

An Assessment of the Philippines' Condition on Coronavirus Disease (CoViD-19) through DMAIC Approach

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Abstract

Coronavirus disease 2019 (CoviD-19) was first reported last December 2019 in Wuhan, China. With the escalating cases and deaths globally, World Health Organization declared CoviD-19 a pandemic in March 2020. With the increasing cases in the Philippines, there is a need to maximize the available resources. In response, isolating CoviD-19 infected from the populace is necessary to minimize the infection. Polymerase Chain Reaction (PCR) is the prescribed diagnostic test for confirming CoViD-19, along with Food and Drug Administration approved rapid tests. In relation from DOH CoviD-19 Case Bulletin as of April 27, there are 198 new active cases, 70 recoveries and 10 deaths, totaling to 7 777 cases, with 932 recoveries and 511 deaths in the Philippines (Department of Health Philippines 2020). Moreover, the researchers stress that the country has heightened its daily capacity aiding in diagnosing CoVid-19 positive individuals. Yet the Philippines is still far from reaching its daily target of 8,000 individuals by the end of April. This study focuses in addressing the following problems using lean six sigma methodology DMAIC. Employing lean tools mainly fishbone analysis, control-impact matrix, and CTQ to examine the data and propose possible alternatives that helps in maximizing the CoViD-19 testing kit resources.

Keywords

CoviD-19, DMAIC, testing kit, infected, pandemic

1. Introduction

The world is currently experiencing a pandemic called Coronavirus disease (CoViD -19); an infective disease caused by the recently discovered virus, SARS-CoV-2 that came from the family Coronavirus, which are known to cause respiratory infections (Research Institute for Tropical Medicine 2020). The Coronavirus pandemic initiated from Wuhan, China and was declared to be a public health emergency of international concern on January 30, 2020. (Preparing for large-scale community transmission of COVID-19 2020). Suspected CoviD-19 patients may show symptoms such as fever, tiredness, and dry cough, some patients may also have aches and pains, nasal congestion, runny nose, sore throat, and diarrhea. (World Health Organization 2020) The CoviD-19 is a communicable disease that can infect people through small droplets from the nose or mouth when coughing and exhaling, resulting to the rapid spread of the said viral infection. The risk of one CoviD-19 positive infecting multiple people is high as CoviD-19 positive are not known within the community and may continue to carry the virus. Thus, there is a need to isolate the virus carrier from uninfected people and community. As of 2:00am CEST, 27 April 2020, there have been 2,858,635 confirmed cases of CoviD-19, globally, including 196,295 deaths, reported to World Health Organization (WHO).

2. Methodology

In order to assess the current condition of the Philippines with regards to CoviD-19, the researchers used a five-step six sigma approach, DMAIC. It is comprised by define, measure, analyze, improve and control phase which will be discussed throughout the paper.

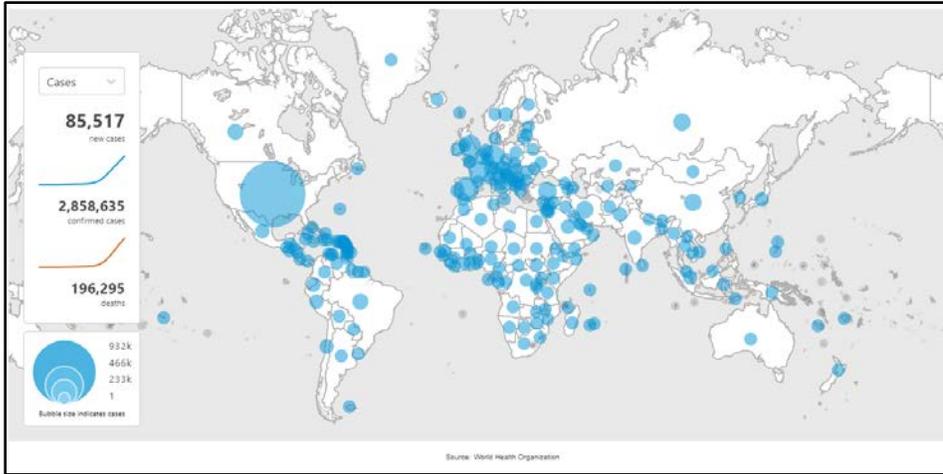
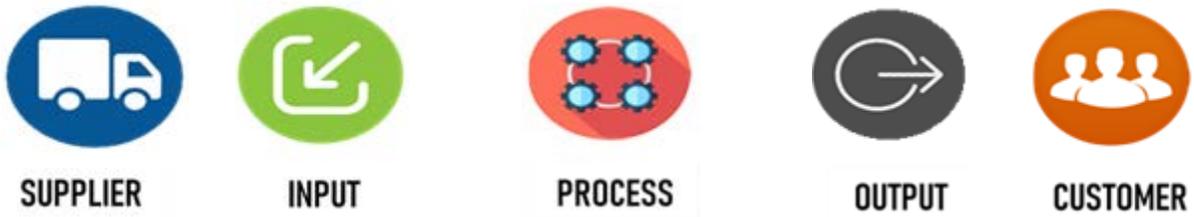


Figure 1. World Diagram of CoviD-19 Cases



Hospitals	Health Professionals (Doctors, Nurses, Medical Technologists)		Test Results (Diagnosis of the patient whether positive or negative to CoviD-19)	Patients Under Monitoring (PUM) Patients Under Investigation (PUI) CoviD-19 Positive Cases
University of the Philippines – Laboratory	Locally-made CoviD-19 test kits			

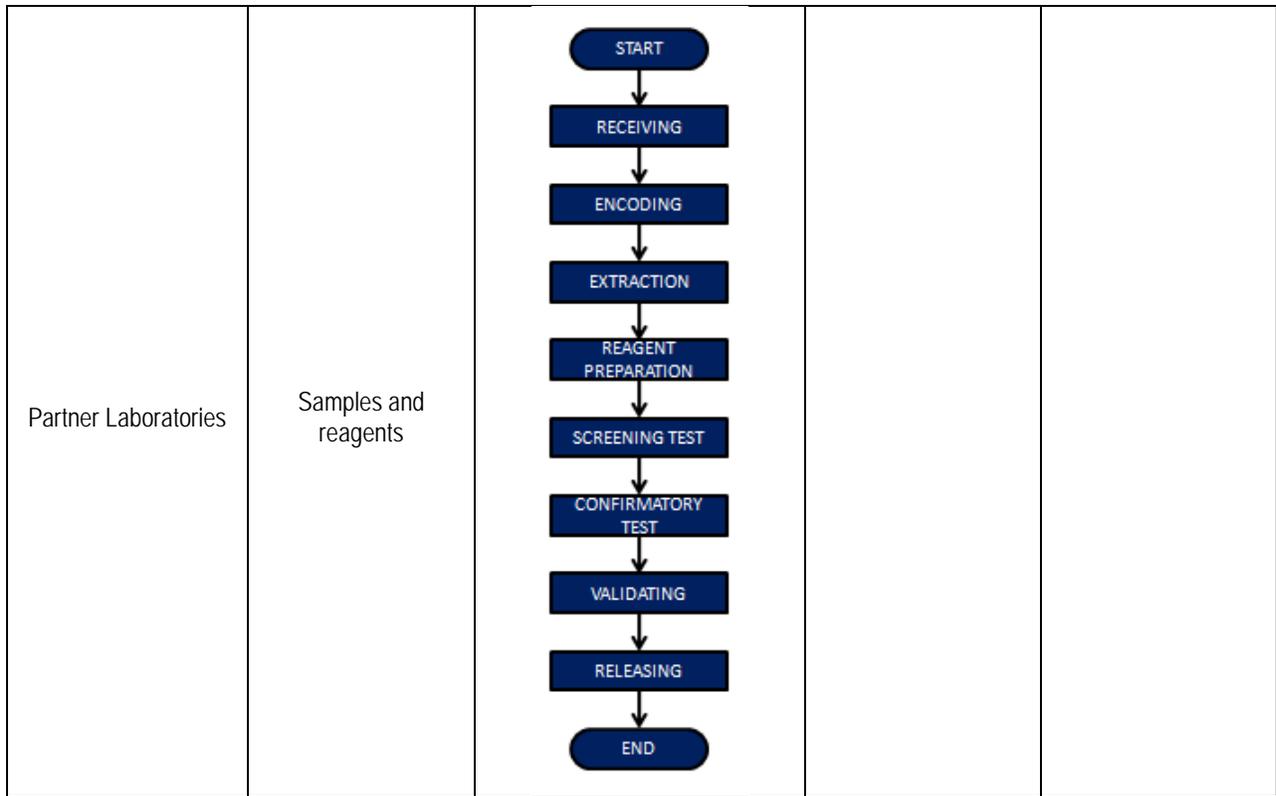
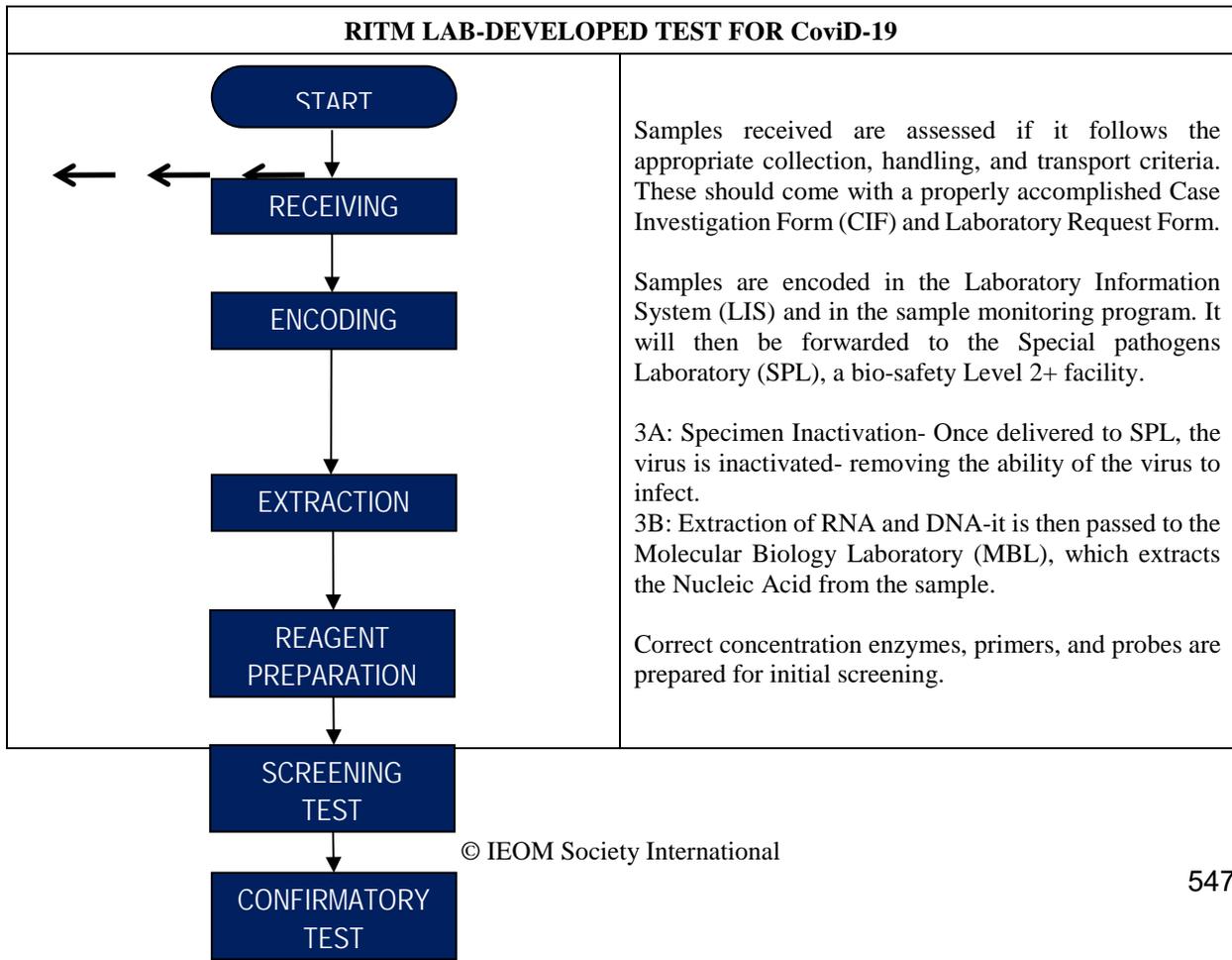


Figure 2. SIPOC Diagram

Table 1. RITM Covid-19 Testing Process Map



	<p>The screening test will determine if there is the presence of known Coronavirus in the samples. To date, there are only six known coronaviruses that can infect humans including SARS-CoV and MERS-CoV.</p> <p>If the sample is positive in the screening test, it will be then subjected to confirmatory testing, Steps 5 and 6 use positive and negative controls to ensure accuracy of results.</p> <p>After the screening and confirming tests, the sample undergoes validation for accurate results.</p> <p>The results are released to RESUs who are in charge of releasing it to the hospitals.</p>
<p>Source: "How does RITM perform COVID-19 testing?" (Research Institute for Tropical Medicine 2020)</p>	

2.1 Measure Phase

Covid-19 cases surged in the Philippines from March and continue to rise up to present. According to the Department of Health (DOH), the first case of CoviD-19 in the country occurred on January 30, 2020 with a 38-year-old female Chinese national. Additionally, the first local transmission of the virus was confirmed by March 7 (Coronavirus disease (COVID-19) in the Philippines 2020). Moreover, with the recent post from DOH CoviD-19 Case Bulletin, as of April 27, there are 198 new active cases, 70 new recoveries and 10 new deaths, which comprises the total number of cases to be 7 777, with 932 total recoveries and 511 total deaths. (Department of Health Philippines 2020). This gives the Philippines a 6.5% to 7% death rate (Santos 2020). According to the Center for Strategic & International Studies (CSIS), the number of confirmed cases of the Philippines continues to increase and is one of the leading in South East Asian countries in new cases per day (Center For Strategic & International Studies 2020).

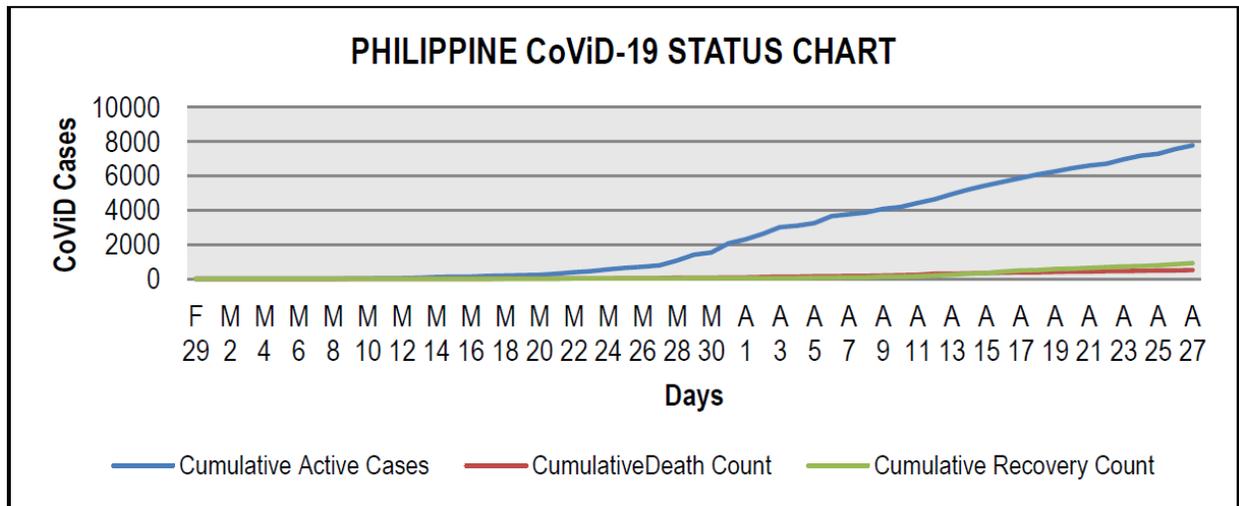


Figure 3. A graph showing the status of the Philippines on CoviD-19 cases, recoveries and deaths

As shown in figure 3, an increasing trend on active CoviD-19 cases is observable. This is brought about by the continuous efforts of the government to increase testing capacity to identify more CoviD-19 positive individuals in

order to isolate them and prevent the disease from spreading. The researchers expect further increase in cases confirmed as the government pushes for mass testing. The researchers emphasize that the increasing trend of cases confirmed shows that Philippines is able to test more individuals on a daily basis which helps in early detection and isolation of CoviD-19 positive individuals. It is also observable that recoveries tend to increase which exceeds the death toll as the end of April approaches.

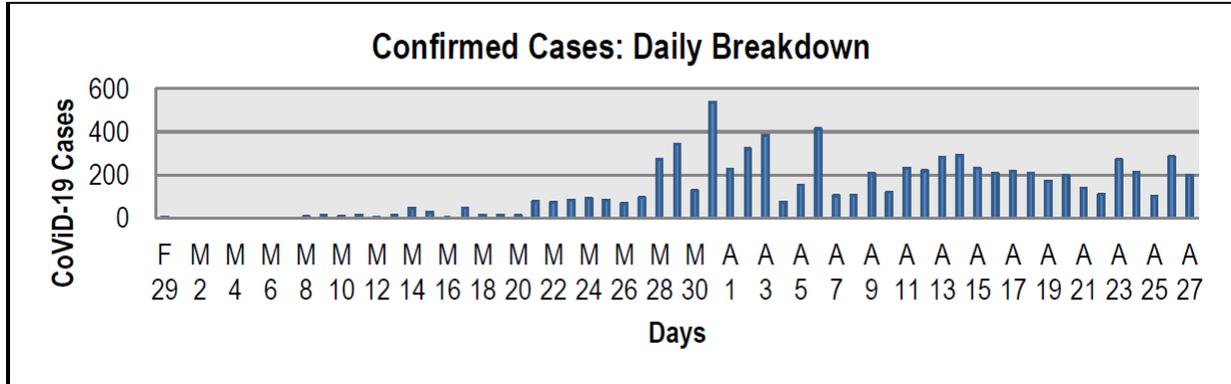


Figure 4. A graph showing the daily count of confirmed CoviD-19 cases

Figure 4 depicts the daily number of cases confirmed from the end of February up to the end of April. March 31 yielded the highest number of confirmed cases per day at 538. CoviD-19 cases run at an average of 132 cases per day.

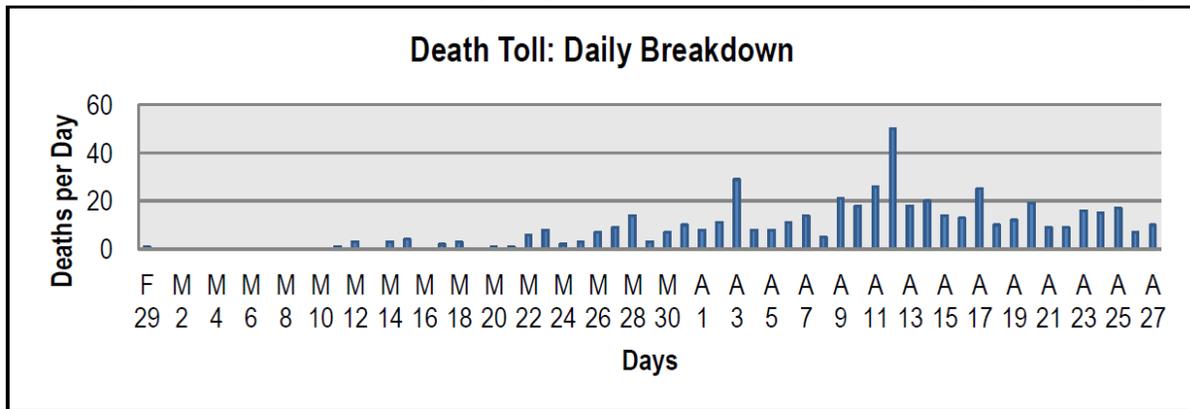


Figure 5. A graph showing the daily death toll due to CoviD-19

Despite the government’s maximum effort to death due to CoviD-19 is an inevitable event. As March began, cases of deaths among Filipinos tend to spike reaching an all time high of 50 deaths last April 12. An average of 9 Filipinos die each day due to CoviD-19. In Figure 6, daily recovery from CoviD-19 is shown. It is observable that number of patients recovering from the disease starts to spike on April 13 and peaked at April 16 with 82 patients defeating CoviD-19. These numbers shows that the country’s battle against the disease is not on a losing end. At present, 16 Filipinos per day are able to win over CoviD-19.

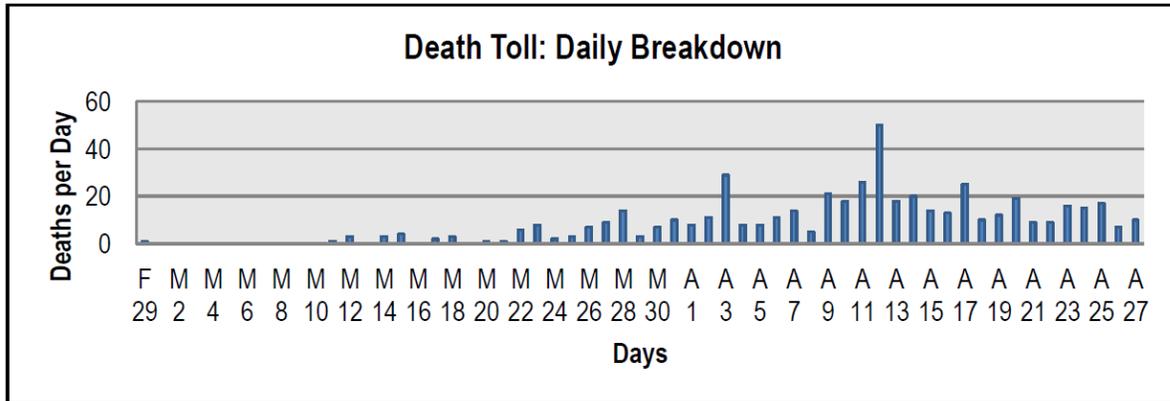


Figure 6. A graph showing the daily recovery from CoviD-19

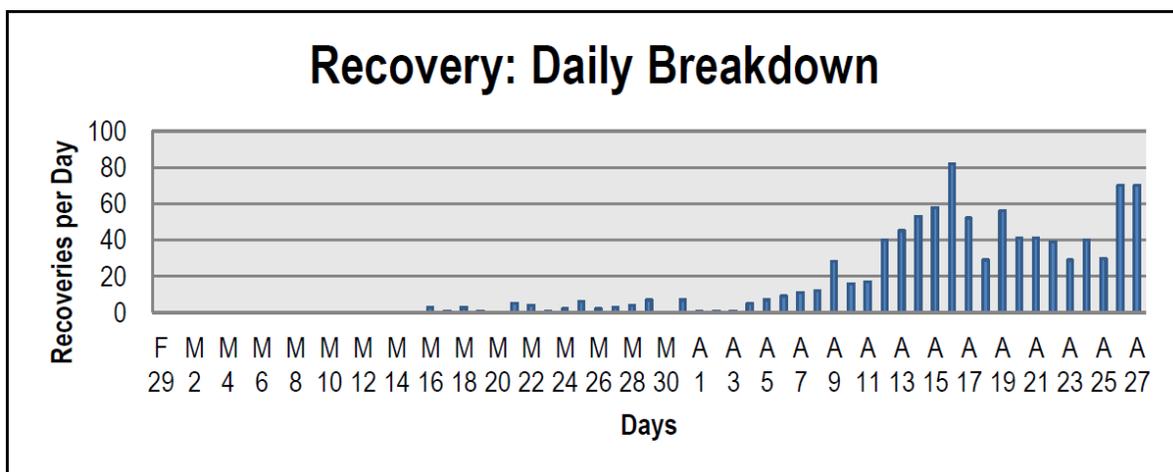


Figure 7. A graph showing the daily confirmed cases, deaths and recoveries

The figure above depicts a daily plot on confirmed cases, deaths and recoveries compared to a cumulative plot shown in figure 3. One can observe the actual rise and drop of cases dues to CoviD-19. Confirmed cases tends to show an increasing trend, however, it is observable that the daily cases of CoviD-19 did not exceed its all-time high of 538 last March 31. Also, after reaching a toll of 50 deaths on April 12, patients dying from the disease started to decline continuously up to present. In addition, the number of recoveries started to surpass the number of deaths last April 13 up to present.

In terms of flattening the curve, as shown in figure 7, number of recoveries tends to exceed the number of deaths on April 13. The researchers also emphasize that the number of recoveries has been greater than the death toll starting on April 13 up until present. This shows that the Philippines is able to curb the death rate and keep it to a minimum from April 13 up to present. Also, according to studies done by different agencies and institutions in the Philippines, it is difficult to determine the exact timeframe when will the pandemic end. In relation to this, it is projected that more than 30,000 Filipinos can be infected for over the next two months if the trend of confirmed cases continues (Guido David, Ph.D., Ranjit Singh Rye, MPA, Ma Patricia Agbulos, MBM 2020).

Testing is an integral part of a country’s battle against CoviD-19. It provides the government a window to see and check how policies and regulations enacted affect the spread of the disease. DOH announced that it will be capable to conduct 3,000 tests per day by April 14, 2020. Furthermore, it aims to increase capacity between 8,000 to 10,000 tests by the end of April. According to Health Undersecretary Maria Rosario Vergeire, pregnant women, people who have a weakened immune system and front-line health workers which has the highest exposure to the virus are prioritized.

DOH expects to get fuller assessment of the current situation of the country by expanding testing protocol (Department of Health 2020). Moreover, according to the Philippine Situation Report on World Health Organization, there are 17

certified laboratories which conduct an approximately 3, 200 tests daily: despite of RITM scaling down their operations. Laboratory assessments are ongoing between RITM, DOH, and WHO in Cagayan, Cebu, Negros, and Iloilo. Moreover, ADB has shipped USD 2.5 million worth of CoviD-19 laboratory equipment from Shenzhen, China to DOH. This will significantly improve the regular testing potential in the country once the laboratory equipment is set up within 7-10 days. Furthermore, The Philippine Red Cross (PRC) and Metro Manila LGUs signed a Memorandum of Understanding to increase PRC's daily COVID-19 testing capacity to 8,000 by the end of April (WHO Philippines 2020). As of April 25, 2020, a total of 84, 789 tests are conducted by the 17 accredited laboratories.

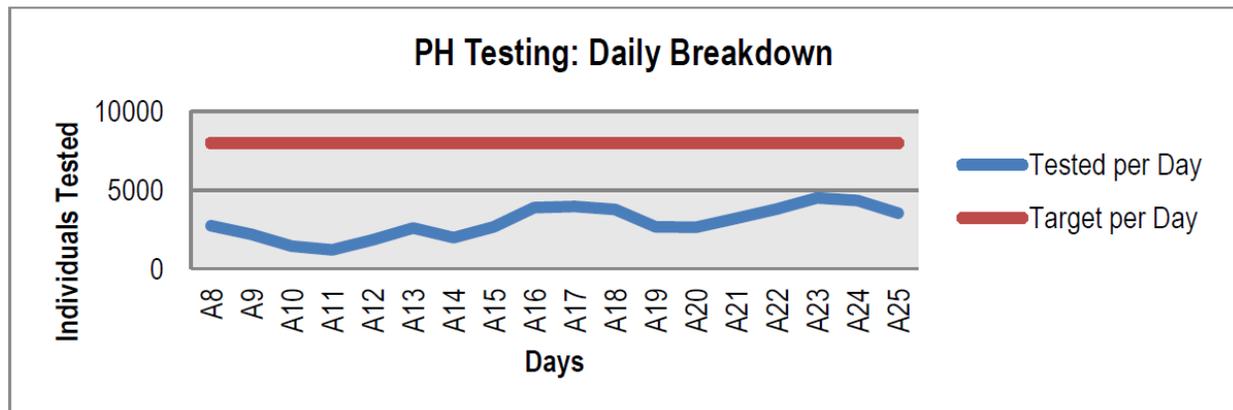


Figure 8. A graph showing number of individuals tested per day against PH government target

The figure above shows the number of individuals tested per day as observed from data starting from April 8 to 25. Though the Philippines' testing capacity was able to reach an approximate of 3,000 individuals per day after April 14, the country is still far from reaching its target of 8,000 individuals per day by the end of April as aimed by DOH.

Table 2. List of Accredited Testing Laboratories and Hospitals and their Testing Capacities

ACCREDITED TESTING LABORATORIES AND HOSPITALS	AVERAGE TESTED PER DAY	MAXIMUM TESTING CAPACITY	UTILIZATION
Philippine Red Cross (PRC)	329	1500	22%
Research Institute for Tropical Medicine (RITM)	1164	1500	78%
Vicente Sotto Memorial Medical Center (VSMCC)	186	500	37%
Makati Medical Center (MMC)	95	350	27%
Baguio General Hospital and Medical Center (BGHMC)	201	300	67%
Lung Center of the Philippines (LCP)	221	300	74%
St. Luke's Medical Center – BGC (SLMC-BGC)	361	250	144%
San Lazaro Hospital (SLH)	132	200	66%
University of the Philippines – National Institutes of Health (UP-NIH)	141	200	71%
Western Visayas Medical Center (WVMC)	127	200	64%
Chinese General Hospital (CGH)	82	180	46%
Detoxicare Molecular Diagnostics Laboratory (DMDL)	41	180	23%
St. Luke's Medical Center - QC (SLMC-QC)	85	180	47%

Southern Philippines Medical Center (SPMC)	112	150	75%
The Medical City (TMC)	52	80	65%
Bicol Regional Diagnostic and Reference Laboratory (BRDRL)	21	50	42%
V. Luna Hospital	29	50	58%

Table 2 shows all accredited laboratories and hospitals in the Philippines that caters all testing activities for Covid-19. At present, the country has 17 main testing centers (excluding testing centers yet to be established by local government units) with varying maximum capacities. The researchers have determined the utilization of these testing centers to have a clearer picture if each testing center is maximized based on its respective capacities.

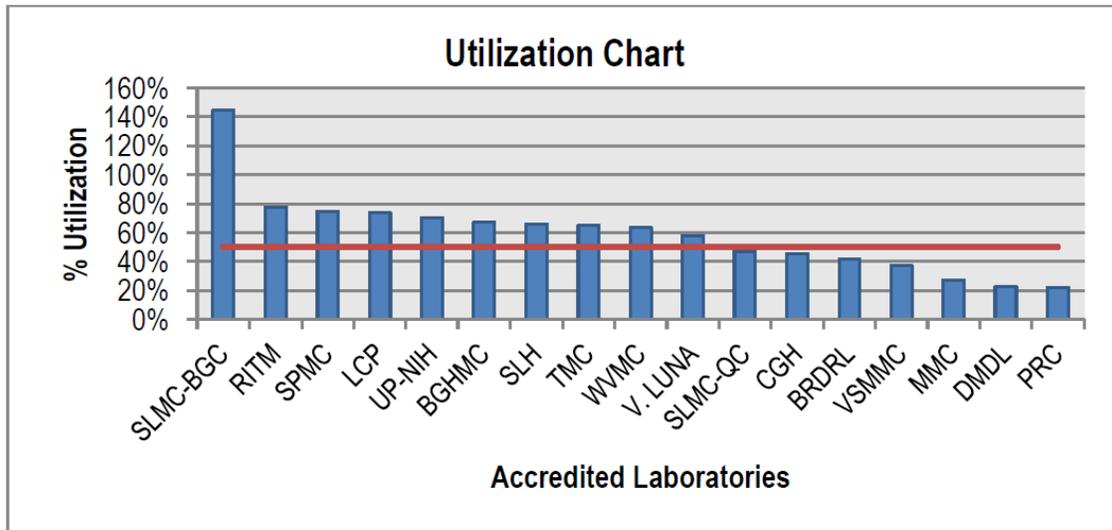


Figure 9. Utilization of Accredited Laboratories and Hospitals

As shown in figure 9, utilization of laboratories and hospitals vary from one another. 10 out of 17 testing centers exceed 50% utilization wherein St. Luke’s Medical Center – BGC (SLMC – BGC) hits 144% utilization which suggests that the facility is over-utilized. On the other hand, 7 out of 17 testing centers fall below the 50% utilization line. It is also notable that the Philippine Red Cross (PRC), despite its 1,500 maximum capacity, is the most under-utilized facility with 22% utilization.

2.2 Analyze Phase

In order to identify the possible causes of the rapid spread of the Covid-19 pandemic, the researchers conducted a fishbone analysis and found that one factor that greatly affects in flattening the curve is the assessment and testing process of Covid-19 positive.

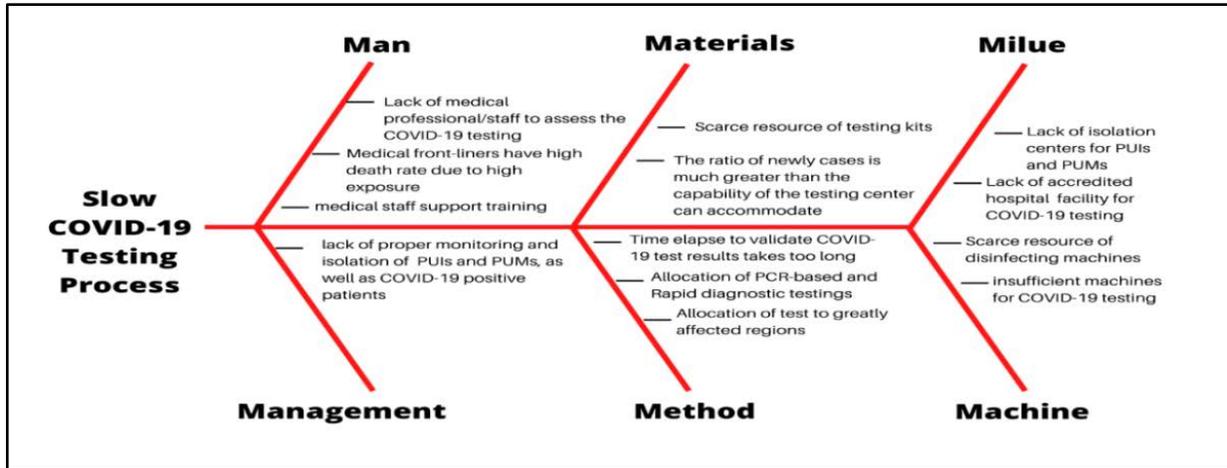


Figure 10. Fishbone Diagram for CoviD-19 Testing Process

The testing process isolates the CoviD-19 infected and prevents the further spread of the virus. As the government is building more laboratories to perform tests and gain more resources, a policy is made on who can be tested for now. Only patients under investigation (PUIs) with serious symptoms can be screened for Coronavirus disease (CoviD-19), along with symptomatic elderly people, symptomatic healthcare staff and those with co-morbidity. Analyzing the problem stated above and by using control - impact matrix, the researchers identified the following root causes to be highly controllable and has high impact compared to other causes that leads to the main problem.

	High Control	Low Control
High Impact	<ul style="list-style-type: none"> - Allocation of PCR-based and rapid diagnostic testing. - Lack of proper monitoring and isolation of PUIs and PUMs, as well as CoviD-19 positive patients 	<ul style="list-style-type: none"> - Scarce number of testing kits - Lack of isolation centers for PUIs and PUMs -Lack of accredited hospital facility for CoviD-19 testing
Low Impact	<ul style="list-style-type: none"> - Stress and fatigue experienced by medical staffs due to long working hours 	<ul style="list-style-type: none"> - Turn-around time for result takes 2 days with PCR-based tests

Figure 11. CoviD-19 Control – Impact Matrix

2.3 Improve Phase

A critical to quality analysis is a measurable function that is used to provide recommendation to the stated problem. Identified critical to quality are as follows: (1) maximization of CoviD-19 test kits and (2) slower spread of CoviD-19.

Table 3. Critical-to-Quality Analysis for CoviD-19 Test Kit Maximization

Critical to Quality	Drivers	Requirements
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Maximization of Covid-19 test kits	Proper allocation of PCR-based tests and rapid diagnostic test	Enough trained medical staff to assess testing
		PCR-based tests are to be allocated for patients under monitoring
		Allocation of Rapid diagnostic test to persons under investigation.
	Allocation of test to greatly affected areas	Utilization of daily reports from Local Government

As Covid-19 test kits are scarce, it is vital to maximize the resources available. The researchers observed through analysis that allocation of Covid-19 test kits can highly affect the spread of the virus in many ways. The researchers identified that there is a need for maximizing the use of different test kits such as Polymerase Chain Reaction (PCR) test and Rapid Diagnostic Test (RDT). PCR-based testing kits, being the current gold standard for epidemiological diagnosis of SARS-CoV-2, will be allocated to those regions with highly concentrated cases or those considered as high-risk areas such as National Capital Region, CALABARZON and Central Luzon which comprises the 68.8%, 13.6% and 4.8% of the total cases respectively. Furthermore, allocating this test kits to high-risk areas would help increase the chances of slowing the spread of the virus. On the other hand, the researcher considered allocating the RDT kits to those regions considered as a low to medium risk. Moreover, the researchers considered allocating the volume of these resources, thus it could be distributed in parallel with the percentage of cases in the affected area.

Table 4. Critical-to-Quality Analysis for Slow Spread of Covid-19

Critical to Quality	Drivers	Requirements
Slow Spread of Covid-19	Faster testing of PUIs and PUMs	More testing kits and testing materials
		Exact number of testing operators and technicians
		Accurate and fast results
	Strict implementation of community quarantine	Enough check points into every city/province exits
		Strict implementation of curfew and other policies
		Enough number of isolation facilities for those PUMs and PUIs
	Self-discipline	Practice of proper hygiene
		Stay at home or practice social distancing and always wear personal protective equipment whenever outside.
		Follow the law and other policy in relation with Covid-19 pandemic.

2.4 Control Phase

In order to ensure that the implementations are maintained, the researchers aim to utilize control charts such as Statistical Process Control Charts which are used to analyze process changes over time. The data are plotted in order or time, and the central line determines the average quantity, and the upper and lower control limits which regulates if the data exceeds its acceptable range. By comparing the current data to these control lines, conclusions can be drawn about whether the improved process is in control or not (Control Chart n.d.). Moreover, utilizing control charts helps in finding and correcting problems as they occur. In relation to this, the volume of allocation of PCR-based testing kits and Rapid Diagnostic test kits can be monitored. Furthermore, one can also determine if the test kits supplied in a particular region is too many or too few. Hence, laboratories could have adequate testing kits in store for CoViD-19 cases in their area.

3. Conclusion

The aim of this research study is to identify the root causes of the problem that leads to the rapid spread of the CoViD-19 in the Philippines. After comprehensive and thorough analysis of the problem it is clear that the utilization of testing process greatly affects the rapid spread of the CoViD-19. After collecting and analyzing of the data that the researcher have gathered and by using problem solving tools such as Ishikawa diagram, control impact analysis and critical to quality, the researcher are able to trim down the main problem and have identified the root causes of the stated problem. By following DMAIC method the researchers are able to generate solutions to the stated problem.

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Biography

Emmanuel Oliver Porciuncula is a 5th year Industrial Engineering student of La Consolacion University Philippines in Malolos, Bulacan, Philippines. He is the organization president of Society of Industrial Engineering Students for 2019-2020. He was also elected as Student Coordinating Board-Collegiate Council President in 2018-2019, President of Sports Club in 2017-2018 and Department Mayor of College of Information Technology and Engineering in 2016-2017. And during his secondary education, he was awarded with Gerry Roxas Leadership Award and served as Supreme Pupil/Student Government President in 2014-2015. He is an author for a research paper published in *Applied Human Factors and Ergonomics*, titled "Ergonomically Designed Backpack for Junior High School Students". He also participated in several research competitions during his collegiate education, accomplishing 2nd place in Feasibility Study during the 10th Philippine Institute of Industrial Engineers' Regional Student Congress and 3rd place during the 9th edition of the same event.

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