Mitigating the Transmission of COVID-19 in the Philippines: A Six Sigma Approach

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Abstract

The COVID-19 pandemic has greatly paralyzed the movement and everyday activities of many countries. In the Philippines, the first local transmission of coronavirus began last March 2020 and there has been a continuous increase in the number of positive cases. The study focuses on analyzing and identifying contributing factors on mitigating the transmission of COVID-19 in the country. Different drivers in achieving the critical need were identified such as the efficiency of contact tracing, isolation of possible carrier of the virus, rate of performed test to determine the individuals' positive on having the disease, the rate of patients' recovery, and the effectiveness of implementing community quarantine and social distancing. The study used Define, Measure, Analyze, Improve and Control (DMAIC) Framework in analyzing and providing improvements on the current situation of COVID-19 pandemic in the country.

Keywords
DMAIC, Six Sigma, COVID-19, Disease Transmission, and Critical to Satisfaction.

1. Introduction
Coronavirus disease also known as COVID-19 is caused by new strain of coronavirus originally identified to begin in Wuhan, China on December 2019 (Coronavirus disease (COVID-19) in the Philippines, 2020). It is a highly transmittable disease that causes patients to experience common symptoms such as fever, tiredness, and dry cough. There are also cases in which the disease gives aches and pains, nasal congestion, runny nose, sore throat and even diarrhea to infected individuals (World Health Organization, 2020). Older people and those groups having an impaired immune system are considered to be greatly vulnerable of being infected by COVID-19.

The first imported case of COVID-19 in the Philippines has been recorded on January 30, 2020 and a total of three (3) confirmed positive cases between the January and February, 2020. On March 7, 2020, the first local transmission has been confirmed in which there were seven (7) reported cases tested positive for COVID-19. Since then, the country's national and local health agencies increased and widen its contact tracing activities to identify possible

carrier of coronavirus disease. During this early stage of COVID-19 in the Philippines, there was only one testing center for COVID-19 test with a capacity of only 300 tests per day (Coronavirus disease (COVID-19) Situation Report 1 Philippines 9 March 2020, 2020). On March 16, 2020, the entire Luzon has been placed under Enhanced Community Quarantine (ECQ) which was initially effective until April 12, 2020. Enhanced community quarantine imposes restrictions on movements of people, stoppage on public transportation and closure of non-essential establishments. Due to increase in number of positive cases and reported fatality, the said ECQ has been extended until April 30, 2020.

Six Sigma methodology provides a systematic way of analyzing and providing solutions to problems. It uses tools and techniques in analyzing data to clearly define and evaluate each component of a system and step of a process. One target of this methodology is to continuously improve a system and processes in order to achieve stable and predictable outcome (Six Sigma Daily, 2020). The most common and effective framework of Six Sigma methodology is the DMAIC approach. This framework involved phases such as Define, Measure, Analyze, Improve and Control stages.

The study aims to have an in-depth and systematic understanding on the current state of COVID-19 pandemic in the Philippines by utilizing DMAIC approach and various Six Sigma tools and techniques. It intends to analyze different contributing factors to mitigate the transmission of coronavirus disease in the country. Moreover, results of data-analysis target to provide recommendations to further improve the present programs and action plans currently implemented in the country.

Figure 1. Six Sigma DMAIC Methodology

2. Define Phase

2.1 Problem Statement

Generally, there is an increasing trend in number of new positive COVID-19 cases in the Philippines as of April 2020. The highest number of new positive cases as of April 14, 2020 was recorded on March 31, 2020 with 538 confirmed COVID-19 cases. At present, the latest number of confirmed positive cases is at least 6,000 and there are 446 cases of deaths. The highest portion of confirmed positive cases and fatalities is identified in Metro Manila (COVID-19 Tracker Philippines, 2020). The effectiveness of identifying the possible carrier of coronavirus disease is very critical and is done through contact tracing. Based on World Health Organization, there are three (3) main procedures in carrying out the contact tracing of individuals who are most likely positive for COVID-19. These procedures include contact identification, contact listing and contact follow-up. The identified individuals are then categorized as Person Under Investigation (PUI) and Person Under Monitoring (PUM) and are required to follow strict home quarantine. Contact identification procedure is performed by interviewing the person's activities and possible contact to other person. One important factor of stemming the transmission of COVID-19 is by intensifying and improving the current state of contact tracing since the procedure merely relies on the response of the person being asked and not on the actual records of activities and whereabouts. In terms of isolation of persons under monitoring and investigations, the primary health agency imposes strict home quarantine due to lack of sufficient isolation facilities. One study explains that there is insufficiency in the number of critical care beds in the country to accommodate the estimated cases of 8,800 to 19,000 critical COVID-19 patients. The same study also determined that the country is far from the WHO standard ratio of 10 doctors for every 10,000 individual since the Philippines only has 3.7 doctors for every 10,000 people (Estimating Local Healthcare Capacity to Deal with COVID-19 Case Surge: Analysis and Recommendations, 2020). Another factor that influences the transmission of COVID-19 in the Philippines is the capacity of testing laboratories to perform COVID-19 test. As of April 22, 2020, the country has a rate of 0.556 performed tests per 1,000 people which is very much lower as compared to other Asian countries like South Korea with 11.221 tests per 1,000 people and Singapore with 10.065 tests per 1,000 people (Total Test per Thousand since 100th case, 2020). A backlog in COVID-19 testing impedes the efficiency of the country in performing its COVID-19 testing and also a contributing factor in proactively containing the spread of the disease. This bottleneck involves a total of 103,230 tests as of April 14, 2020 which evidently indicates the urgent need on increasing the capacity of the country's testing kits, testing laboratories and number of medical personnel capable of performing the test (COVID-19 Tracker Philippines, 2020). On the other hand, as of April 23, 2020 the recovery rate of patients infected of COVID-19 in the Philippines is at 60.79% which is lower than the global recovery rate of at least 79%. The prompt response of the country to impede the local transmission of coronavirus disease is to implement Enhanced Community Quarantine (ECQ) particularly

on the entire Luzon. According to the Department of Health of the Philippines, the implementation of Luzon-wide ECQ effectively decreases by half the expanding number of COVID-19 positive cases (Ornedo, 2020). However, the country is having difficulty in achieving the full execution of this protocol due to some people consistently violating orders. Based on the report of the Philippine National Police (PNP), as of April 21, 2020 there are 136, 517 recorded violators of on-going enhanced community quarantine for the past 35 days (Bajo, 2020). This condition could negatively affect the goal of ECQ in stemming the transmission of COVID-19 in the country.

2.2 Critical to Satisfaction

The diagram below illustrates the critical need which is to mitigate the transmission of coronavirus disease in the country. Additionally, it shows the specific drivers the critical need or contributing factors that might have significant effect in stemming the spread of COVID-19 in the country. Also, it determines the minimum requirement in order to satisfy the drivers and eventually the identified critical need. These minimum requirements are also known as critical to satisfaction which will serve are the measurable target in mitigating the transmission of coronavirus disease.

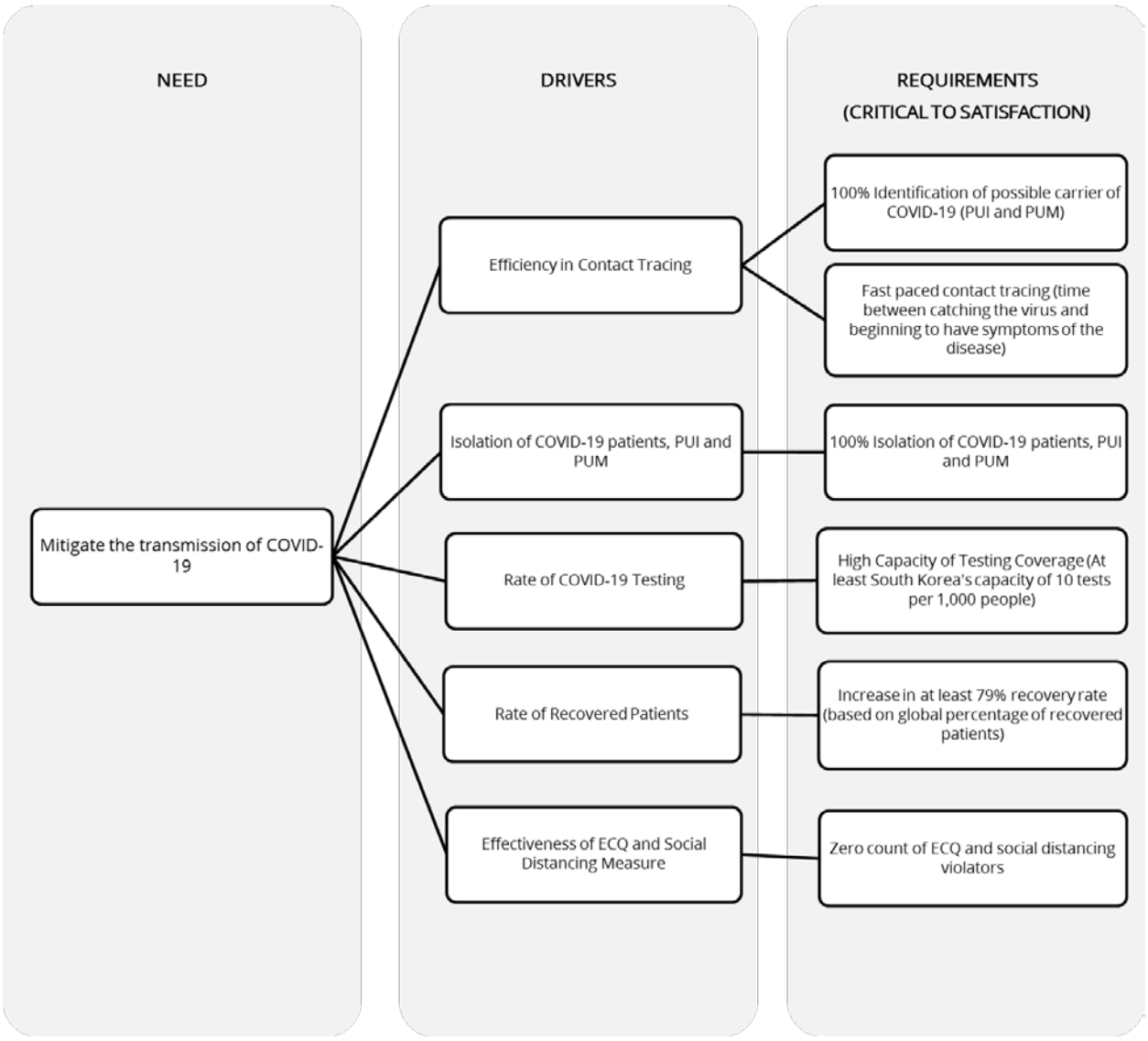


Figure 2. Critical to Satisfaction - Mitigating the Transmission of COVID-19

2.3 Process Map

In order to mitigate transmission of COVID-19, containment strategies must be taken first into priority. Containment procedures must be strictly implemented to delay the spread of the COVID-19. Persons Under Investigation (PUIs) and Persons Under Monitoring (PUMs) are the persons being observed in the containment of COVID-19. PUIs are those persons who are symptomatic, has travel history abroad for the past 14 days (especially to countries affected by COVID-19), and/or has exposure to a person with confirmed case of COVID-19. PUMs, on the other hand, are the persons who are similar with PUIs but they are merely asymptomatic. (DOH, 2020) Eventually, PUI and PUM classification are replaced by Suspect, Probable, and Confirmed Cases when the COVID-19 expanded testing was commenced. Suspect and Probable Cases are both PUIs and the only difference is that Suspect has not been tested while Probable has been tested but not yet getting reliable results. Confirmed Case, in addition, is the case when the reliable result was released and the patient is confirmed positive to COVID-19.

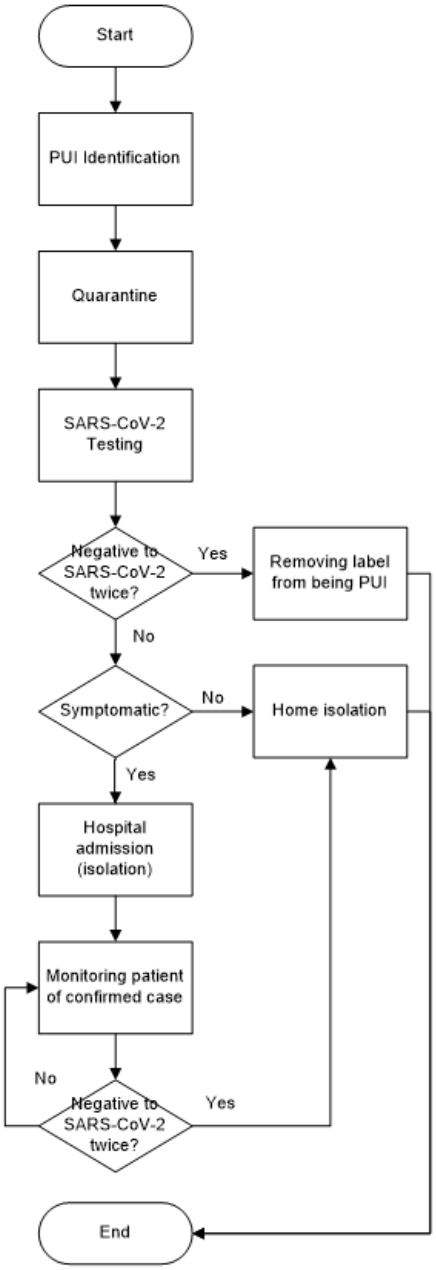


Figure 3. COVID-19 Containment Process Map for PUI

The containment process starts from identification of PUI based from the classification from the Department of Health (DOH). As long as a person has travel history abroad and exposure to a person with confirmed case whether symptomatic or asymptomatic, a person is considered PUI. After identifying PUIs, they are subjected for quarantine for 14 days either quarantine at home or barangay isolation units. All PUIs will be tested to confirm if they have COVID-19 but the vulnerable people will be prioritized first due to limited testing resources like testing kits, qualified testing facilities and laboratories, and specialists. Vulnerable people are composed of elderly persons, pregnant women, and persons with preexisting conditions (i.e., pneumonia, diabetes). Testing is conducted twice which is once per week to check the presence of the virus (SARS-CoV-2) in the throat and in the lungs through mucus from the nose. The result is released around 24 to 48 hours depending on the testing laboratory. Once results are negative, that person will be removed from the list of being PUI. If otherwise and the person is asymptomatic, that person is subjected for home isolation or quarantine in a barangay isolation unit and if symptomatic, that person is subjected for hospital admission. In the hospital, the patient is monitored if SARS-CoV-2 virus is still present on that person. The testing is same as before the hospital admission. If the result is both negative for two (2) tests and the person has no observed symptoms, that person will now be discharged but still under home isolation, otherwise, the patient will still be in the hospital for recuperation. The process map is shown in Figure 2.

3. Measure Phase

3.1 Measurement System Analysis (MSA)

MSA is conducted to show accuracy and precision of acquired data but due to certain limitation in terms of accessibility, this will not be presented as the typical Gage Repeatability and Reproducibility (Gage R&R) Study and Attribute Agreement Analysis for continuous and discrete data, respectively. This is because the data source about COVID-19 is mainly from government agencies such as the Department of Health (DOH) and no other institutions are generating and keeping COVID-19 related reports and records. The government collated these data all over the country with the help of its local agencies. For the data collected, a metric classification is made for the critical to satisfaction requirements identifying the measure type whether response variable or predictor variable and the data type whether continuous or discrete. (Table 1)

Table 1. Metric Classification for Critical to Satisfaction Requirements

Metric	Measure type*	Data type	Need/Drivers	Operational definition
Cases	Y	Discrete	Transmission of COVID-19	Number of daily reported COVID-19 cases
Testing capacity	X	Discrete	Rate of COVID-19 testing	Number of daily tests done in qualified facilities
Bed capacity	X	Discrete	Isolation of COVID-19 patients	Number of beds in qualified hospitals or healthcare facilities
Recovery rate	X	Discrete	Rate of recovered patients	Number of daily recovered patients

*Y refers to the response variable and X refers to the predictor variable

The factors considered in this classification are those related to the number of cases such as the testing capacity, bed capacity, and recovery rate. They represent the drivers for the need of mitigating COVID-19 transmission in the Philippines. Contact tracing parameters are not included in this classification because of its dependency to the testing capacity for the prevailing policy is that contact tracing will be done after identifying a PUI to be a confirmed positive case. On the other hand, effectiveness of ECQ and social distancing measure is not included in the list of factors due to limited data availability but will be included in the analysis to show if it has effect on the number of COVID-19 cases in the Philippines.

3.2 Baseline Performance Metric

To check whether the current mitigation procedures are doing well, targets are set for each metric of critical to satisfaction requirements. (Table 2) The targets specified in Table 2 are based from default 95% confidence level. It includes the mean actual value and standard deviation of the current values of each metric. Based on the guidelines of

the Department of Health, contact tracing will commence after identifying confirmed cases. It can be observed that the bed capacity can accommodate admitted confirmed positive patients based on the mean actual value of the acquired data. It can be inferred that there is no existing problem in the number of beds for isolation of COVID-19 patients. But since the number of cases is continuing to exist, target is still placed on the bed capacity as a preparation for the future state in the number of COVID-19 patients admitted. In addition, recovery rate is continuously increasing which is good but still a target is indicated to lessen chances of spreading the virus through reduction of active confirmed positive cases.

Table 2 Baseline Performance Metric for Mitigation of COVID-19 Transmission

Metric	Mean Actual Value (MAV)	Standard deviation	Target
Cases	193	55	<5% MAV ≤ **9** (based on default significance level)
Testing capacity	72,056	13,717	>2.5 times MAV **≥ 180,140** (based on average number of PUI)
Bed capacity	1,805	686	>5 times MAV **≥ 9,025** (based on 5% of average number of PUI)
Recovery rate	48	17	>4 times MAV **≥ 192** (based on average number of confirmed cases)

4. Analyze Phase

4.1 Key Source of Variation

To identify the key sources of variation of the number of confirmed positive COVID-19 cases in the Philippines, it is necessary to check and describe the data gathered. Before conducting any inferential statistics, it is better to consider assumptions and conditions for each appropriate test. Since there are identified factors as predictor variables and a response variable, regression analysis was conducted. But before proceeding with this analysis, the data must be normally distributed. Normality test was done to determine the data gathered per variable are normally distributed shown in Table 4. Based on the results, the data are all normally distributed, they are fit for a regression analysis.

Table 3. Regression Analysis on Identifying Factors Affecting the Transmission of COVID-19 in the Philippines

Poisson Regression Analysis: Cases versus Test_Cap, Beds, Recoveries

Method

Link function Natural log
Rows used 12

Deviance Table

Source	DF	Adj Dev	Adj Mean	Chi-Square	P-Value
Regression	3	33.62	11.21	33.62	0.000
Test_Cap	1	13.35	13.35	13.35	0.000
Beds	1	16.83	16.83	16.83	0.000
Recoveries	1	19.21	19.21	19.21	0.000
Error	8	151.49	18.94		
Total	11	185.11			

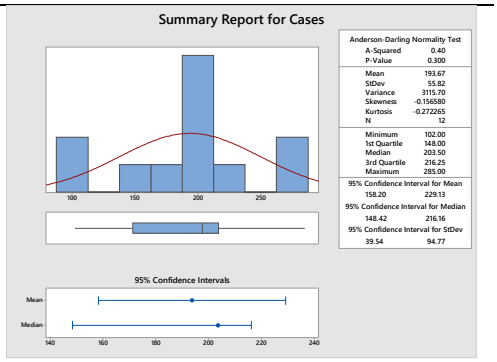
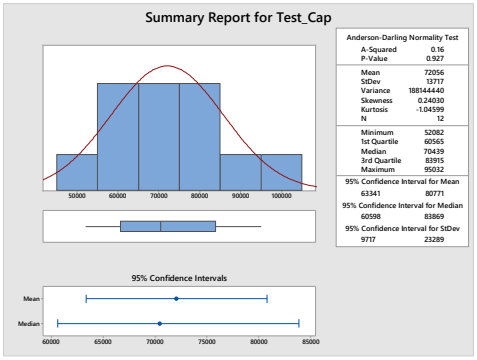
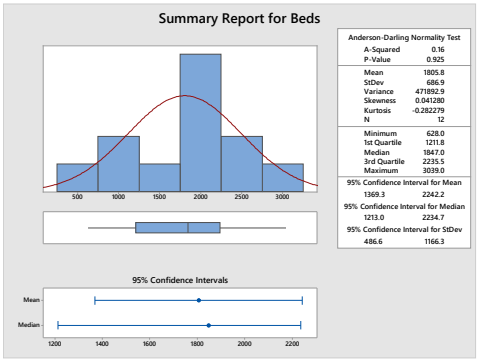
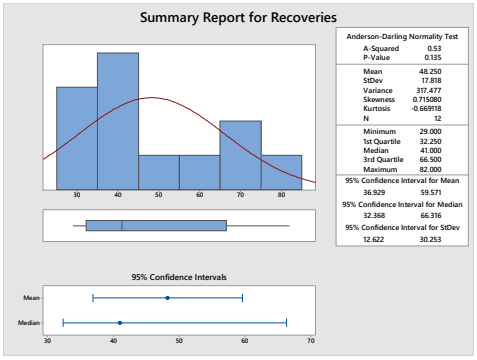
Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC
18.16%	16.54%	244.23

Coefficients

Term	Coef	SE Coef	VIF
Constant	5.635	0.216	
Test_Cap	-0.000020	0.000006	12.96
Beds	0.000438	0.000109	12.93
Recoveries	0.00539	0.00122	1.03

Table 3. Normality Test of the Identified Factors Affecting the Transmission of COVID-19 in the Philippines

Metric	Anderson-Darling Test p-value (α=5%)	Interpretation	Graphical Summary
Cases	0.300	Normal	
Testing capacity	0.927	Normal	
Bed capacity	0.925	Normal	
Recovery rate	0.135	Normal	

After satisfying the normality and independency assumption, regression analysis was conducted. Poisson regression is used to identify relationship of discrete response variable with discrete predictor variables. The results in Table 3 shows that all identified factors namely testing capacity (Test_Cap), bed capacity (Beds), and recovery rate (Recoveries) are significantly related with the response variable of COVID-19 cases (Case). The identified factors are not enough to significantly explain the variability of the response variable of COVID-19 cases because of low Deviance R-squared (18.16%) and Deviance R-squared adjusted (16.54%) values and Akaike information criterion (AIC) (244.23) value is high. There are still other factors that are not considered but significantly related to the COVID-19 cases. No multicollinearity (dependency among factors) exists in the variables due to low variance inflation factor (VIF).

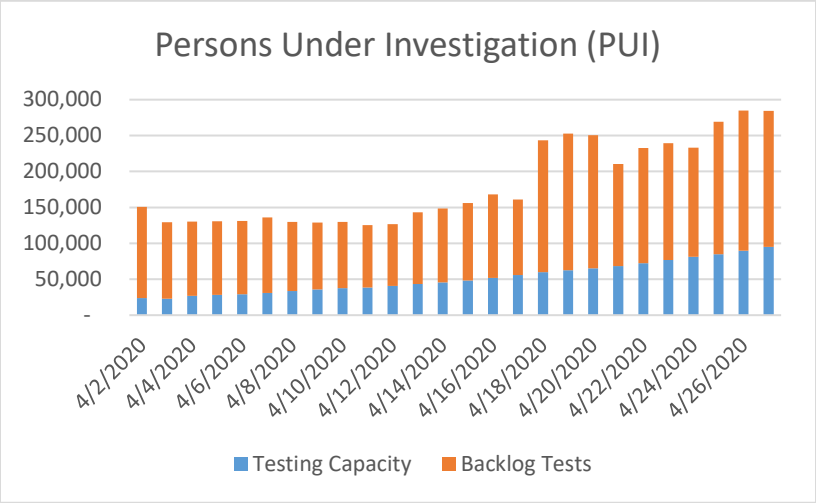


Figure 4. Persons under Investigation Based on Testing Capacity and Backlog Tests

Since the factors run in regression analysis were not sufficient, other factors seemingly related to the number of COVID-19 cases were also analyzed. Based from the health department data, testing capacity is too low compared to the number of backlog tests (Figure 4) meaning many PUI are waiting for the test results. Based on some reports, there are PUI who already passed away but results are still hanging wherein some of these PUI were confirmed positive. In that note, contact tracing was not efficiently done and it imposed a risk to increase more PUI because some people were unaware that they might be exposed to these persons and they were not isolated.

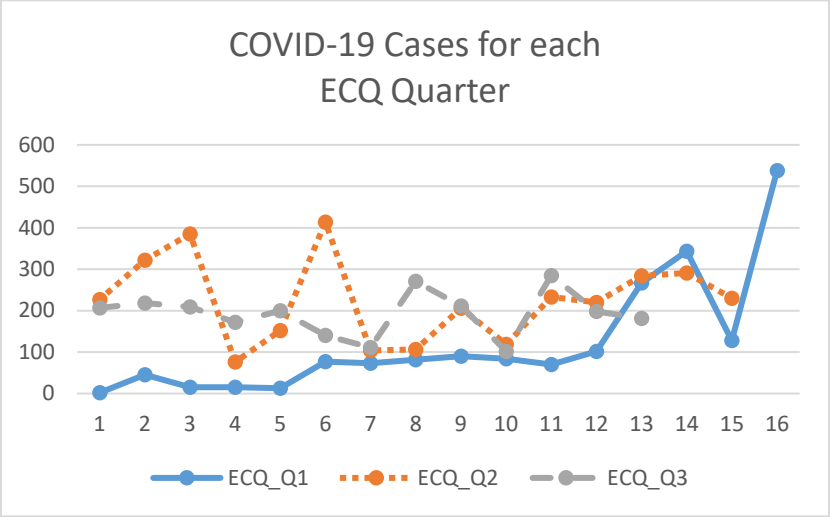


Figure 5. Time Series Plot for COVID-19 Cases of 3 ECQ Quarters

As additional consideration, effectiveness of ECQ and social distancing measure was also analyzed. Based on the time series plot of 3 ECQ quarters particularly in Luzon area with highest number of COVID-19 cases, it can be observed that the range of COVID-19 cases were reduced per quarter (Figure 5). As ECQ was extended, variability was being reduced showing that controls were done effective. But still, the number of COVID-19 cases are 100 and up. To show that there is an improvement in the number of COVID-19 cases per ECQ quarter, one-way ANOVA as conducted. Based on the results on Table 5, there is no significant difference between the 3 ECQ quarters which means no significant improvement can be shown.

Table 5. Analysis of Variance (ANOVA) on the Number of Cases Each Quarter of ECQ

One-way ANOVA: ECQ_Q1, ECQ_Q2, ECQ_Q3

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Method

Null hypothesis         All means are equal
Alternative hypothesis  At least one mean is different
Significance level      α = 0.05

Equal variances were not assumed for the analysis.


Factor Information

Factor  Levels  Values
Factor       3  ECQ_Q1, ECQ_Q2, ECQ_Q3


Welch's Test

         DF
Source  Num   DF Den  F-Value  P-Value
Factor    2  25.2889     2.62    0.093
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Table 6. Why-Why Analysis for the Identified Factors Related to the Increase of COVID-19 Cases in the Philippines

Identified factors affecting the transmission of COVID-19	**Why**	**Why**	**Why**
Low testing capacity	Limited qualified testing facilities	It takes time for testing facilities to be accredited	Limited personnel of health department to conduct accreditation
	Limited testing kits	Delayed purchase of testing kits	The health department prioritized the treatment of confirmed positive cases
	Limited specialists to conduct testing	Specialists are not sourced out	The health department prioritized specialists for the treatment of confirmed positive cases
Poor contact tracing	Contact tracing is dependent on test results	Conducted after identifying confirmed positive cases	Policy imposed by the health department
Ineffective ECQ and social distancing measure	Many people in places with most number of cases still go out	Ineffective control of people	Policy is not strictly implemented

Based on the results of why-why analysis in Table 6, there are 6 root causes identified for the identified factors affecting transmission of COVID-19. These factors are low testing capacity, poor contact tracing and ineffective ECQ and social distancing measure. The root causes are mainly due to limited personnel and in problem and deficiency with imposed policies.

5. Improve Phase

5.1 Recommendation

For the Improve Phase, recommendations were presented for each identified root cause. Ease level, cost basis, and impact level were indicated in prioritizing solutions. Cost and benefit analysis in monetary values are not presented in Table 7 due to limited access to actual costs and gains. As an alternative, subjective rating was made to weigh which solutions are more impactful, easy, and highly probable to be funded especially by the government. Since contact tracing is highly dependent on the testing rate and ECQ policies will be improved if all PUI are tested, it is better to solve first the problem in COVID-19 testing. The solutions with regards to testing rely on adding more resources such as personnel for the accreditation of testing facilities, specialists for testing, and testing kits. If given enough prioritization, the solutions can be done and may reflect significant improvement in the number of COVID-19 cases in the Philippines. It is also recommended to perform mass testing particularly in high-risk community or those areas with high number of COVID-19 positive cases. Local government units (LGU) may allot resources to perform mass testing on their respective areas. LGU may evaluate the allocation of available resources and determine if providing free testing is feasible.

Table 7. Summary of Recommendation for the Improve Phase

Root Cause	Solution	Ease Level	Cost Basis*	Impact Level
Limited personnel of health department to conduct accreditation	Adding more personnel to conduct accreditation of health facilities for COVID-19 testing	Medium	Compensation of added personnel (quantity will depend on the health department)	High impact
The health department prioritized the treatment of confirmed positive cases	Prioritizing procurement of testing kits to aid in faster COVID-19 testing	Easy	Cost of ample number of testing kits to suffice for all testing requirements	High impact
The health department prioritized specialists for the treatment of confirmed positive cases	Adding more specialists from different regions of the Philippines to speed up COVID-19 testing	Hard	Compensation of added specialists (quantity will depend on the requirement)	High impact
Contract tracing policy is imposed by the health department	Suggesting to have logbooks per establishment for the record of the persons who will go inside	Easy	Cost of logbooks and pens to be used in each establishments	Medium impact
ECQ policy is not strictly implemented	Strictly assigning isolated facilities for all PUI until results are not released and strictly assigning limitations for people who will go outside for their needs	Medium	Cost of facility conversion for PUI isolation	Medium impact

*Limited access to actual costs

Another recommendation is providing aid in contact tracing procedure. The current procedure involves asking the person activities and whereabouts. It might be helpful to persons doing the contact tracing to have physical records regarding the activities in order to identify possible carriers of coronavirus disease. Thus, it is recommended that the residents going to market or other establishments should log first their contact information and destination on their respective local district or village checkpoints. Also, surveillance cameras positioned on every street might be a good source of information for contact tracing. In addition, public market and private establishments may require their

customers to record first their contact information before entry. Another recommendation is for every member of households to have an initiative in recording their daily activities, whereabouts and people they have contact with while the country is still affected by local transmission of COVID-19. In order to achieve a higher level of effectiveness of these recommendations, it is recommended to strictly isolate person under investigation and monitoring in community centralized isolation facility.

Lastly, enhanced community quarantine violators add to difficulty achieving the critical need of mitigating the transmission of COVID-19 in the country. At present, different localities implement their own reprimands for ECQ violators. It is recommended to strictly implement ECQ and curfew hours since this can considerably affect the transmission of COVID-19 particularly in high-risk areas. Strict and effective checkpoints are already in position. Thus, ECQ and curfew hour's violators may be given reprimands by participating programs beneficial to the community.

6. Control Phase

For the recommendations to be placed into reality, implementation plan was made. (Table 8) This plan shows how will the recommendations will be done and other details needed for them to happen. In addition to that, constant monitoring must be done regularly to track whether there is an improvement happening through applying these recommendations. Better to track daily number of cases and daily changes of other parameters instead of just looking at the cumulative figures of the reports for COVID-19.

Table 8. Implementation Plan for the Recommendations

What	Where	Who	When	How	How often
Adding more personnel to conduct accreditation of health facilities for COVID-19 testing	Health department	Health department secretary and undersecretary	Before ECQ ends (May 15)	Recruitment of qualified personnel to accredit health facilities for testing	Once until sufficient testing facilities are accredited
Prioritizing procurement of testing kits to aid in faster COVID-19 testing	From countries with good quality but cost effective testing kits and from locally produced testing kits which are already accredited	Health department secretary and undersecretary	Before ECQ ends (May 15)	Buying good quality but cost effective testing kits from accredited suppliers abroad and in the country	Every week until it reaches enough quantity to suffice for all testing
Adding more specialists from different regions of the Philippines to speed up COVID-19 testing	Health department	Health department secretary and undersecretary	Before ECQ ends (May 15)	Coordinating within the country's available specialists subjected for recruitment	Once until sufficient testing facilities are accredited
Suggesting to have logbooks per establishment for the record of the persons who will go inside	Opened establishments particularly in areas with most number of cases	Inter-Agency Task Force (IATF) and local government units (LGU)	As soon as possible before ECQ ends (May 15)	Clearly communicating the policy to establishment owners and to the public through the help of LGU and then providing logbooks and pens to each establishment with sample guide for the details to be filled out (in native language)	Every week or until the logbooks and pens need replacement
Strictly assigning isolation facilities for all PUI until	In areas with most number of	Inter-Agency Task Force (IATF) and local	As soon as possible	Assigning isolation facilities through the help of LGU and the residents of that area	Once until sufficient isolation

results are not released and strictly assigning limitations for people who will go outside for their needs	COVID-19 cases like Luzon	government units (LGU)	before ECQ ends (May 15)	wherein PUI must be properly monitored and cared of; Deployment of enough soldiers and policemen to control people from crowding in different areas with most number of COVID-19 cases	facilities are assigned and provided

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Biographies

Jeremy Laurence M. Bañez is an Industrial Engineer who is currently an Instructor of Industrial Engineering Department in Bulacan State University, City of Malolos, Bulacan, Philippines. He is now taking up Master of Science in Industrial Engineering major in Operations Research in University of the Philippines Diliman, Quezon City, Philippines. He used to work as an Area Leader in a waste treatment facility. He is recognized as a Certified Industrial Engineer by the Philippine Institute of Industrial Engineers (PIIE) and an Associate ASEAN Engineer endorsed by the Philippine Technological Council (PTC). He is also a Certified Lean Six Sigma Yellow Belter. He has published a journal regarding ergonomics and an article related to evolution of lean. His research interests include Ergonomics, Simulation, Optimization, and Lean Six Sigma. He is also interested in conducting feasibility studies. Moreover, he is interested in field areas of environment, agriculture, and energy.

Hazel Caparas is an ASEAN Engineer and a graduate of Master of Science in Industrial Engineering with specialization in Human Factors and Ergonomics at University of the Philippines – Diliman on June 2017. She received Bachelor of Science in Industrial Engineering in Bulacan State University on 2010. She conducted various studies focusing on Process Improvements and Human Factors and Ergonomics. She also acquired solid experience in operations management as an Operations Analyst in a food manufacturing company for four years. Caparas is

currently a College Instructor in a State University handling Industrial Engineering courses such as Human Factors and Ergonomics, Occupational Safety and Health and Facilities Planning and Design.

Ivy Mar Ramos is an ASEAN Engineer and a Professional Industrial Engineer. He earned Master of Business Administration degree in Bulacan State University. He conducted various studies focusing on Process Improvements, Operations Management and Methods Engineering. He also acquired solid experience in Strategic Process Management and Quality Assurance. Ramos is currently a Director of Internal Quality Audit and an Associate Professor in a State University handling Industrial Engineering courses such as Methods Engineering, Engineering Economy, Marketing and Strategic Project Management.