Local Government Responses for COVID-19 Management in the Philippines

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Abstract

Background: Responses of subnational government units are crucial in the containment of the spread of pathogens in a country. To mitigate the impact of the COVID-19 pandemic, the Philippine national government through its Inter-Agency Task Force on Emerging Infectious Diseases outlined different quarantine measures wherein each level has a corresponding degree of rigidity from keeping only the essential businesses open to allowing all establishments to operate at a certain capacity. Other measures also involve prohibiting individuals at a certain age bracket from going outside of their homes. The local government units (LGUs)–municipalities and provinces–can adopt any of these measures depending on the extent of the pandemic in their locality. The purpose is to keep the number of infections and mortality at bay while minimizing the economic impact of the pandemic. Some LGUs have demonstrated a remarkable response to the COVID-19 pandemic. The purpose of this study is to identify notable non-pharmaceutical interventions of these outlying LGUs in the country using quantitative methods.

Methods: Data come from public databases such as Philippine Department of Health, Philippine Statistics Authority Census, and Google Community Mobility Reports. These are normalized using Z-transform. For each locality, infection and mortality data (dataset \(Y\)) are compared to the economic, health, and demographic data (dataset \(X\)) using Euclidean metric \(d = (x - y)^2\), where \(x \in X\) and \(y \in Y\). If a data pair \((x, y)\) exceeds, by two standard deviations, the mean of the Euclidean metric values between the sets \(X\) and \(Y\), the pair is assumed to be a ‘good’ outlier.

Results: Our results showed that cluster of cities and provinces in Central Luzon (Region III), CALABARZON (Region IV-A), the National Capital Region (NCR), and Central Visayas (Region VII) are the ‘good’ outliers with respect to factors such as working population, population density, ICU beds, doctors on quarantine, number of frontliners and gross regional domestic product. Among metropolitan cities, Davao was a ‘good’ outlier with respect to demographic factors.

Conclusions: Strict border control, early implementation of lockdowns, establishment of quarantine facilities, effective communication to the public, and monitoring efforts were the defining factors that helped these LGUs curtail the harm that was brought by the pandemic. If these policies are to be standardized, it would help any country’s preparedness for future health emergencies.

Keywords: COVID-19; local government; policies; outlier; quantitative methods
Introduction
Since the emergence of the COVID-19 pandemic, the number of cases have already reached 82 million worldwide at the end of 2020. In the Philippines, the number of cases exceeded 473,000. As countries around the world face the continuing threat of the COVID-19 pandemic, national governments and health ministries formulate, implement and revise health policies and standards based on recommendations by WHO, experiences of other countries, and on-the-ground experiences. Early health measures were primarily aimed at preventing and reducing transmission in populations at risk. These measures differ in scale and speed among countries, as some countries have more resources and are more prepared in terms of healthcare capacity and availability of stringent policies. [1, 2]

During the first months of the pandemic, several countries struggled to find tolerable, if not the most effective, measures to ‘flatten’ the COVID-19 epidemic curve so that health facilities will not be overwhelmed. [3, 4] In responding to the threat of the pandemic, public health policies included epidemiological and socio-economic factors. The success or failure of these policies exposed the strengths or weaknesses of governments as well as the range of inequalities in the society. [5, 6]

As national governments implemented large-scale ‘blanket’ policies to control the pandemic, local government units (LGUs) have to consider granular policies as well as real-time interventions to address differences in the local COVID-19 transmission dynamics due to heterogeneity and diversity in communities. Some policies in place, such as voluntary physical distancing, wearing of face masks and face shields, mass testing, and school closures, could be effective in one locality but not in another. [7, 8, 9] Subnational governments like LGUs are confronted with a health crisis that have economic, social and fiscal impact. While urban areas have been hot spots of the COVID-19 pandemic, there are health facilities that are already well in placed as compared to less developed and deprived rural communities. [10] The importance of local narratives in addressing subnational concerns are apparent from published experiences in the United States [11], China [12, 13], and India [14].

In the Philippines, the Inter-Agency Task Force on Emerging Infectious Diseases (IATF) was convened by the national government in January 2020 to monitor a viral outbreak in Wuhan, China. The first case of local transmission of COVID-19 was confirmed on March 7, 2020. Following this, on March 8, the entire country was placed under a State of Public Health Emergency. By March 25, the IATF released a National Action Plan to control the spread of COVID-19. A community quarantine was initially put in placed for NCR starting March 13, 2020 and it was expanded to the whole island of Luzon by March 17. The initial quarantine was extended up to April 30. [5, 15] Several quarantine protocols were then implemented based on evaluation of IATF:

- Community Quarantine (CQ) refers to restrictions in mobility between quarantined areas.
- In Enhanced Community Quarantine (ECQ), strict home quarantine is implemented and movement of residents is limited to access essential goods and
services. Public transportation is suspended. Only economic activities related to essential and utility services are allowed. There is heightened presence of uniformed personnel to enforce community quarantine protocols.

- Modified Enhanced Community Quarantine (MECQ) is implemented as a transition phase between ECQ and GCQ. Strict home quarantine and suspension of public transportation are still in placed. Mobility restrictions are relaxed for work-related activities. Government offices operates under a skeleton workforce. Manufacturing facilities are allowed to operate with up to 50% of the workforce. Transportation services are only allowed for essential goods and services.

- In General Community Quarantine (GCQ), individuals from less susceptible age groups and without health risks are allowed to move within quarantined zones. Public transportation can operate at reduced vehicle capacity observing physical distancing. Government offices may be at full work capacity or under alternative work arrangements. Up to 50% of the workforce in industries (except for leisure and amusement) are allowed to work.

- Modified General Community Quarantine (MGCQ) refers to the transition phase between GCQ and the New Normal. All persons are allowed outside their residences. Socio-economic activities are allowed with minimum public health standard.

LGUs are tasked to adopt, coordinate, and implement guidelines concerning COVID-19 in accordance with provincial and local quarantine protocols released by the national government. [16]

In this study, we identified economic and societal factors that are correlated with epidemiological metrics related to COVID-19, specifically to the number of infected cases and number of deaths. [17, 18] At the regional, provincial, and city levels, we investigated the localities that differ with the other localities, and determined the possible reasons why they are outliers compared to the average practices of the others.

**Methods**

We categorized the data into economic, health, and demographic components (See Table 1). In the economic setting, we considered the number of people employed and the number of work hours. The number of health facilities provides an insight into the health system of a locality. Population and population density, as well as age distribution and mobility, were used as the demographic indicators. The data (as of November 10, 2020) from these seven factors were analyzed and compared to the number of deaths and cumulative cases in cities, provinces or regions in the Philippines to determine the outlier.

The Philippine government’s administrative structure and the availability of the data affected its range for each factor. Regional data were obtained for the economic component. For the health and demographic components, data from cities and provinces were retrieved from the sources. Due to the National Capital Region
Table 1 Epidemiological, Economic and Societal Factors Considered in the Study

| Factor                  | Definition                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| COVID-19 cases          | Cumulative COVID-19 cases in the Philippines (as of 10 November 2020) from the DOH Data Drop [19]                                           |
| COVID-19 deaths         | Cumulative COVID-19 deaths in the Philippines (as of 10 November 2020) from the DOH Data Drop [19]                                         |
| Population              | Forecasted 2020 locality population size based from the 2015 Philippine Statistics Authority Census [20]                                    |
| Population Density      | Forecasted 2020 locality population density based from the 2015 Philippine Statistics Authority Census [20]                                  |
| Working Population      | Forecasted 2020 locality working population size (21 - 49 yrs old) based from the 2015 Philippine Statistics Authority Census [20]          |
| Senior Population       | Forecasted 2020 locality senior population size (70+ yrs old) based from the 2015 Philippine Statistics Authority Census [20]              |
| Mobility                | Percentage change in activity at each location category compared to that on baseline days before the advent of COVID-19 (a 5-week period running from 3 January 2020 to 6 February 2020). We consider retail and recreation, grocery and pharmacy, parks, transit stations, workplaces and residential areas. [21] |
| Doctors on Quarantine   | Cumulative number of doctors in quarantine (as of 10 November 2020) at home or in a facility due to COVID-19 exposure (close contact, suspect, probable, confirmed). [19] |
| Nurses                  | Cumulative number of nurses in quarantine (as of 10 November 2020) at home or in a facility due to COVID-19 exposure (close contact, suspect, probable, confirmed). [19] |
| Frontliners             | Cumulative number of other frontliners currently in quarantine (as of 10 November 2020) at home or in a facility due to COVID-19 exposure (close contact, suspect, probable, confirmed). [19] |
| No. of ICU Beds         | Total number of ICU Beds (as of 10 November 2020). [19]                                                                                     |
| Employment              | Employment Rate (as of 10 November 2020). [22]                                                                                                |
| Mean Hours Worked       | The average work hours of an employee in a week (on 10 November 2020)). [22]                                                                |
| GRDP                    | Gross Regional Domestic Product (as of 10 November 2020) [23]                                                                                |

(GCR) exhibiting the highest figures in all key components, an investigation was conducted to identify an outlier among its cities. The z-transform

\[ z = \frac{x - \mu}{\sigma} \]

where \(x\) is the actual data, \(\mu\) is the mean and \(\sigma\) is the standard deviation were applied to normalize the dataset. Two sets of normalized data \(X\) and \(Y\) were compared by assigning to each pair \((x, y)\), where \(x \in X\) and \(y \in Y\), its Euclidean metric \(d\) given by \(d = (x - y)^2\). Here, the \(Y\)’s are the number of COVID-19 cases and deaths, and \(X\)’s are the other demographic indicators. Since 95% of the data fall within two standard deviations from the mean, this will be the threshold in determining an outlier. This means that if a data pair \((x, y)\) exceeds, by two standard deviations, the mean of the Euclidean metric values between the sets \(X\) and \(Y\), the pair is assumed to be an outlier.

To identify a good outlier, a bias computation was performed. In this procedure, \(Y\) represents the normalized data set for the number of deaths or the number of cases while \(X\) represents the normalized data set for every factor that were considered in this study. The bias is computed using the metric

\[(x - y) \times 100\]
for all $x$ in $X$ and $y$ in $Y$. To categorize a city, province, or region as a good outlier, the bias corresponding to this locality must exceed two standard deviations from the mean of all the bias computations between the sets $X$ and $Y$.

Results and Discussion

**Figure 1 Correlation of components to COVID-19 cases and deaths at the regional level**

The data used are the reported COVID-19 cases and deaths in the Philippines as of November 10, 2020 which is 240 days since community lockdowns were implemented in the country. Figure 9 shows the different lockdowns implemented per province since March 15. It can be seen that enhanced community quarantine (ECQ) was implemented in Luzon and major cities in the country in the first few weeks since March 15, and slowly eased into either GCQ or MGCQ as time progressed. By August, the most stringent lockdown was MECQ in the National Capital Region (NCR) and some nearby provinces. Places under MECQ on September were Iloilo City, Bacolod City, and Lanao del Sur, with the last province as the lone community to be placed under MECQ the month after. By November 1, 2020, communities were either placed under GCQ or MGCQ.

Comparison of Economic, Health, and Demographic Components and COVID-19 Parameters

The economic, health and demographic components were compared to COVID-19 cases and deaths. These comparisons were done for different community levels (regional, provincial, city/metropolitan) (See Tables 2, 3, and 4). Figure 1 summarizes the correlation of components to COVID-19 cases and deaths at the regional level. In all components, correlations with other parameters to both COVID-19 cases and deaths are close. Every component except Residential Mobility and GRDP have slightly higher cases correlation as compared to deaths.
Among the components, the number of ICU beds component has the highest correlation with COVID-19 parameters. This makes sense as this is one of the first-degree measures of COVID-19 transmission. Population density comes in second, followed by mean hours worked and working population, which are all related to how developed the region is economy-wise. Regions having larger population density also have a huge working population and longer working hours [24]. Thus, having a huge population density implies high chance of having contact with each other [25, 26]. Another component with high correlation to the cases and deaths is the number of doctors on quarantine, which can be looked at two ways; (i) huge infection rate in the region which is the reason the doctors got exposed/are on quarantine, and (ii) lots of doctors on quarantine which resulted to less frontliners taking care of the infected individuals. All definitions of mobility and the GDP are not strongly correlated to any of the COVID-19 measures.

Outliers
In each data set, outliers were identified depending on their distance from the mean. For simplicity, we denote components that are compared with COVID-19 cases by (C) and with COVID-19 deaths by (D). The summary of outliers among regions in the Philippines is shown in Figures 2 and 3. Data is classified according to groups of component. In each outlier region, NPIs implemented and their timing are identified.

Region III is an outlier in terms of working population (C) and the number of ICU beds (C) (see Figure 4 and Table 5). This means that considering the working population of the region, the number of COVID-19 infections are better than that of other regions. Same goes with the number of ICU beds in relation to COVID-19 deaths. Region III is comprised of Aurora, Bataan, Nueva Ecija, Pampanga, Tarlac, Zambales, and Bulacan. This good performance might be attributed to their performance especially on their programs against COVID-19. As early as March 2020, the region had been under a community lockdown together with other regions in Luzon. Being the closest to NCR, Bulacan has been the most likely to have high number of COVID-19 cases in the region. But the province responded by opening infection control centers which offer free healthcare, meals, and rooms for moderate-severe COVID-19 patients. [27] They have also implemented strict monitoring of entry-exit borders, organization of provincial task force and incident command center, establishment of provincial quarantine facilities for returning overseas Filipino workers, mandated municipal quarantine facilities for asymptomatic cases, and mass testing, among others. [27] Most of which have been proven effective in reducing the number of COVID-19 cases and deaths. [28]

Region IV-A is an outlier in terms of population and working population (D) and doctors on quarantine (D) (see Figure 4 and Table 5). Considering their population and working population, the COVID-19 death statistics show better results compared to other regions. Same goes with the number of doctors in the region which are in quarantine in relation to the reported COVID-19 deaths. This shows that the region is doing well in terms of decreasing the COVID-19 fatalities compared
Figure 2 Outliers among regions in the Philippines with respect to COVID-19 cases
Figure 3  Outliers among regions in the Philippines with respect to COVID-19 deaths
to other regions in terms of populations and doctors on quarantine. Region IV-A is comprised of Batangas, Cavite, Laguna, Quezon, and Rizal. Same with Region III, they have been under the community lockdown since March of last year. Provinces of the region such as Rizal have been proactive in responding to the epidemic as they have already suspended classes and distributed face masks even before the nationwide lockdown. [29] Despite being hit by natural calamities, the region still continue ramping up the response to the pandemic through cash assistance, first aid kits, and spreading awareness. [30]

An interesting result is that NCR, the center of the country and the most densely populated, is a good outlier in terms of GRDP (C) and GRDP (D). Cities in the region launched various programs in order to combat the disease. They have launched mass testings with Quezon City, Taguig City, and Caloocan City starting as early as April 2020. Pasig City started an on-the-go market called Jeepalengke. Navotas, Malabon, and Caloocan recorded the lowest attack rate of the virus. Caloocan city had good strategies for zoning, isolation and even in finding ways to be more effective and efficient. Other programs also include color-coded quarantine pass, and quarantine bands. It is also possible that NCR may just have a very high GRDP compared to other regions. A breakdown of the outliers within NCR can be seen in Figure 7.

Region VII is also an outlier in terms of population density (D) and frontliners (D) (see Figure 5 and Table 5). This means that given the population density and the number of frontliners in the region, their COVID-related deaths in the region is better than the rest of the country. This region consists of four provinces (Cebu, Bohol, Negros Oriental, and Siquijor) and three highly urbanized cities (Cebu City, Lapu-Lapu City, and Mandaue City), referred to as metropolitan Cebu. This significant decline may be explained by how the local government responded after they were placed in stricter community quarantine measures despite the rest of the country easing in to more lenient measures. Due to the longer and stricter quarantine in Cebu, the lockdown had a greater impact here than in other areas where restrictions were eased earlier. [31] Dumaguete was one of the destinations of the first COVID case in the Philippines [32], their local government was able to keep infections at bay early on. Siquijor was also COVID-19-free for 6 months. [33] The compounded efforts of the different provinces in the region can account for the region being identified as an outlier.

Among the metropolitan cities, Davao came out as a good outlier in terms of population (C) and working population (C) (see Figures 6, 8, and Table 5). This result may be attributed to their early campaign on consistent communication of COVID-19-related concerns to the public. [34] They were also able to set up transportation for essential workers early on. [35]

**Conclusions**

This study identified outliers in each data group and determined the non-pharmaceutical interventions (NPI) implemented in the locality. Economic, health
and demographic components were used to identify these outliers. For the regional data, three regions in Luzon and one in Visayas were identified as outliers. Apart from the minimum IATF recommended NPIs, various NPIs were implemented by different regions in containing the spread of COVID-19 in their areas. Some of these NPIs were also implemented in other localities yet these other localities did not come out as outliers. This means that one practice cannot be the sole explanation in determining an outlier. The compounding effects of practices and their timing of implementation are seen to have influenced the results. A deeper analysis of daily data for different trends in the epidemic curve is considered for future research.

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Availability of data
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate
Not applicable. We used secondary data. These are from the public database of the Philippine Department of Health (https://www.doh.gov.ph/covid19tracker) and Philippine Statistics Authority Census (https://psa.gov.ph)

Competing interests
The authors declare that they have no competing interests.

Consent for publication
Not applicable.

Authors’ contributions
All authors are involved in drafting the manuscript and in revising it.

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Table 2 Correlation Table for NCR Data

| height     | COVID CASES | COVID DEATH |
|------------|-------------|-------------|
| Population | 0.970       | 0.945       |
| Population Density | 0.358       | 0.411       |
| Working Population | 0.969       | 0.926       |
| Senior Population   | 0.970       | 0.945       |
| No. of ICU Beds    | 0.958       | 0.933       |

Table 3 Correlation Table for Metropolitan Data

| height                  | COVID CASES | COVID DEATH |
|-------------------------|-------------|-------------|
| Population              | 0.865       | 0.765       |
| Population Density      | 0.603       | 0.437       |
| Working Population      | 0.998       | 0.981       |
| Senior Population       | 0.993       | 0.990       |
| Mobility (Retail and Recreation) | -0.258     | -0.267      |
| Mobility (Grocery and Pharmacy) | 0.137     | 0.112       |
| Mobility (Parks)        | -0.149      | -0.136      |
| Mobility (Transit Stations) | -0.533     | -0.591      |
| Mobility (Workplaces)   | -0.499      | -0.575      |
| Mobility (Residential)  | 0.119       | 0.223       |

Table 4 Correlation Table for Provincial Data

| height                  | COVID CASES | COVID DEATH |
|-------------------------|-------------|-------------|
| Population              | 0.851       | 0.697       |
| Population Density      | 0.820       | 0.446       |
| Working Population      | 0.874       | 0.803       |
| Senior Population       | 0.737       | 0.728       |
| No. of ICU Beds         | 0.666       | 0.636       |

Table 5 Labels for Figures 4,5 and 6

| heightLabel | Province | Label Province | Label Province |
|-------------|----------|----------------|----------------|
| 1 Abra       | 29       | Occidental Mindoro | 57 Zamboanga City |
| 2 Apayao    | 30       | Oriental Mindoro | 58 Zamboanga Sibugay |
| 3 Benguet   | 31       | Palawan | 59 Bukidnon |
| 4 Ifugao    | 32       | Romblon | 60 Camiguin |
| 5 Kalinga   | 33       | Albay | 61 Lanao del Norte |
| 6 Mountain Province | 34 | Camarines Norte | 62 Misamis Occidental |
| 7 Ilocos Norte | 35 | Camarines Sur | 63 Misamis Oriental |
| 8 Ilocos Sur | 36       | Catanduanes | 64 Compostela Valley |
| 9 La Union  | 37       | Masbate | 65 Davao del Norte |
| 10 Pangasinan | 38 | Sorsogon | 66 Davao del Sur |
| 11 Batanes  | 39       | Aklan | 67 Davao Occidental |
| 12 Cagayan  | 40       | Antique | 68 Davao Oriental |
| 13 Isabela  | 41       | Capiz | 69 Cotabato (North Cotabato) |
| 14 Nueva Vizcaya | 42 | Guimaras | 70 Sarangani |
| 15 Quirino  | 43       | Iloilo | 71 South Cotabato |
| 16 Aurora   | 44       | Negros Occidental | 72 Sultan Kudarat |
| 17 Bataan   | 45       | Bohol | 73 Agusan del Norte |
| 18 Bulacan  | 46       | Cebu | 74 Agusan del Sur |
| 19 Nueva Ecija | 47 | Negros Oriental | 75 Dinagat Islands |
| 20 Pampanga | 48       | Siquijor | 76 Surigao del Norte |
| 21 Tarlac   | 49       | Biliran | 77 Surigao del Sur |
| 22 Zambales | 50       | Eastern Samar | 78 Basilan |
| 23 Batangas | 51       | Leyte | 79 Lanao del Sur |
| 24 Cavite   | 52       | Northern Samar | 80 Maguindanao |
| 25 Laguna   | 53       | Samar (Western Samar) | 81 Sulu |
| 26 Quezon   | 54       | Southern Leyte | 82 Tawi-Tawi |
| 27 Rizal    | 55       | Zamboanga del Norte |
| 28 Marinduque | 56 | Zamboanga del Sur |
Figure 4  Outliers among the provinces in Luzon with respect to COVID-19 cases and deaths
Figure 5 Outliers among the provinces in Visayas with respect to COVID-19 cases and deaths
Figure 6 Outliers among the provinces in Mindanao with respect to COVID-19 cases and deaths
Figure 7 Outliers in the national capital region with respect to COVID-19 cases and deaths
Figure 8 Outliers among metropolitan areas in the Philippines with respect to COVID-19 cases and deaths
Figure 9 COVID-19 community quarantines in Regions III, IVA and VII