



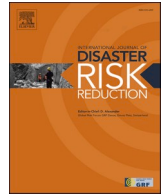
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Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

A topic modeling analysis on the early phase of COVID-19 response in the Philippines

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ARTICLE INFO

Keywords:

COVID-19
Philippines
Pandemic
Government response
Machine learning

ABSTRACT

Like many others across the globe, Filipinos continue to suffer from the COVID-19 pandemic. To shed light on how the Philippines initially managed the disease, our paper analyzed the early phase of the government's pandemic response. Using machine learning, we compiled the official press releases issued by the Department of Health from early January to mid-April 2020 where a total of 283,560 datasets amounting to 2.5 megabytes (Mb) were analyzed using the Latent Dirichlet Allocation (LDA) algorithm. Our results revealed five latent themes: the highest effort (40%) centered on "Nationwide Reporting of COVID-19 Status", while "Contact Tracing of Suspected and Infected Individuals" had the least focus at only 11.68% - indicating a lack of priority in this area. Our findings suggest that while the government was ill-prepared in the early phase of the pandemic, it exerted efforts in rearranging its fiscal and operational priorities toward the management of the disease. However, we emphasize that this article should be read and understood with caution. More than a year has already passed since the outbreak in the country and many (in)actions and challenges have adversely impacted its response. These include the Duterte administration's securitization and militarization of pandemic response and its apparent failure to find a balance between the lives and livelihoods of Filipinos, to name a few. We strongly recommend that other scholars study the various aspects of the government's response, i.e., economic, peace and security, agriculture, and business, to assess better how the country responded and continually responds to the pandemic.

1. Background

The novel coronavirus challenged the health welfare of billions of people across the world. The virus was initially recorded in Wuhan City, China, in December 2019 [1] and named by the International Committee on Taxonomy of Viruses (ICTV) as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [2]. The Chinese government recognized the COVID-19 disease in early January 2020 and it was declared as a Public Health Emergency of International Concern by the United Nations' World Health Organization (WHO) by the end of the same month [2]. The number of COVID-19 cases outside of China increased drastically [3], and its inevitable danger of worldwide contagion prompted the WHO to categorize COVID-19 as a pandemic in March 2020 [2]. Fig. 1 indicates that, at the time of writing, available data from the Center for Systems Science and Engineering (CSSE) of Johns Hopkins University show that the virus has already infected at

least 3,256,846 people from 187 countries or territories and killed 233,388 individuals [4]. In the Philippines, 8,488 cases were confirmed, of which 568 died, and 1,043 have recovered [4].

The Philippine government's response to the current pandemic received various criticisms, questions, and feedback. For example, Amnesty International warned about the government's possible human rights violations due to the concentration of power on President Rodrigo Duterte to manage the disease [5]. This concentration of power was made possible through the passage of the *Bayanihan* to Heal as One Act, a policy giving Pres. Duterte 30 special emergency powers, including the power to penalize "individuals or groups creating, perpetrating or spreading false information regarding the COVID-19 crisis on social media and other platforms" [6]. The policy's broad and poorly defined sections gave law enforcers too much discretion in implementing it, thereby putting free speech - including the right to express dissent and discontent in the government's response - in peril. Another criticism

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<https://doi.org/10.1016/j.ijdrr.2021.102367>

Received 10 May 2020; Received in revised form 6 April 2021; Accepted 23 May 2021

Available online 6 June 2021

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worth mentioning is the Health Secretary's "lack of competence, efficiency and foresight bordering on negligence in handling the health crisis" [7]. At least 14 Senators wanted Secretary Francisco Duque of the Department of Health to resign in early April 2020. This, however, was not acted upon by Pres. Duterte.

In this context, the current pandemic can neither be seen as an economic nor health issue alone. The compounding risks it pose warrant interdisciplinary investigations - including from the social sciences, computer science, and disaster nursing - to better understand how government institutions responded and continually respond in various disease control and management areas. This study positions itself within the multi- and interdisciplinary inquiry on pandemics as it unpacks the nexuses between the COVID-19 as a disaster and the early phase response of the Philippine government. On top of the many problems we face, one thing is clear: the current pandemic exposed public health system's fragility and challenged many government institutions in all parts of the globe.

While a corpus has been published about the impacts of the pandemic in the Philippines' frontline healthcare workers [8], higher education institutions [9,10], students' psychological health [11], and Indigenous peoples [12], among others, there is still an absence of works analyzing the Philippine government's response to the early stage of COVID-19 contagion in the country. This is the specific literature gap this paper hopes to fill to understand the current pandemic better.

This paper is novel because it is the first of its kind to analyze the Philippine government's early response to the COVID-19 pandemic, specifically from January to April 2020. We used machine learning in topically analyzing the Department of Health's (DOH) official press releases and public health advisories issued from early January to mid-April 2020 to answer the following research questions:

1. How did the Philippines respond in the early stage of the pandemic?
2. What areas of response did the government focus on from January to April 2020?
3. How did the government mobilize its various agencies and instrumentalities in managing the pandemic?

2. Materials and methods

2.1. Design algorithm

Using Knowledge and Discovery in Databases (KDD) as a process (see Fig. 2), we anchored and modified the framework to fit the necessary procedures and techniques for this study. KDD refers to the overall process of finding knowledge in data and emphasizes the "high-level" application of particular data mining methods [13].

2.2. Data collection and cleaning

We collected secondary data from the press releases/PRs issued by the DOH during the early phase of the government's response (January–April 2020). We compiled it in a Microsoft Excel file where a total of 60 documents with 283,560 datasets amounting to 2.5 megabytes (Mb) were scrapped, processed, and analyzed. After cleaning the data, a total of 141,780 elements remained. The data cleaning process involved removing special characters, numbers, stop words, transforming data to lowercase, and data stemming.

We used data stemming to identify the root or stem of a word. For example, the words connect, connected, connecting, and connections can be stemmed to "connect". We did this to reduce the total number of distinct terms in a document or a query to decrease the processing time of the final output. In particular, we used the N-Gram Stemmer because it is language-independent and advantageous in many applications [14, 15]. An N-gram is an N-character slice of a longer string [16]. After cleaning the datasets, we prepared them for data processing and used unsupervised machine learning to generate results.

2.3. Software for data mining and processing

We used R Programming version 3.6.2 as core interpreter language using R Studio version 1.4.1106 as Graphical User Interface (GUI) for source code readability, understandability, and easy-to-do computer programming. One of R's strengths is the ease with which well-designed publication-quality plots can be produced, including mathematical symbols and formulae where needed [17]. In general, R is one of the world's most popular language for developing statistical software [18]

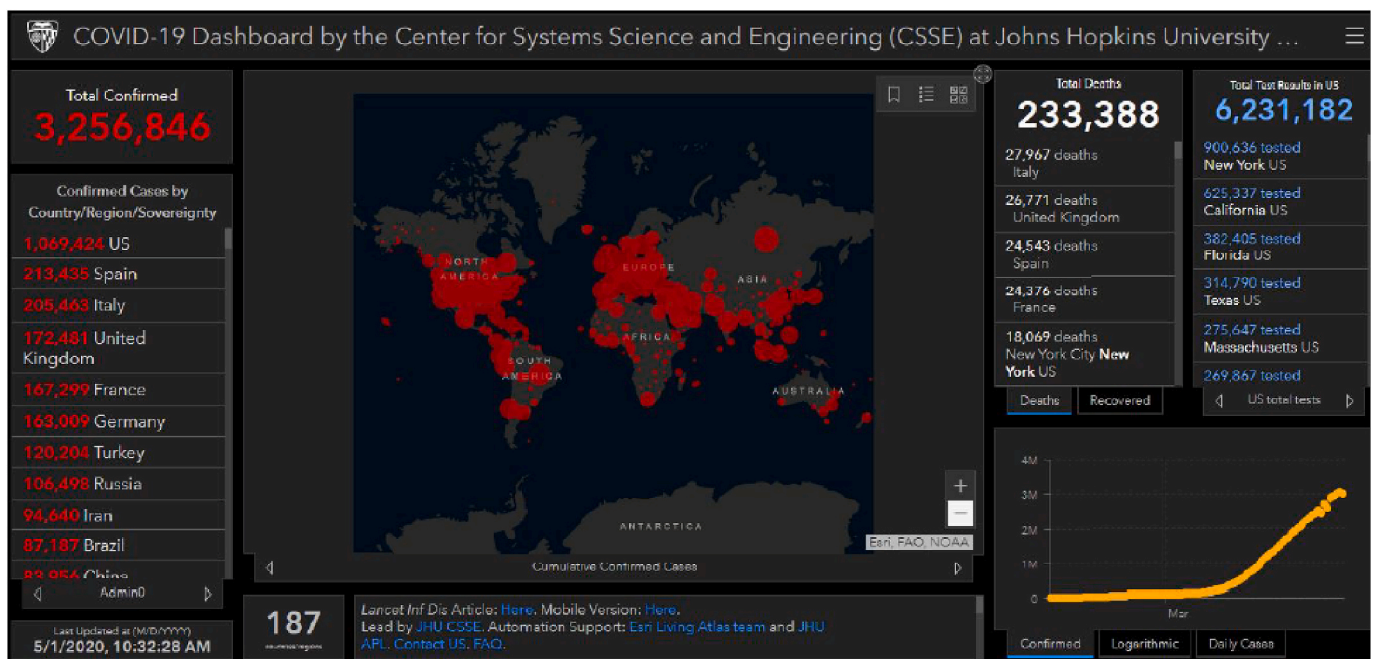


Fig. 1. Global COVID-19 data as of May 2020 based on CSSE-JHU online dashboard.

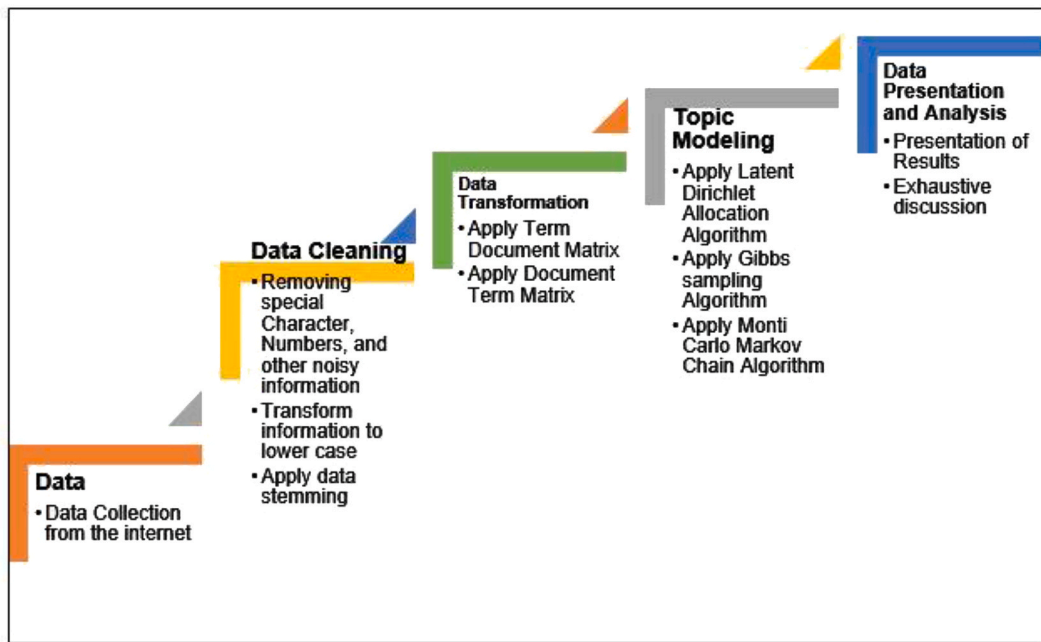


Fig. 2. Design algorithm process utilizing modified KDD used by the authors.

because of its data handling and modeling capabilities and flexibility [19].

2.4. Data transformation

We used the Term Document Matrix (TDM) process to present the words in a matrix or text table and determine the most prominent terms and associated terms in the documents. Each text was extracted from the press releases and placed in a column format before assessing the frequency of each text as it appeared in every document. The matrix rows represent the text responses analyzed, while the columns represent the words from the text used in the analysis [20]. As such, if X and Y represent two text documents, each word will be an attribute in a dataset called a term-document matrix or document vector [21]. Each record in the document dataset resembles a discrete document or a text blob. We then used the Jaccard similarity coefficient equation to measure the simple matching similarity, but we ignored the non-occurrence frequency in the calculation [22].

$$\text{Jaccard Coefficient} = \frac{\text{Common occurrences}}{\text{Total occurrences}}$$

Or

$$J(X, Y) = \frac{|X \cap Y|}{|X \cup Y|} = \frac{|X \cap Y|}{|X| + |Y| - |X \cap Y|}$$

If X and Y are mutually empty, define $J(X, Y) = 1$

$$0 \leq J(X, Y) \leq 1$$

It is necessary to build a Document Term Matrix (DTM) that contains the number of term occurrences per document to conduct topic modeling with methods like Latent Dirichlet Allocation. Document Term Matrix (DTM) is similar to TDM; what differs is, in a matrix, rows correspond to documents, and columns are for terms. The rows of the DTM usually represent the documents, and the columns represent the whole vocabulary [23]. This technique in data mining is also called Term Frequency-Inverse Document Frequency (TF-IDF) information retrieval. TF-IDF is a numerical statistic that shows how important a word is to a document in a text database [24]. We performed the following equations to calculate the TF-IDF [25]:

a. Term Frequency utilizing augmented frequency to avoid biases

$$tf(t, d) = 0.5 + 0.5 * \frac{f_{t,d}}{\max\{f_{t,d} : t \in d\}}$$

$$idf(t, D) = \log \frac{N}{|\{d \in D : t \in d\}|}$$

$$tfidf(t, d, D) = tf(t, d) * idf(t, D)$$

- t – number of times a term occurs.
 - d – document.
 - $f_{t,d}$ – row count.
- b. We used Inverse Document Frequency to measure how much a piece of information provides.
- D – document.
 - N – is the total number of documents in a corpus.
 - t - term.
 - $|\{d \in D : t \in d\}|$ - is the number of the document where the terms (t) appear.

c. Term Frequency- Inverse Document Frequency

2.5. Topic modeling and data validation

Topic modeling or topic models provide a simple way to break down vast volumes of unlabeled data. A “topic” contains a cluster of a term that frequently occurs together. Using contextual traces, topic models can link words with similar meanings and distinguish between uses of words with multiple meanings [26]. Latent Dirichlet Allocation (LDA) is an example of a topic model used to classify a term in a document to a particular topic. It builds a topic per document model and words per topic model, modeled as Dirichlet distributions. We used this because LDA enables discovering potential topics from our extensive unstructured review data [27]. The generative process for a document collection D under the LDA model is as follows [28]:

1. For $k = 1 \dots K$:
 - a. $\phi^{(k)} \sim \text{Dirichlet}(\beta)$
2. For each document $d \in D$:
 - a. $\theta_d \sim \text{Dirichlet}(\alpha)$

- b. For each word $w_i \in d$:
 - i. $z_i \sim \text{Dirichlet}(\theta_d)$
 - ii. $w_i \sim \text{Dirichlet}(\varnothing^{(z_i)})$

where K is the number of latent topics in the collection, $\varnothing^{(k)}$ is a discrete probability distribution over a fixed vocabulary that represents the k th topic distribution, θ_d is a document-specific distribution over the available topics, z_i is the topic index for the word w_i , and α and β are hyper-parameters for the symmetric Dirichlet distributions that the discrete distributions are drawn from.

We used the Gibbs Sampling Algorithm to validate our data. Gibbs Sampling Algorithm belongs to a family of algorithms from the Markov Chain Monte Carlo (MCMC) framework [29]. Gibbs sampling generates subsequent samples by sweeping through each variable or block of variables to sample from its conditional distribution with the remaining variables fixed to their current values [30]. Gibbs sampling performs the following algorithm [28]:

1. Randomly initialize each x_i
2. For $t = 1 \dots T$:
 - 2.11 $x_1^{t+1} \sim p(x_1 | x_2^{(t)}, x_3^{(t)}, \dots, x_m^{(t)})$
 - 2.12 $x_2^{t+1} \sim p(x_2 | x_1^{(t)}, x_3^{(t)}, \dots, x_m^{(t)})$
 - 2.13 $x_m^{t+1} \sim p(x_m | x_1^{(t)}, x_2^{(t+1)}, \dots, x_{m-1}^{(t+1)})$

2.6. Ethics statement

We did not use any personal information of a juridical person but used publicly posted and issued PRs from the Philippines’ Department of Health official website. Moreover, we assigned random codes to each PR to secure its contents.

3. Results

The press releases were assigned topics using the LDA algorithm. Table 1 shows the assignment of press releases to topics, while Fig. 3 shows the probability of the topic. Table 2 shows the summary of topic probability, and Table 3 shows the top 20 words from over a thousand words assigned in each topic and the following themes generated in each.

Overall, our findings revealed five (5) latent themes:

1. Government facilities and health response against COVID-19.

2. Nationwide reporting of COVID-19 status.
3. Establishment of COVID-19 testing centers, capabilities & purchase of personal protective equipment (PPEs).
4. Government response on the health status of repatriates and preparations of quarantine facilities.
5. Contact tracing of suspected and infected individuals.

4. Discussion

4.1. Government facilities and health response against COVID-19

At the time of writing, the country has around 456 hospitals where COVID-19 patients were confined, isolated, and treated. These hospitals, excluding those classified as specialty hospitals, have a total bed capacity of 67,119 [31]. On the other hand, available data from 2018 show that the country has 40,775 doctors and 90,308 nurses. To augment the lack of specialized referral hospitals for virus-positive patients, the government converted some public and private schools, entertainment centers, ports, and cultural centers into COVID-19 quarantine and treatment centers. As of late April 2020, the country had over 3000 COVID-19 quarantine and treatment centers [32] with a holding capacity of more than 5,100 beds [33]. The conversion of non-treatment buildings to treatment spaces required collaborative planning and execution of health experts, designers, engineers, and builders. A combination of these experts is needed to understand infection-control measures vis-à-vis its functional and structural layout. We argue that the best practices in converting these spaces need to be documented to provide educational materials and a baseline for improvements that could be useful in responding to future pandemics. The long-term aim of this strategy should be to strengthen the surge capacity of the Philippine healthcare system to effectively manage the sudden influx of patients in future emergency and/or disaster events.

The government also boosted its Research and Development (R&D) efforts against the disease. The Department of Science and Technology (DOST) has set up the COVID-19 CORE Portal. This website supplies the latest updates and information on current research initiatives relative to the disease (see Fig. 4) [34]. Locally made COVID-19 testing kits and ventilators were also funded (see Fig. 5). These are a) the GENAMPLIFY™ COVID-19 rRT-PCR test kits and b) the GINHAWA ventilator, a portable and user-friendly equipment used in Intensive Care Units (ICUs), Emergency Rooms (ERs), and ambulances. For more locally-developed technologies on COVID-19, visit <http://www.pchrd.dost.gov.ph/>. Locally made COVID-19 test kits and health equipment were cheaper than its imported counterparts; hence, buying and

Table 1
Press release to topic assignment made by the authors.

Document Code	Topic Assignment	Document Code	Topic Assignment	Document Code	Topic Assignment
PR1	2	PR21	4	PR41	3
PR2	2	PR22	2	PR42	3
PR3	2	PR23	2	PR43	5
PR4	4	PR24	4	PR44	1
PR5	2	PR25	2	PR45	3
PR6	2	PR26	2	PR46	1
PR7	2	PR27	2	PR47	3
PR8	2	PR28	2	PR48	3
PR9	2	PR29	2	PR49	5
PR10	4	PR30	2	PR50	5
PR11	2	PR31	2	PR51	1
PR12	2	PR32	2	PR52	3
PR13	2	PR33	2	PR53	5
PR14	5	PR34	4	PR54	3
PR15	2	PR35	2	PR55	5
PR16	4	PR36	5	PR56	1
PR17	4	PR37	3	PR57	3
PR18	4	PR38	1	PR58	1
PR19	4	PR39	3	PR59	1
PR20	4	PR40	3	PR60	1

Doc Code	Topic1 Prob	Topic2 Prob	Topic3 Prob	Topic4 Prob	Topic5 Prob	Doc Code	Topic1 Prob	Topic2 Prob	Topic3 Prob	Topic4 Prob	Topic5 Prob	Doc Code	Topic1 Prob	Topic2 Prob	Topic3 Prob	Topic4 Prob	Topic5 Prob
PR1	0.13	0.45	0.09	0.17	0.17	PR21	0.06	0.13	0.09	0.64	0.08	PR41	0.11	0.10	0.42	0.11	0.26
PR2	0.06	0.59	0.13	0.10	0.11	PR22	0.08	0.36	0.12	0.32	0.13	PR42	0.14	0.05	0.45	0.17	0.19
PR3	0.09	0.50	0.09	0.13	0.18	PR23	0.09	0.35	0.08	0.28	0.20	PR43	0.28	0.16	0.18	0.06	0.32
PR4	0.07	0.33	0.11	0.36	0.15	PR24	0.11	0.17	0.08	0.53	0.11	PR44	0.36	0.09	0.24	0.11	0.19
PR5	0.08	0.44	0.09	0.22	0.17	PR25	0.07	0.66	0.11	0.05	0.12	PR45	0.13	0.18	0.35	0.09	0.24
PR6	0.12	0.41	0.11	0.21	0.15	PR26	0.05	0.39	0.19	0.12	0.25	PR46	0.47	0.18	0.16	0.06	0.13
PR7	0.14	0.51	0.12	0.13	0.10	PR27	0.05	0.62	0.05	0.08	0.20	PR47	0.30	0.08	0.35	0.08	0.18
PR8	0.11	0.44	0.11	0.20	0.14	PR28	0.08	0.61	0.13	0.07	0.11	PR48	0.11	0.11	0.42	0.21	0.15
PR9	0.05	0.67	0.09	0.11	0.08	PR29	0.03	0.69	0.15	0.07	0.06	PR49	0.13	0.09	0.14	0.18	0.46
PR10	0.10	0.12	0.08	0.60	0.11	PR30	0.09	0.34	0.11	0.34	0.13	PR50	0.31	0.06	0.19	0.10	0.35
PR11	0.07	0.58	0.12	0.14	0.10	PR31	0.07	0.50	0.09	0.11	0.22	PR51	0.40	0.15	0.09	0.10	0.26
PR12	0.11	0.37	0.11	0.29	0.12	PR32	0.09	0.34	0.07	0.18	0.32	PR52	0.07	0.05	0.75	0.08	0.05
PR13	0.09	0.45	0.09	0.25	0.10	PR33	0.25	0.27	0.12	0.13	0.23	PR53	0.25	0.06	0.18	0.11	0.40
PR14	0.17	0.07	0.11	0.08	0.57	PR34	0.10	0.17	0.10	0.54	0.10	PR54	0.11	0.07	0.36	0.14	0.32
PR15	0.10	0.50	0.14	0.19	0.07	PR35	0.13	0.34	0.16	0.13	0.23	PR55	0.12	0.06	0.15	0.06	0.62
PR16	0.05	0.05	0.18	0.66	0.06	PR36	0.19	0.14	0.12	0.13	0.42	PR56	0.36	0.21	0.12	0.10	0.21
PR17	0.06	0.10	0.09	0.66	0.09	PR37	0.12	0.13	0.57	0.09	0.09	PR57	0.30	0.10	0.31	0.11	0.17
PR18	0.06	0.13	0.07	0.63	0.11	PR38	0.30	0.18	0.07	0.16	0.29	PR58	0.63	0.08	0.08	0.12	0.08
PR19	0.05	0.05	0.19	0.65	0.06	PR39	0.18	0.06	0.60	0.05	0.11	PR59	0.55	0.13	0.14	0.08	0.09
PR20	0.11	0.12	0.07	0.60	0.10	PR40	0.14	0.08	0.54	0.13	0.12	PR60	0.63	0.08	0.07	0.10	0.12

Fig. 3. Press release topic probability made by the authors.

Table 2

Summary of topic probability made by the authors.

Topic1	Topic2	Topic3	Topic4	Topic5
0.46	0.47	0.47	0.59	0.45

prioritizing these local innovations will be beneficial for the government in terms of reduced import costs, shortened delivery time, and minimized payments of State-sponsored insurance claims. Most importantly, these cheap but effective local innovations democratize the access and control of Filipinos to quality and reliable COVID-testing and treatment.

Table 3

Generated topics to themes made by the authors.

No	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5
1	health	ncov	covid	health	march
2	hospitals	Visayas	DOH	DOH	Filipino
3	department	cases	health	quarantine	city
4	secretary	confirmed	center	case	medical
5	centers	admitted	workers	China	cases
6	local	February	testing	contact	hospital
7	patients	updates	secretary	Filipinos	cough
8	Philippines	central	medical	puis	mar
9	directors	total	public	symptoms	center
10	national	coronavirus	facilities	contacts	feb
11	coronavirus	visit	PPEs	public	covid
12	line	NCR	April	respiratory	validation
13	ncov	latest	sets	government	history
14	disease	Davao	chief	Duque	san
15	Philippines	mimaropa	department	number	fever
16	public	Luzon	hospital	close	admitted
17	information	tracker	general	patient	confirmed
18	development	eastern	press	travel	February
19	control	western	release	bureau	DOH
20	advisory	northern	patients	repatriate	Makati
Latent Themes					
	<i>Government facilities and health response against COVID-19</i>	<i>Nationwide reporting of COVID-19 status</i>	<i>Establishment of COVID-19 testing centers, capabilities & purchase of personal protective equipment (PPEs)</i>	<i>Government response on the health status of repatriates and preparations of quarantine facilities</i>	<i>Contact tracing of suspected and infected individuals</i>

4.2. Nationwide reporting of COVID-19 status

More than three months after recording the first case of COVID-19 in the country, the number of infected individuals ballooned to 8,488, of which 568 died [35]. On the other hand, 1,043 have recovered from the disease. Out of all infected individuals, 1,552 were healthcare workers/HCWs (doctors/physicians, nurses, nursing assistants). In the initial response phase, the Department of Health worked closely with the Interagency Task Force on Emerging Infectious Diseases (IATF-EID) which included representatives from the Department of Foreign Affairs, Department of the Interior and Local Government, Department of Justice, Department of Labor and Employment, Department of Tourism,

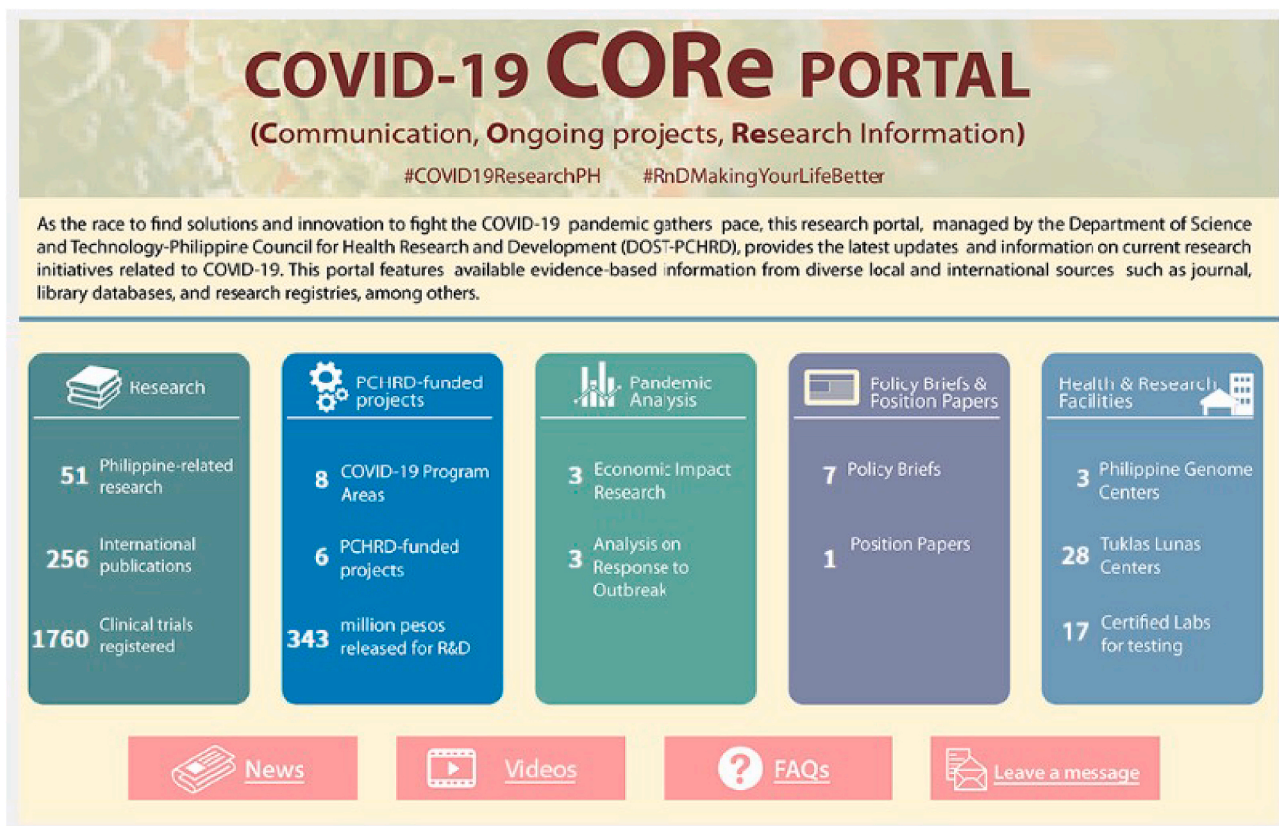


Fig. 4. Screenshot of the web design of the COVID-19 CORE Portal taken by the authors.



Fig. 5. Pictures of locally-made COVID-19 testing kit (left) and the GINHAWA ventilator (right) compiled by the authors.

Department of Transportation, and Department of Information and Communications Technology [35]. The creation and mobilization of the COVID-19 Response team by the IATF-EID is the Philippines’ attempt to implement the “Whole of Government Approach”. According to Kathryn H. Floyd, the Whole of Government Approach encompasses interagency cooperation and coordination on a crisis threatening national security is implemented [36]. This approach acknowledges that it takes an entire village to solve a problem, in this case, the COVID-19 pandemic that destabilized people’s jobs and well-being. By using this approach, the government could maximize the knowledge and expertise of various agencies in responding to issues plaguing the various sectors and stakeholders which they are mandated to serve.

4.3. Establishment of COVID-19 testing centers, capabilities & purchase of personal protective equipment (PPEs)

As of late April 2020, the Philippines had 19 subnational laboratories capable of detecting the SARS CoV-2 virus [37]. 14 out of 19 laboratories were in Metro Manila, while the remaining were in five other regions. On the other hand, 36 subnational laboratories were under evaluation by the DOH to be licensed and registered centers capable of handling COVID-19 testing.

For personal protective equipment (PPEs), the DOH distributed 287,640 coveralls, 1,700,390 medical face masks, 345,700 gloves, 168,175 gowns, 149,775 Kn95 masks, 83,860 N95 masks, 41,292 face

shields, 157,503 protective goggles, and 371,800 head caps [37]. The Vice-President's office also conducted a 49-day donation drive that collected around PHP55 million (~USD1.1 million) [38]. This was supplemented with the budget from the Vice President's office and totaled PHP60 million (~USD2 million) which provided dormitories for medical frontline workers; purchased test kits; distributed PPE sets to health facilities nationwide; bought food and care packages; and hired tailors to sew locally made and reusable PPEs [38].

While we acknowledge the vital function of the State in sustaining health services and reducing COVID-related health risks [39,40], our findings also show that civil society organizations and social mobilizations can play essential roles in managing the pandemic [41,42]. In the Philippines, where the government was usually relied upon in crises, the current pandemic overwhelmed its capacity to efficiently provide adequate support to healthcare workers at the frontline of response. Hence, the donations from the private sector have played an augmenting role in the government's capacity to respond through their contributions. While this is commendable, we note that the private sector's willingness to donate is only a short-term response, hence, not sustainable.

4.4. Government response on the health status of repatriates and preparations of quarantine facilities

As early as February 2020, the DOH and the IATF-EID laid down guidelines and protocols for the voluntary repatriation of overseas Filipinos from the Hubei province in China. As the disease rapidly spread worldwide, the quarantine facilities for Filipino repatriates were expanded and all arriving overseas Filipino workers (OFWs) were required to undergo rapid COVID-19 tests. Two privately-owned ships were rented and were converted as floating hospitals and quarantine facilities for repatriates. These were supplemented by converting seaports, cultural centers, sports complexes, and schools into quarantine facilities. In April 2020, the Department of Foreign Affairs repatriated 19,466 OFWs, of whom 15,130 were seafarers and 4,336 were land-based OFWs [43]. As of the date of writing, all persons arriving in the Philippines were required to undergo monitored home quarantine [44]. However, while repatriation efforts were in place, OFWs' delayed testing and transport revealed coordination lapses among national agencies and local government units and exacerbated the growing stigma against OFWs feared to be potential disease spreaders [45]. Repatriating citizens is only the first step in helping them. Proper testing, quarantine, and safe integration to their home communities should also hold equal significance in the government's programs for repatriates.

The government should be conscious of the need for a multidisciplinary approach in repatriating OFWs from many parts of the world. A clear understanding of the socio-political situation of a country, transmission routes of a pathogen, disease presentation, and knowledge of aviation procedures, aircraft engineering, and design are of great importance in preparing for repatriation missions [46].

4.5. Contact tracing of suspected and infected individuals

Rapid contact tracing of virus-suspected and infected individuals at the community level was essential in the early detection, isolation, and treatment of patients to manage cluster outbreaks. Barangays or villages with confirmed COVID cases implemented localized lockdown measures. They used the help of the barangay health workers/BHWs (village-level healthcare volunteers) to trace and investigate people who may have been exposed to the virus. These BHWs were part of the community-led Barangay Health Emergency Response Teams (BHERTs). Each barangay chairperson or Punong Barangay (PB) appointed BHERT members composed of an executive officer, a barangay *tanod* (volunteer police officer), two barangay health workers, and one nurse or midwife [47]. The BHERT members were equipped with protective gear such as

surgical gowns, goggles, masks, and gloves.

Mobile phone applications or Apps were used both in tracking and providing medical services. The data collected by these tools and Apps can then rapidly be re-deployed to inform participants of urgent health materials [48]. In the case of contact tracing, usage of Apps makes it easier to locate the source of the virus transmission and determine places to which the public should avoid. In the Philippines, various websites and mobile applications (Apps) developed by private companies, individuals, and government agencies also helped make contact tracing more efficient. Fig. 6 shows some of these Apps, including COVCT, StaySafe.ph, WeTrace, ENDCoV, TanodCOVID, and CLEAR (Citizens Logistics and Early Assessment Report Tool). Technology plays a vital role in real-time tracking of the status of the virus and limiting manual contact tracing methods that have cost, time, and risk implications. From the human resource-heavy, high-risk, and costly traditional and manual form of contact tracing, the government's use of tech innovations not only involved individual voluntary participation and tracking of people's traffic with the help of smartphones but also democratized the response by encouraging individual participation as well as community policing [49]. However, while we recognize the critical role technology plays in controlling and containing the virus, we strongly argue that contextual realities should be kept in mind. As reminded by Miriam Caryl Carada and Ginbert Permejo Cuaton [49], using these Apps should be with caution as it may raise issues on public trust, data privacy, and human rights.

5. Conclusion

The COVID-19 pandemic serves as a strong wake-up call to many governments to review, modify, and strengthen their healthcare systems to make them resilient from sudden and severe disruptions like pandemics and other biological hazards. Our results suggest that the Philippine government was ill-prepared in responding to the early phase of the pandemic. However, despite the apparent lack of preparation, it tried to cope and respond immediately. The country's Department of Health had focused, in varying levels, on five broad areas in the early phase of its COVID-19 response from January to April 2020. The topic models revealed that these were 1) increasing health facilities to improve response, 2) reporting the status of COVID cases, 3) establishing testing centers and procuring PPEs, 4) repatriating OFWs and preparing for their quarantine facilities, and 5) tracing and isolating suspected and infected individuals. The country's early phase response also cut across sectors and involved various stakeholders. Its attempt to implement the *Whole of Government Approach* through the activation of the Interagency Task Force/IATF for COVID-19 was a sign that the government acknowledged the need to collaborate and innovate to better respond to the COVID-19 health crisis. The provincial, city/municipal, and local barangay units have also exemplified their roles in securing public health and safety. These actions were augmented with the participation and donations from the private sectors and other groups that filled the response gaps.

Apart from these, technology-based innovations helped the government turn away from the human resource-heavy, high-risk, and costly traditional and manual contact tracing of suspected and infected patients. However, although these technology-based innovations promote efficiency, we argue that people in poverty and those who do not have access to these technologies should be capacitated and aided by government institutions. Doing so would help ensure that no one is left behind in all programs and activities in its medium- and longer-term COVID-19 response, rehabilitation, and recovery efforts to build back better in a post-pandemic world.

Most importantly, more than a year has already passed since the outbreak in the Philippines and many (in)actions and challenges have adversely impacted its pandemic response. These include the Duterte administration's securitization and militarization of health response and its failure to find a balance between the lives and livelihoods of Filipinos,



Fig. 6. Apps and platforms used for COVID-19 contact tracing from January to April 2020 compiled by the authors.

among others. We strongly recommend that other scholars study the various aspects of the pandemic response, i.e., economic, peace and security, agriculture, and business, to assess better how the country responded and continually responds to the pandemic.

In terms of policy contributions, this study can help the health and allied-health practitioners, policymakers, and local government officials to assess how they can improve policies, regulations, and services to enhance public health in times of pandemics and epidemics. The findings of this study can also be integrated into secondary and higher education institutions' courses, subjects, and programs on public policy, community health, science, communication, and information technology. Lastly, this interdisciplinary research highlights the need to conduct further inquiries to understand and examine better the socio-political, community, and health dynamics surrounding the current pandemic and other future biological hazards in the country.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijdr.2021.102367>.

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