS), with a user acceptance rate of 93.59%, serves as an information system dedicated for the MMCHD in combating epidemics and assessing health programs within Metro Manila. Not only does the system address inconsistent and untimely data, it also incorporates disease surveillance and program management with the help of data analytics to assess its effectiveness. In the creation of this system, interviews, research and feasibility studies were done to fully understand and incorporate the concepts needed by MMCHD. As for development, a web application was created in order to integrate and centralize the processes being carried out within the MMCHD and the different units. The resulting system is divided into five modules: Patient and Case Management, Analytics and Visualization, Feedback and Report Management, Programs Documentation, and Program and Surveillance Evaluation. These interdependent modules function to handle the input, preprocessing, storage, manipulation, analysis and evaluation of disease surveillance and programs data. While the system itself now uses data to maximize the creation of meaningful insights for decision makers, many more opportunities are still available. The system may also expand to integrate with laboratories within Metro Manila for smoother processes, as well as expanding towards the use of predictive analytics to gain further insights on the spread of disease cases.

**Key Words:** Epidemiology; Health Programs; Disease Surveillance; Disease Response; Integrated System; Information System; Analytics

# 1. INTRODUCTION

## *1.1 Background*

"Philippines records all-time high 39,004 COVID-19 cases" (Bolledo, 2022). Since the start of the outbreak in 2020, the number of cases still continues to rise critically, even after 2 years have already passed.

The onslaught of the pandemic has raised the bar for disease surveillance and response. As of writing, the number of confirmed cases and deaths globally has reached more than 400 million and 5 million, respectively, and the Philippines constitutes more than 3 million confirmed cases and more than 55,000 deaths to these numbers - with the National Capital Region (NCR) having the highest number of cases among all regions across the country (World Health Organization, 2020).

Such a huge threat to public health demands for continuous improvements on existing disease surveillance and response systems all over the world. Government authorities, alongside healthcare practitioners, should be at the forefront of ensuring public health safety and providing prompt and appropriate public health actions to either maintain the health status of the community or combat a threat. For Metro Manila, MMCHD is responsible for handling and ensuring quality and effective health care systems.

## *1.2 Challenges*

Currently, the Department of Health (DOH) mostly supports a paper-based reporting of disease and surveillance information. These go through a lot of time being transported and encoded one by one into their system. Given this existing process and considering the number of reporting and surveillance units, the essence of disease surveillance is lost because of the delays and incomplete reporting which leads to incorrect and inaccurate information.

Donelle, et al. (2021) highlighted the importance of technology being used especially during the COVID-19 pandemic, to reduce and prevent the spread of diseases through detection, tracking, reporting, and analysis. Aside from the problems mentioned, there are also limitations in the technological tools available, such as the use of Excel spreadsheets as their manner of storing disease case data recorded. Therefore, it is also a challenge to use data that may not be reliable due to the possibility of clerical errors.

## *1.3 Significance and Aim*

With MMCHD as the client, this project aims to address and cater to their needs in understanding the underlying problems with current existing processes and looking for solutions to combat these issues they experience. This also includes developing a system for MMCHD, through further integrating relevant surveillance and support activities with response processes, as well as tackling the opportunities for the organization and its stakeholders.

The significance of this study lies in empowering, equipping, and providing MMCHD with a system that is capable of integrating disease surveillance and response systems with the use of analytics which helps the organization in decision making, eventually impacting the health sector, academic community, and the general public. This also falls in line with SDG 3, Good Health and Well-being.

## *1.4 Scope*

The research and system are geared toward further enhancing and improving the existing processes. This means the system only covers their current processes, which includes disease surveillance and reporting. The use of this system is only limited to those from MMCHD, Regional Epidemiology & Surveillance Unit (RESU), disease reporting units (DRUs), and local government units (LGUs) from Metro Manila with the collected data being relevant information not limited to their basic information (age, gender, address), but also includes their lifestyle information, and relevant past medical history to be used for analysis.

# 2. METHODOLOGY

For the development of the system, the Scrum method was decided to be the software project management process. This method followed iterations of biweekly intervals in making the team more productive. The project also made use of a backlog to keep track of goals to achieve during development, along with regular meetings in sprints (Way et al., 2009).

As a result of research on the field and the organisation, along with interviews done with various resource persons, a Cause and Effect Analysis was created, pointing out the key problems the MMCHD is facing. In summary, the identified problems are (1) incomplete surveillance data from DRUs, (2) redundant

data are possibly stored as well as undetected cases, (3) data used for analysis and feedback is not readily integrated and pre-processed, delaying prevention and control efforts, (4) data gathered is not maximized to help in deciding prevention and control plans, and (5) difficulty in allocation of manpower due to unavailability of analyzed data. As a consequence of these, the MMCHD has decentralized surveillance data, leading to an incapacity to promptly generate reports. To confirm these findings, meetings with the MMCHD were conducted in order to align the identified problems and potential solutions with them. Their feedback was also taken into account in identifying solutions for them.

Thus, literature on related systems was gathered in order to gather effective implementations of systems that dealt with disease surveillance and data integration. These served as the basis to create and build upon ideas for the implementation of the system and its modules and features. Using Scrum as the method of development, the system was designed, created, tested, and revised. The system was created using Node.JS and Nuxt.JS as the backend and frontend frameworks respectively, with MySQL as the database management system, and using Amazon Web Services as the cloud hosting platform. Microsoft PowerBI was also used for the dashboard and analytics charts.

## 3. RESULTS AND DISCUSSION

IDSRS was developed for MMCHD as a decision support information system. It specifically supports MMCHD in monitoring and analyzing immediately notifiable disease cases, weekly notifiable disease cases, and health events for prompt public health action. This is achieved through five (5) modules: Patient and Case Management, Analytics and Visualization, Feedback and Report Management, Programs Documentation, and Program and Surveillance Evaluation.

The first module, Patient and Case Management, handles data entry where patient, disease case, and health event details are recorded by DRUs into the system. This module houses the viewing and updating of disease case definitions which are used to diagnose the case level of a patient. It also features electronic forms available on web and mobile devices with appropriate data validations to eliminate the issue of incomplete data as well as enough tooltips to guide users in filling out the forms even without medical background. This module also addresses redundant data being stored because the database is centralized. Here, previous patient records can be accessed by authorized users, easing data encoding. Furthermore, DRUs that are not capable of laboratory testing to confirm the disease case are given the ability to forward the case to a laboratory registered within the system. Afterwards, the chosen laboratory can update the disease case information. Lastly, the most important problem that this module addresses is the timeliness of reports. This module has an "automatic submit" functionality, wherein case report forms (CRFs) recorded by DRUs are automatically submitted to MMCHD at a specified time that only MMCHD can set. In case the DRU has not yet recorded any case for a particular week and the submit is triggered, their submission is tagged as a "Zero Report", which is important when evaluating the DRU. To still account for late cases, DRUs are still allowed to add them to a particular CRF, but similar to zero reports, they are tagged as "Late Cases" and are also crucial when it comes to evaluation.

IDSRS does not only support an indicator-based surveillance approach where disease cases being monitored are verified and tested by hospitals or laboratories. The system also supports an event-based surveillance approach through the Event-based Surveillance and Response (ESR) feature where details of health events that impose risks to public health, regardless of veracity, are being collected for MMCHD to verify and act upon.

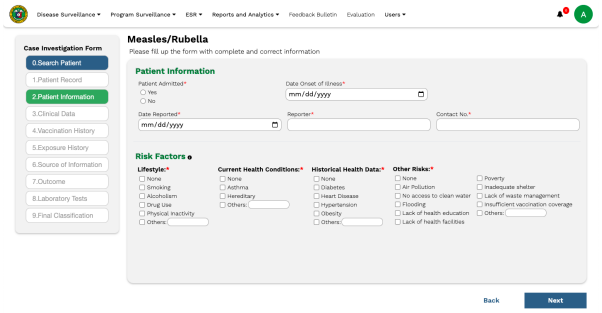


Fig. 1. A case form data capture from Module 1

Following data entry, MMCHD now has the capability to immediately analyze the collected data through the second module, Analytics and Visualization. The system is able to generate both descriptive and diagnostic analytics using Microsoft PowerBI. Previously, MMCHD has to download, process, and visualize data outside of the existing system. In IDSRS, the following analyses are generated automatically using the data collected through the system: (1) Prevalence Analysis, (2) Fatality Analysis, (3) Person Analysis, (4)

Place Analysis, (5) Time Analysis, (6) Risks Analysis, (7) Accomplishments Analysis, (8) Comparative Analysis, and (9) Correlation Analysis. In general, this module answers the following questions:

- Who is getting infected by and dying from the disease? (Specifically by age, gender, marital status, occupation, health risks, and vaccination status if applicable)
- Which areas are having clustering of disease cases?
- When are disease cases prevalent throughout the year?
- Is there a trend in the disease cases over the years?
- Are vaccines or treatments given at the right time, place, and to the right demographic?

The figure below is one of many visuals (Place Analysis) made available which can further be filtered by month, year, disease, city, demographics, and other inputs. Overall, this module serves as the focal point of the system where decisions, such as which city needs more resources in which month, are influenced through the use of visualizations ultimately addressing the last three problems identified in the previous section.

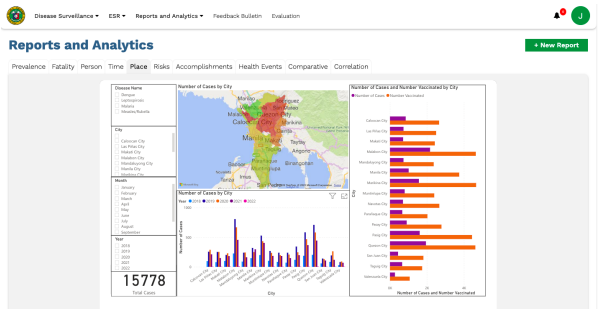


Fig. 2. IDSR's Place Analysis from Module 2

MMCHD uses the analyses from the previous module to create feedback reports containing interpretations and suggestions on health programs. This is supported by IDSRS through the third module, Feedback and Report Management. In this module, authorized users have the ability to create the following types of feedback reports: weekly, monthly, yearly, ad hoc, and outbreak reports with their choice of analysis charts to include. The feedback report will undergo approval which is assisted by the system through automatic emails. Once approved, feedback reports are made available to all users across the system through the Feedback Bulletin, which notifies affected and nearby cities on what actions to take.

To aid in additional efforts by the government to counteract the disease cases, the fourth module, Programs Documentation, serves this purpose. Here, governmental public health programs at their planning and implementation stages have their data inputted into the system through the recording of program targets, Immunization Target Client Lists (TCL), and program accomplishments. The data recorded here will also act as evaluation and performance monitoring, so that programs implemented of this nature in the future will be improved upon further. The programs themselves undergo the processes of documenting the program targets for the DRUs and recording the program accomplishments for each patient under them.

Lastly, the fifth module, Program and Surveillance Evaluation, makes use of the outputs of all previous modules as basis for evaluation and performance gauging. The reporting of both surveillance and program data would be evaluated against various metrics used for their respective natures, such as the quality attributes for surveillance (especially for Timeliness and Completeness) and effectiveness. These may be interpreted for future reference and feedback on improvements needed.

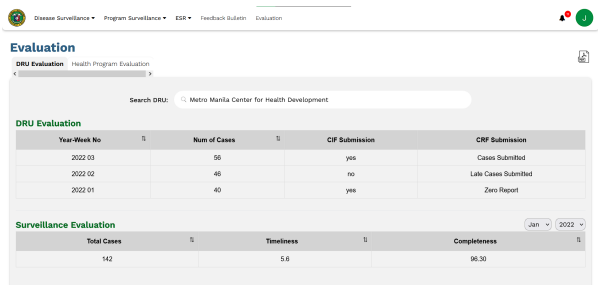


Fig. 3. DRU Surveillance Evaluation from Module 5

A conceptual framework of the project can be found in the next page (Fig. 4), which encapsulates all features, modules, and users involved in the system.

In order to validate the system, the researchers reached out to the client for Usability and User Acceptance Test (UAT) after it was developed. A video of all the modules and features was presented along with the researchers demonstrating each functionality. Four MMCHD personnel participated in the said testing or feedback session. A Likert scale was used to gauge the usability of various aspects of each module from the user's perspective, and UAT verdicts were given as "Accept" or "Reject" to understand if the system fulfilled the needs of the users.

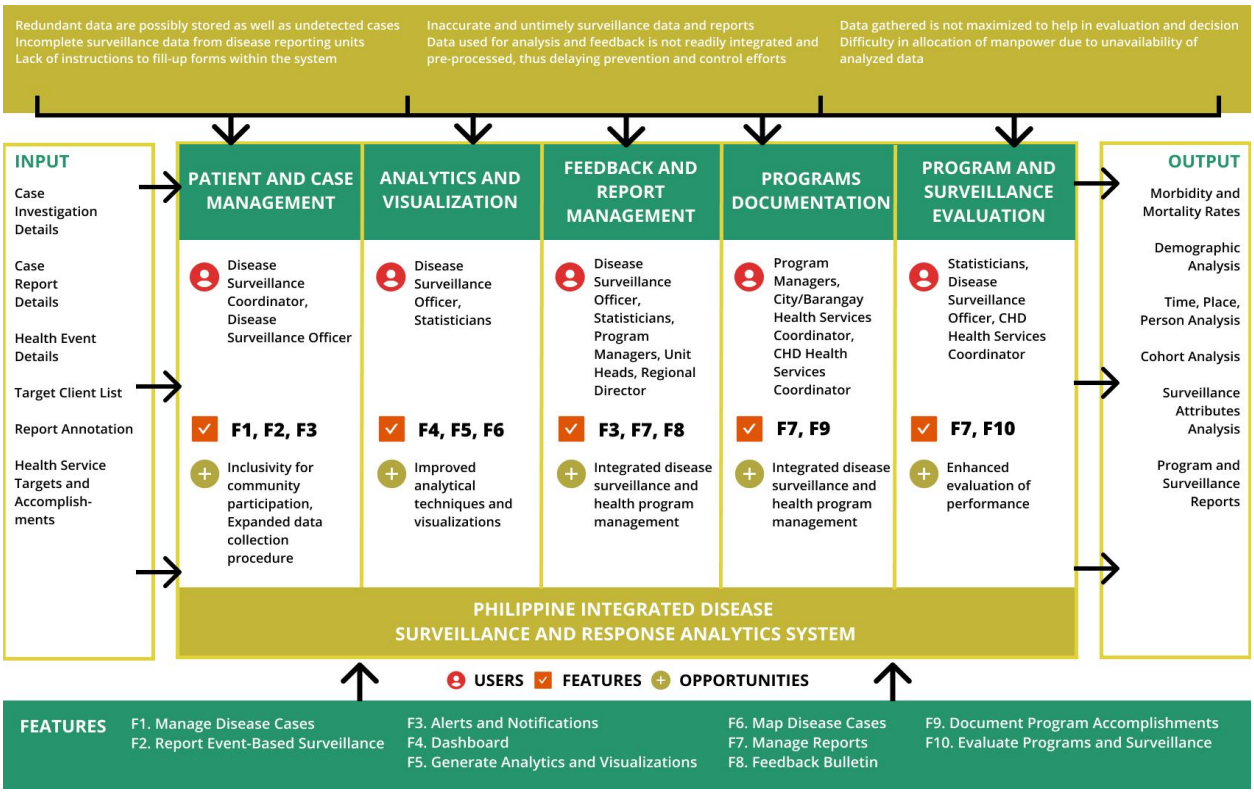


Fig. 4. Conceptual Framework of IDSRS

Table 1. UAT results

| Module | Score |
|---|---|
| Patient and Case Management | 92.86% |
| Analysis and Visualization | 100.00% |
| Feedback and Report Management | 95.83% |
| Programs Management | 75.00% |
| Program and Surveillance Evaluation | 91.67% |

Overall, results of the UAT (Table 1) showed that the respondents were satisfied with the system and found it to be in line with the current existing processes they have within the unit. Based on the UAT results, four out of the five modules received acceptance rates of at least 90%, with Module 2 reaching 100%. Module 4 only received 75% acceptance due to program documentation being outside the responsibility of the unit. This gives the system an overall acceptance rate of 93.59%.

Table 2. Usability test results

| Feature | Score |
|---|---|
| Design | 84.17% |
| Functionality | 81.11% |
| Usability | 90.00% |
| M1: Patient and Case Management | 88.75% |
| M2: Analysis and Visualization | 84.29% |
| M3: Feedback and Report Management | 86.25% |
| M4: Programs Management | 82.00% |
| M5: Program and Surveillance Evaluation | 86.67% |

With regards to the usability test results (Table 2), the design, functionality, usability, and all five modules fared well, achieving an 85.40% score. This

means that the users are satisfied with the experience of using the system for their needs within the unit.

## 4. CONCLUSIONS

It is anticipated that the use of IDSRS will help MMCHD, DRUs, and LGUs in coming up with and executing proactive and prompt health programs to avoid the spread of diseases in their respective areas. More specifically, it is expected that through expanded data collection procedures (i.e., ESR and mobile application counterpart of data collection tools), incomplete and late reports will be minimized. Thus, data used are maximized to create meaningful insights for decision makers. Furthermore, it is expected that inefficient processes such as redundant data entry and consolidation, as well as the problem of pre-processed data not readily available for analysis will become obsolete because all are already handled by the system. Lastly, it is expected that the extent of analysis available in the system will provide a wider perspective to decision makers for them to make more specified actions that will benefit the public.

For further research, it is promising to look into the possibility of completely integrating laboratory operations around Metro Manila to the system of MMCHD. This shall provide them with a wider snapshot of ongoing cases that are under testing or verification, thus further eliminating redundancy and delays in collecting data, analyzing, and interpreting the current situation of a particular disease. Given the volume of data collected within the system, other researchers may also look into injecting predictive analytics into the system for certain diseases, such as vector-borne and air-borne diseases which make use of environmental data.

## 5. ACKNOWLEDGMENTS

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