ORIGINAL ARTICLE

THE ASSOCIATION OF COVID-19 CASES WITH THE SOCIAL AMELIORATION PROGRAM (SAP) AND POPULATION DENSITY: A GEOSPATIAL ANALYSIS

Vicente E. Montaño[1],*

[1]Faculty of Business Administration Education, University of Mindanao, Bolton, 8000 Davao City, Philippines

ABSTRACT – The COVID-19 pandemic prompts the government to lock down communities and spread safety nets through subsidies to control the contagion. Consequently, the strict lockdowns refrained individuals from venturing outside and impacted their reliance on the Social Amelioration Program (SAP) from the government. This study attempts to assess the effect of SAP distribution in highly populated cities in Metro Manila in the situation of possible increase of COVID-19 contagion. The geospatial analysis showed a significant association between the SAP distribution and high population density being vulnerable during the COVID-19 pandemic outbreak. The cities of Manila, Caloocan, and Quezon City pose the highest risk for individuals defined by the ratio of correct predictions to the overall occurrence of the predicted COVID-19 cases.

INTRODUCTION

The 2019 coronavirus disease (COVID-19) is a global pandemic that exponentially spread worldwide (Chinazzi et al., 2020). As the virus spread to all continents, countries, and territories, the World Bank (W.B.) warned about the pressure the pandemic would bring to the health system of developed countries (Legido-Quigley et al., 2020) and especially among developing countries (Loayza & Pennings, 2020) including the Philippines. Most states adopted several measures to slow down the rapid spread of the virus (WHO, 2020).

In response to the imminent public health crisis, last March 23, 2020, the Philippines Senate enacted the Republic Act no. 11469, otherwise known as the Bayanihan to Heal as One Act granting the President additional powers to fight the COVID-19 pandemic (GARCIA). Previously, the Executive Branch issued Executive Order No. 168, creating the Interagency Task Force on Emerging Infectious Disease (IATF-EID), with the primary purpose of assessing, containing, controlling, monitoring, and preventing any potential epidemic in the country. Consequently, the IATF created the National Task Force to manage the operational command efficiently. As the policy-making body of operation, the IATF recommends actions to President (Estadilla, 2020).

One of the significant recommendations of the IATF was to place the entire National Capital Region (NCR), composed of 16 cities, under the Enhanced Community Quarantine (ECQ), limiting the movement of people and strictly implementing the social distancing rule. However, cities in the NCR have the highest population density in the country, and authorities find it challenging to implement quarantine measures. Most of the COVID-19 cases in the Philippines came from the cities in the NCR (Quimbo, Latinazo, & Peabody, 2020).

In addition to social distancing, the government required a temporary stoppage of business operations (San Juan), suspension of classes, and advised people to stay home. Until an effective vaccine is discovered, public health experts believe that delaying the movement temporarily and eliminating social interaction among people is the only way to curb the spread of the virus (Antonio, Deldacan, Ogena, & Noche, 2020). Early data show that a combination of massive public information on protecting one from contracting and transmitting COVID-19 through social and physical distancing is effective (Sjödin, Wilder-Smith, Osman, Farooq, & Rocklöv, 2020). Nonetheless, for the Philippines, where many people earn a daily wage, asking them to refrain from going out is very difficult.

Local government-issued passes control people's movement (Kabiling, 2020) and arrest people violating quarantine rules and curfews (Loblen, 2020). Thus, people thought the lockdowns and community quarantine, which started on March 17, 2020, lasted for weeks and were extended to more than two months until May 31, 2020 (Lim, 2020). Community quarantine was extended thrice because the IATF did not observe the "flattening of the curve" (Beyond numbers, 2020). It is a data analytics indicator that the aggressive program of the government to control the rapid increase of the virus was taking effect (Thunstrom, Newbold, Finnoff, Ashworth, & Shogren, 2020). However, for many residents of informal settlements in NCR, these are unrealistic, and they cannot cope with such requirements.

To convince individuals to stay at home, the National Government subsidized low-income families' income through the Social Amelioration Program (SAP) (Gentilini, Almenfi, Orton, & Dale, 2020). More than 1.7 million individuals in the NCR were identified as recipients of P12.46 billion (Luci-Atienza, 2020). Unfortunately, during the scheduled distribution, beneficiaries have mass-gathered in different community halls to claim the cash (Santos, 2020).

During the pandemic, geospatial modeling techniques helped in pattern detection (Fatima, O'Keefe, Wei, Arshad & Gruebner, 2021). This study intended to present a model which finds the association between the initial SAP distribution

and the increase of COVID-19 in highly dense populated communities in the NCR. Specifically, the study seeks to explore the relationship between data elements associated with location and process geospatial analysis of the data to depict insight. By evaluating both spatial and nonspatial data, overall data accuracy is enhanced and presents a more profound understanding of the initial SAP distribution, the spread of COVID-19, and communities with high population density. Identifying the variable associated closely with the increasing number of virus cases is the primordial importance. The present study identified that the NCR cities' vital profile has a geospatial association with the number of COVID-19 cases.

METHODOLOGY

The research used the standard demographic profile of the 16 cities (Caloocan, Malabon, Valenzuela, Navotas, Las Pinas, Makati, Mandaluyong, Manila, Marikina, Muntinlupa, Paranaque, Pasay, Pasig, Quezon City, San Juan, and Taguig) in NCR, such as the population density, amount of SAP distributed, and the number of barangay published on the official websites of the cities. The number of confirmed COVID-19 cases was obtained from the Department of Health database published by the University of the Philippines. Next, the research laid the coordinates on the number of COVID-19 cases from the 16 cities to proceed to the geospatial analysis applying the association rules that assisted in uncovering insightful correlation between the COVID-19 cases, SAP distribution, and population density. The data of confirmed COVID-19 cases covered the period from January 30 to May 12, 2022, marking the country's 100 days of COVID-19. During the period, both the local and national governments initially mounted a multi-sectoral response to contain the spread of the virus and mitigate the socioeconomic impact of the community quarantine (WHO, 2020). During this phase, the emerging experience created lessons for government to adapt models and initiate operations to control the pandemic and soften its impact through the SAP distribution (Vallejo Jr, & Ong, 2020). For the duration until May 12, 2022, SAP beneficiaries from these cities were most vulnerable to the increased spread of the virus. This study examined how the initial SAP distribution contributed to the increase in COVID-19 cases among the cities in NCR.

Through the geospatial modeling technique, this study applied the association rule that helped uncover insightful associations among the spatial and nonspatial attributes, such as the COVID-19 cases, SAP, and population densities during the initial SAP distribution. The spatial, temporal prediction was used to fit linear models for the measurement taken over the NCR, allowing the researchers to predict vulnerable areas easily and how these areas contributed to the contagion.

RESULT

Last May 12, 2020, there were 11,350 confirmed COVID-19 cases in the Philippines, 6,080 of these cases were in the 16 cities in the NCR. Reflected in Table 1 is the distribution of COVID-19 cases in the NCR. The highest number of registered cases were from Quezon City, 1,601 (26%), followed by Manila, 863 (14%), and the least number of cases came from Navotas, 48 (1%).

Table 1. Confirmed COVID-19 cases in NCR cities as of May 12, 2020

NCR Cities	*f*	Percentage
City of Caloocan	261	4%
City of Malabon	64	1%
City of Valenzuela	122	2%
City of Navotas	48	1%
City of Las Pinas	207	3%
City of Makati	497	8%
City of Mandaluyong	450	7%
City of Manila	863	14%
City of Marikina	141	2%
City of Muntinlupa	186	3%
City of Paranaque	529	9%
City of Pasay	241	4%
City of Pasig	325	5%
Quezon City	1601	26%
City of San Juan	247	4%
City of Taguig	298	5%
Total	**6080**	**100%**

Table 2 shows the barangays in the NCR that have the most concentrated cases of COVID-19. The Local Government authorities decided to impose a hard lockdown in these barangays for several days, even weeks, to require residents to stay home. While health personnel conduct extensive viral testing to sort out possible COVID-19-positive residents, notably, these barangays are in the City of Manila (BREAKING, 2020) and Quezon City (Hallare, 2020).

Table 2. Barangays in NCR required a hard lockdown by the Local Government for COVID-19 cases in NCR cities, on May 12, 2020

City	Barangay	COVID-19 Cases	Percentage
Quezon City	Silangan	12	2%
	Culiat	37	7%
	Batasan Hills	29	6%
	Bahay Toro	21	4%
	Sauyo	19	4%
	Tatalon	17	3%
City of Caloocan	156	25	5%
City of Manila	Sampaloc	111	22%
	Tondo Dist.1	109	21%
City of Mandaluyong	Mamay	71	14%
	Addition Hills	59	12%
	Total	510	100%

Table 3 below presents the NCR cities' profiles. The cities of Manila and Caloocan have the most number of barangay. Furthermore, the two cities have one of the highest population densities, while Quezon City has the highest SAP subsidy.

Table 3. Confirmed COVID-19 cases in NCR cities as of May 12, 2020.

NCR Cities	Number of barangay	SAP Budget	Population Density
City of Caloocan	188	1726	29,701.44
City of Malabon	21	335.05	23,000.0
City of Valenzuela	33	661.66	13,194.85
City of Navotas	18	223.82	23,162.77
City of Las Pinas	20	541.9	18,014.5
City of Makati	33	558.3	23,347.0
City of Mandaluyong	27	368.37	34,925.5
City of Manila	896	1485	41,511.19
City of Marikina	16	449.88	20,945.21
City of Muntinlupa	9	430.68	12,692.05
City of Paranaque	16	621.39	13,961.46
City of Pasay	201	370.28	29,815.46
City of Pasig	30	750.93	15,589.27
Quezon City	142	3020	17,665.46
City of San Juan	21	130.47	20,534.45
City of Taguig	28	789.77	16,811.09

Depicted in Table 4 is the result of the rule table confidence. The confidence has 100 per cent correct rule prediction. Regarding the rule, 6.25 per cent of the case indicates that the rule is valid. The lift is about 16, which measures the degree the rule improves prediction compared to random chance. It is the overall occurrence of the predicted value expressed as the correct prediction ratio at 16. Thus the predicted value occurs 16% of the time. The condition support is 6.25. Lastly, deployability is zero, which implies a zero per cent of incorrect prediction when the conditions are true.

Table 4. Rule Table Confidence

Rank	Rule ID	Condition	Prediction	Sorted By Confidence (%)	Other Evaluation Statistics			
					Condition Support (%)	Rule Support (%)	Lift	Deployability (%)
1	1	Close to no. of Barangay > 452.500	covid = Manila	100	6.25	6.25	16	0
2	2	Close to no. of Barangay > 452.500 Close to SAP ≤ 1575.235	covid = Manila	100	6.25	6.25	16	0
3	3	Close to no. of Barangay> 452.500 Close to Density > 27101.622	covid = Manila	100	6.25	6.25	16	0
4	4	Close to SAP > 1575.235 Close to Density ≤ 27101.622	covid = Quezon City	100	6.25	6.25	16	0
5	5	Close to SAP > 1575.235 Close to Density > 27191.622	covid = Caloocan	100	6.25	6.25	16	0

A heat map exhibiting the NCR with the number of HEIs in the city and the current geographic COVID-19 case volume is shown in Figure 1. The highest-risk cities for individuals are defined by the ratio of correct predictions to the overall occurrence of the predicted COVID-19 cases which are Manila, Caloocan, and Quezon City (Table 4). Precisely, the number of COVID-19 patients in Manila is indicated to be close to the number of barangay and HEIs. In the case of Manila, Caloocan, and Quezon City, the number of COVID-19 cases is predicted to be close to the amount of SAP distribution and population density areas based on patterns are likely to change over time.
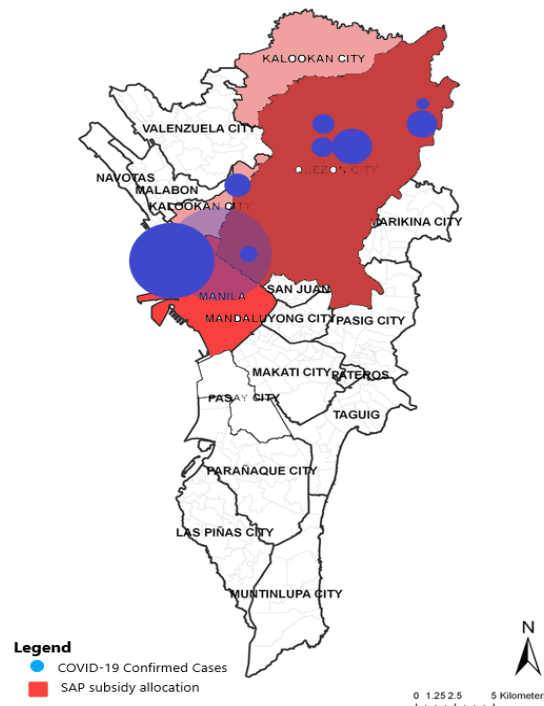

Figure 1. Geographic distribution of SAP allocated budget and COVID-19 confirmed case numbers.

DISCUSSION

The result of the study exhibits the association of SAP distribution during the COVID-19 pandemic. The geospatial analysis illustrates the NCR cities with high COVID-19 cases proportions to the amount of SAP, focusing on the barangays that are at increased risk of contracting or even unknowingly transmitting the virus to others. Similarly, there is an association with population density during the COVID-19 pandemic (Rocklöv & Sjödin, 2020). The geospatial analysis depicts the NCR cities with high population density confirmed COVID-19 cases. The result highlights that cities with high population densities are vulnerable during the COVID-19 pandemic (Desai, 2020).

Based on the findings, Manila, Quezon City, and Caloocan have the highest SAP allocation. Hence, SAP beneficiaries and high population density in the NCR experience a higher degree of viral exposure. These cities are likely to be vulnerable to a spike in COVID-19 cases after the distribution of the SAP subsidy attributed to the mass gathering (Nunan & Brassey, 2020).

The rapid increase of COVID-19 cases in cities and the desperate effort of individuals to secure their SAP funds during the community quarantine are alarming (Santos, 2020). It is common to observe the mass gathering of SAP beneficiaries during the distribution of funds in which authorities find it challenging to implement social distancing (McCloskey et al., 2020). Similarly, the inefficient allocation of the SAP subsidy left several individuals and families with no source of sustenance, forcing them to venture outside to source their next meal. However, with systematic precautions in strictly implementing social distancing during SAP funds distribution is possible to limit risk to beneficiaries and help reduce potential transmission. Various system recommendations for SAP distribution during the COVID-19 pandemic have suggested eliminating the mass gathering of recipients.

If the government had earlier implemented the national I.D. system and migrated from cash to a digital transaction-based society, the mass gathering of SAP recipients would be avoidable (Reganit, 2020). Some have cited the City of Makati which distributed the city government assistance using the G-cash feature available in a mobile telecom company (James, 2020).

The key is for the local and national government authorities involved in the SAP subsidy distribution to strike a balance between delivering essential needs and implementing preventive procedures to protect recipients from transmitting or contracting the COVID-19 virus. However, when the National Government officials set a deadline for Local Government authorities to thoroughly distribute SAP subsidy by May 10 (Lalu, 2020), the desire to secure the essential needs outweigh the preventive procedure (CNN Philippine Staff, 2020). However, the preventive procedure preceded the crucial needs of the identified vulnerable individuals. Specifically, for the most susceptible SAP recipients, the senior citizens, pregnant, and those with heart and respiratory conditions who can authorize relatives to claim on their behalf, the SAP subsidy can reduce their risk of exposure.

Even though a prolonged Enhanced Community Quarantine (ECQ) can stop or slow down the rapid spread of COVID-19, it is sensible for IATF to adopt a better preventive procedure to complement the distribution of essential needs. As the rates of new cases started to decrease and IATF shifted to a Modified Enhanced Community Quarantine (MECQ), which allowed the certain business to open, the country continued to exercise caution in their calibrated "return-to-work" plan in the coming days (Aspinwall, 2020). The future distribution of the second tranche of SAP subsidy was anticipated that with fewer beneficiaries of 5 million families (Report, 2020), the National and the Local Government authorities finally had the chance to balance the essential needs and preventive procedures during the SAP subsidy distribution

CONCLUSION AND IMPLICATIONS

Across the country, cities in the NCR reported a disproportionate number of COVID-19 cases, especially in Manila, Caloocan, and Quezon City. Specifically, most barangays where local authorities require a hard lockdown are in the three cities. In addition, these barangays have the highest number of SAP subsidy recipients. As the different cities move from ECQ to MECQ, the National and Local Governments must evaluate how to balance the essential needs with the preventive procedure during the second tranche distribution to avoid the second wave that might arise from these barangays.

RECOMMENDATION

Communities with a high-density population require alternative solutions during SAP distribution. These solutions are needed to prevent the physical distribution of SAP during outbreaks, such as providing affordable access to technology and the internet. Next, it is essential to consider the possibilities of redesigning these communities or repurposing their environment to recover faster as a more resilient urban neighborhood with a more substantial social capital to deal with future pandemics. For future studies, researchers may need to consider how the variants of COVID-19 affect the model differently.

LIMITATIONS OF THE STUDY

The NCR is a highly populated area in the country with a single national government response for physical SAP distribution, which allowed the geospatial analysis as an epidemic surveillance technique. However, a precise estimation for effective epidemic surveillance is considered too disingenuous. Admittedly, there are various unidentified variables even among cities in the NCR to present an accurate modeler to precisely identify vulnerable areas

REFERENCES

Antonio, F. M. L., Deldacan, N. F. U., Ogena, N. M. L., & Noche, N. F. L. (2020). Master in Crisis and Disaster Risk Management (MCDRM) and Education in Time of Pandemics.

Aspinwall, N. (2020, May 13). Philippines Will Gradually Ease Lockdowns as Testing, Relief Payments Remain Stalled. The Diplomat. Retrieved from https://thediplomat.com/2020/05/philippines-will-gradually-ease-lockdowns-as-testing-relief-payments-remain-stalled/

Beyond numbers: What the flattening curve really means; protecting children in the time of COVID-19. (2020, May 06). Department of Health. Retrieved from https://www.doh.gov.ph/doh-press-release/BEYOND-NUMBERS%3A-WHAT-THE-FLATTENING-CURVE-REALLY-MEANS%3B-PROTECTING-CHILDREN-IN-THE-TIME-OF-COVID-19

BREAKING: The entire first district of the City of Manila will be placed under a 48-hour hard lockdown. Republic of the Philippines, City of Manila. (2020, April 30). Retrieved from http://manila.gov.ph/2020/04/breaking-the-entire-first-district-of-the-city-of-manila-will-be-placed-under-a-48-hour-hard-lockdown-on-sunday-may-3-2020/

Chinazzi, M., Davis, J. T., Ajelli, M., Gioannini, C., Litvinova, M., Merler, S., . . . Sun, K. (2020). The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. Science, 368(6489), 395-400.

COVID-19 Updates: Philippines, as of (2020, May 12). University of the Philippines. https://endcov.ph/dashboard/

CNN Philippine Staff. (2020, April 30). Gov't extends cash aid distribution in NCR, other areas for another week. CNN Philippines. Retrieved from https://www.cnn.ph/news/2020/4/30/DSWD-DILG-extend-cash-aid.html

Desai, D. (2020). Urban Densities and the COVID-19 Pandemic: Upending the Sustainability Myth of Global Megacities. Occasional Papers.

Estadilla, L. S. (2020). The Economics of COVID-19 in the Philippines. Eubios Journal of Asian and International Bioethics, 30(9), 178.

Fatima, M., O'Keefe, K. J., Wei, W., Arshad, S., & Gruebner, O. (2021). Geospatial analysis of COVID-19: A scoping review. International Journal of Environmental Research and Public Health, 18(5), 2336.

GARCIA, C. M. Legal Perspective on the Bayanihan to Heal as One Act.

Gentilini, U., Almenfi, M., Orton, I., & Dale, P. (2020). Social protection and jobs responses to COVID-19: a real-time review of country measures. Live Document. World Bank, Washington, DC. http://www. ugogentilini. net/wp-content/uploads/2020/03/global-review-of-social-protection-responsesto-COVID-19-2. pdf.

Hallare, K. (2020, May 12). 20 areas in fivQ.C.QC barangays under two-week 'special concern lockdown'. INQUIRER.NET. Retrieved from https://newsinfo.inquirer.net/1273954/qc-govt-places-20-areas-in-five-barangays-under-two-week-special-concern-lockdown

Jams, N. (2020, May). Binay distributes Makatizen cards to District 1 residents. Metro Central News. Retrieved from http://metronewscentral.net/makati/metro-cities/binay-distributes-makatizen-cards-to-district-1-residents

Kabiling, G. (2020, March 21). Gov't allows only one person per household to leave home; other guidelines for ECQ. Manila Bulletin. https://news.mb.com.ph/2020/03/18/govt-allows-only-one-person-per-household-to-leave-home-other-guidelines-for-ecq/

Lalu, G.P. (2020, May 11). A day after SAP deadline, only 89% of beneficiaries got aid — DSWD. INQUIRER.NET. Retrieved from https://newsinfo.inquirer.net/1273119/a-day-after-sap-deadline-only-89-of-sap-beneficiaries-got-aid-dswd

Legido-Quigley, H., Asgari, N., Teo, Y. Y., Leung, G. M., Oshitani, H., Fukuda, K., . . . Heymann, D. (2020). Are high-performing health systems resilient against the COVID-19 epidemic? The Lancet, 395(10227), 848-850.

Lim, S. (2020, May 13). Businesses allowed under 'modified' ECQ identified. Metro Central News. Retrieved from http://metronewscentral.net/metro-business/businesses-allowed-under-modified-ecq-identified

Loayza, N. V., & Pennings, S. (2020). Macroeconomic policy in the time of COVID-19: A primer for developing countries: World Bank.

Loblen, P. (2020, April 24). ECQ violators warned of outright arrest, jail term. Philippine News Agency, Retrieved from https://www.pna.gov.ph/articles/1100824

Luci-Atienza, C. (2020, April 29). DSWD: Disbursed SAP subsidies in NCR now at P3.4 billion. Manila Bulletin. Retrieved from https://news.mb.com.ph/2020/04/29/dswd-disbursed-sap-subsidies-in-ncr-now-at-p3-4-billion/

McCloskey, B., Zumla, A., Ippolito, G., Blumberg, L., Arbon, P., Cicero, A., . . . Borodina, M. (2020). Mass gathering events and reducing further global spread of COVID-19: a political and public health dilemma. The Lancet, 395(10230), 1096-1099.

Nunan, D., & Brassey, J. (2020). What is the evidence for mass gatherings during global pandemics? A rapid summary of best-available evidence: Oxford (U.K.): The Centre for Evidence-Based Medicine: Oxford COVID-19 ….

Organization, W. H. (2020). Coronavirus disease 2019 (COVID-19): situation report, 72.

Quimbo, S., Latinazo, C., & Peabody, J. (2020). (D.P. 2020-07) A Risk Assessment on the COVID-19 Situation in the Philippines: Implications on the ECQ Policy. UPSE Discussion Papers.

Reganit, J.C. (2020, April 3). Implement National ID System vs. future pandemics: solon. Philippine News Agency. Retrieved from https://www.pna.gov.ph/articles/1098797

Report to the Joint Congressional Oversight Committee. (2020, May 11). Retrieved from https://www.officialgazette.gov.ph/downloads/2020/05may/20200511-Report-to-the-Joint-Congressional-Oversight-Committee.pdf

Rocklöv, J., & Sjödin, H. (2020). High population densities catalyse the spread of COVID-19. Journal of travel medicine.

San Juan, D. M. M. Economic Relief in the Time of COVID-19: Rationale, Mechanics, Costing, and Prospective Impact of Temporary Value-Added Tax (VAT) Suspension and Income Tax Waiver for the Poor and the Middle Class in the Philippines.

Santos, P.C. (2020, May 10). Chaos mars SAP release. Daily Tribune. Retrieved from https://tribune.net.ph/index.php/2020/05/10/chaos-mars-sap-release/

Sjödin, H., Wilder-Smith, A., Osman, S., Farooq, Z., & Rocklöv, J. (2020). Only strict quarantine measures can curb the coronavirus disease (COVID-19) outbreak in Italy, 2020. Eurosurveillance, 25(13), 2000280.

Thunstrom, L., Newbold, S., Finnoff, D., Ashworth, M., & Shogren, J. F. (2020). The benefits and costs of flattening the curve for COVID-19. Available at SSRN 3561934.

Vallejo Jr, B. M., & Ong, R. A. C. (2020). Policy responses and government science advice for the COVID 19 pandemic in the Philippines: January to April 2020. Progress in disaster science, 7, 100115.

CONFLICT OF INTEREST

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