A Statistical Comparison of Novel Coronavirus Cases between the Philippines and South Korea

Kianna Denise C. Villapando, Maria Angelica D. Bare, Francee Mae. F. Castro,
Angelo Luis S. Doctora, William Davin D. Perez, Michael N. Young
Department of Industrial Engineering, Mapúa University, Manila, Philippines
kdcvillapando@gmail.com, angelicabare23@gmail.com, franceecastro@gmail.com,
angelo.doctora@gmail.com, william.davin@live.com, mnyoung@mapua.edu.ph

Abstract - **The Novel Coronavirus has been affecting several regions across the globe. It is noticeable that several countries address the problem better than other nations due to social and economic factors. With this, the present study distinguished and analyzed the state of two countries, the Philippines and South Korea, in the current pandemic, in relation to their socio-economic factors. The data was obtained from online platforms and trackers, and these were statistically analyzed using joint probability distribution, one sample t-test, confidence intervals, and normal distribution. Upon performing the calculations, the study found out that South Korea has a better situation in the pandemic compared to the Philippines, since the said country had implemented commendable measures.**

Keywords - **coronavirus, novel coronavirus, pandemic**

I. INTRODUCTION

A pandemic is a global outbreak of a disease spreading throughout various regions across the globe. In December 31, 2019, the Novel Coronavirus was first detected in Wuhan City, Hubei Province of China when the World Health Organization China Country Office was first informed of pneumonia cases with unknown causes. Previously, the virus was still in its epidemic stage as it solely affects two or more countries, with the earliest cases correlated to a wholesale food market in Wuhan. Environmental tests were taken in the said market in December 2019 and had positive cases for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), insinuating that the market in Wuhan was one of the sources of the enhancement of the said outbreak [1].

During a media briefing last March 11, 2020, WHO Head Mr. Tedros Adhanom declared the Novel Coronavirus a pandemic since it had already spread to other regions. The 2019 Novel Coronavirus had its virus named SARS-CoV-2 and its disease named COVID-19 [1]. According to WHO (2020), people infected by the virus will experience mild to moderate respiratory illnesses but some of them might recover without being accommodated with special treatments.

Many countries across the globe were infected with COVID-19. For instance, in January 2020, South Korea (SK) had confirmed its first case of the virus. In February 2020, SK witnessed an overflowing transmission within a month of revealing their first case. The cases were found to expand multi-overlap on February 21, most of them being accounted for in the city of Daegu. Due to this, the decision of the government was to implement widespread testing; this implementation was observed to be quick and decisive. With the given data under the confirmed cases, only 30 cases and no deaths were recorded by South Korea between January 19 to February 18 of 2020 [2].

Another country that is greatly infected with COVID-19 is the Philippines (PH). In December 2019, news about the Novel Coronavirus outbreak were being continuously disseminated throughout the country. However, the Philippine media has yet to broadcast the reality of the effect achieved by the new epidemic from China. In January 2020, there were reports of Chinese people who arrived in the Philippines – particularly in Cebu. Whilst travelling to Manila, they experienced symptoms in correlation with the disease. The hospital then came up with test results being positive with the disease of COVID-19. Despite this, from December 2019 to January 2020, PH had not conducted other measures besides its response to the said first virus infected cases [4].

President Rodrigo Duterte may not have given the proper response to this pandemic [5]. There were serious issues regarding the economy of the Philippines particularly in GDP growth. The average GDP growth was around 6 percent annually for the past decade and approximately 1.2 million Filipinos would lose their jobs as the lockdown limits all economic activities. As said by National Economic and Development Authority (NEDA), there was restricted access of individuals to employment and essential social administrations in the field of health, education, sustenance, water and sanitation, information, communication, and transport, which features poor people and their vulnerability [6].

Although the Novel Coronavirus has affected most countries worldwide, it is greatly evident that few nations had already controlled the spread of the pandemic. This is because countries have different strategies in addressing the said problem. Socio-economic factors such as financial capacities, employment, and public safety implementations could all be related to the extent and severity of COVID-19 in a country. Poor and densely-populated communities have higher risk of acquiring the Novel Coronavirus since most people living in these areas seldom observe national preventive measures; they also tend to neglect proper nutrition and hygiene [5].

For instance, the Philippines, which is considered poorer than other countries, faces problems regarding socio-economic factors. Moreover, most Filipinos complain about the COVID-19 response and health advisories implemented by the Philippine government [6].

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This could be due to the lack of preparation of the government regarding its address to the pandemic. As the country has low capabilities in approaching the issue, health services also lack in products to protect their health staff. Furthermore, the production of protective equipment for the health workers are also in shorthand. Due to this issue, some private institutions had stepped in to create more protective equipment for the front liners. On the contrary, South Korea, which is considered a developed country, satisfactorily faces the pandemic. Its government is competent in addressing the pandemic through proper screening and control, social distancing implementation, isolation systems, mass testing, and quarantine system installation [7]. Through these actions, they generated big information about the pandemic and they had also idealized different forms of treatment and prevention methods to reduce the number of cases in their country. With this, it is indeed important for the government to focus on improving programs and policies concerning the society's income and subsidence [8].

As of May 8, the conducted tests in the Philippines and South Korea were 145,586 and 645,863, respectively. Out of those tests, 10,463 turned positive in the PH, and 10,822 were positive for SK. The number of cases in both countries were almost equal but fatalities and recoveries have massive differences. PH had high fatality rates with 696 deaths and a low recovery rate of only 1,734 recoveries. On the other hand, SK had managed to decrease fatality rates and increased recovery rates, with only 256 deaths and 9,484 recoveries. A country with a high case of Fatality Rate (CFR) and a Low Case of Recovery Rate (CRR) are the ones that should be monitored and aided [9]. The variations might be due to the approach of each country to the pandemic.

This research aims to distinguish and analyze the state of the Philippines and South Korea in the current pandemic through gathering online data. Also, we aim to compare how both countries address the situation whilst maintaining their socio-economic stability. However, this study is only limited to comparing the two countries, and the data and analyses were only based on the total positive cases, recoveries, deaths, and total number of tests conducted. Lastly, the span of data used in this research was only from February 15 to May 8 of 2020.

II. METHODOLOGY

This research aims to compare and analyze the strategies of the Philippines and South Korea in the current pandemic whilst maintaining their socio-economic stability. In accomplishing these, the study interpreted the trends of Novel Coronavirus cases, recoveries, deaths, and number of tests using different statistical analyses.

In consequence of the current situation, the researchers were limited to accessing the quantity of COVID-19 cases, including recoveries, deaths, and number of tests, through platforms and trackers available online. The COVID-19 Dashboard developed by the University of the Philippines, Resilience Institute, and Project NOAH, is a useful website that exhibits updated statistics concerning the cases throughout PH only [10]. On the other hand, the data accumulated for SK was garnered from *Worldometers* in which it also provides specific statistics for the said countries [11].

In order to perform the analysis, the number of positive cases, recoveries, deaths, and COVID-19 tests in PH and SK were initially gathered from online records and trackers. Consequently, problems and hypotheses were formulated based on the available data. It is ensured that appropriate statistical formulas were applied in order to analyze the COVID-19 trends. Based on the results, data inferences were finally made.

To precisely study the Novel Coronavirus data trends, various statistical concepts were applied in this research. First, marginal and conditional probability distributions were utilized in order to study the active cases, recoveries, and deaths from each country. Second, to compare the daily positive cases, recoveries, and deaths from PH and SK, a one sample t-test was used to determine whether the difference between the mean numbers of cases from each countries was significant. Third, to analyze the number of tests conducted in both countries, the concept of confidence intervals was applied. Fourth, in order to visualize the behavior of COVID-19 cases, the normal distribution and histogram of data from both countries were constructed.

III. RESULTS

This research performed four statistical analyses to distinguish the difference of Philippines and South Korea's addresses and preventive measures against the Novel Coronavirus pandemic in their respective countries. Foremost, the concept of joint probability distribution was used to show the likelihood of active case, recovery, and death circumstances in the Philippines and South Korea.

TABLE I
MARGINAL PROBABILITY MASS FUNCTION

	Active Cases	Recovered	Fatalities	Marginal Probability
SK	0.081	0.377	0.012	0.47
PH	0.446	0.051	0.033	0.53
Marginal Probability	0.527	0.428	0.045	1.000

Table 1 shows the marginal probability mass function of active cases, recoveries, and deaths in South Korea and Philippines.

TABLE II
CONDITIONAL PROBABILITIES

Conditional Probabilities	Result
P(PH | Active)	88.08%
P(PH | Recovered)	15.37%
P(PH | Fatalities)	73.33%
P(SK | Active)	11.92%
P(SK | Recovered)	84.63%
P(SK | Fatalities)	26.67%

Table II shows the conditional probabilities of recoveries in Philippines and active cases in South Korea.

The calculations in Tables I and II indicated that acquiring a recovered case in South Korea is more likely

to happen than in the Philippines since it resulted to a 15.37% probability for the latter country, implying that Philippines has lower cases of recoveries than South Korea. Moreover, the calculations also showed that South Korea managed to reduce the number of active cases effectively having the probability of getting an active case in South Korea, as of May 8, 2020 of only 11.92%.

TABLE III
T-TEST FOR POSITIVE CASES

	Sample size	Mean	Standard Deviation	T	P
Data	84	-4.0	266.1	-0.14	0.891

Table III shows the t-test results for determining the difference between the COVID-19 positive cases of the Philippines and South Korea.

TABLE IV
T-TEST FOR RECOVERIES

	Sample size	Mean	Standard Deviation	T	P
Data	84	-92.7	118.8	-7.15	0.000

Table IV shows the t-test results for determining the difference between the COVID-19 recoveries of the Philippines and South Korea.

TABLE V
T-TEST FOR DEATHS

	Sample size	Mean	Standard Deviation	T	P
Data	84	5.24	9.82	4.89	0.000

Table V shows the t-test results for determining the difference between the COVID-19 deaths of Philippines and South Korea.

For the hypothesis testing, the data from South Korea were subtracted from the data from the Philippines. The acquired numerical differences were analyzed through one sample t-test, wherein the hypothesized mean is 0. Tables III, IV, and V showed the calculations for the hypothesis testing of the positive cases, recoveries, and deaths for both countries in which it entails that within the 84 days (February 15 to May 8, 2020) since this pandemic escalates the cases in these countries, there's no significant difference in the positive cases recorded in Philippines and South Korea because the P-value calculated is greater than 0.05. However, there's a significant difference in the number of recoveries and death cases. In this particular statistical analysis, outliers were not removed in the process because doing so would not record the actual trends of COVID-19 cases in both countries.

TABLE VI
CONFIDENCE INTERVALS TEST CONDUCTED

Country	Population	Test Conducted	Test Conducted per Million
Philippines	109,368,430	148,832	1.361
South Korea	51,262,814	654,863	12.775

Table VI shows the number of COVID-19 tests conducted per million in the Philippines and South Korea.

To distinguish the gap from the mean number of tests conducted from each country, confidence intervals for the said quantities from both countries was also calculated. With reference to the data supplied by table VI, upon applying the confidence interval formula at 95% confidence level, it is evident that the mean lies between 7.050 and 7.086 to which the average test conducted for Philippines and South Korea is 7.068.

$$7.050 \leq \mu \leq 7.086$$

In essence, this test was conducted in order to find the range of ideal number of tests from each country. Since the obtained confidence interval is from 7.050 to 7.068 tests per million, it is noticeable that the tests from the Philippines is below the range, while tests from South Korea is above it.

Lastly, normal distribution was applied to illustrate the difference of the confirmed cases, active cases, recoveries, and deaths in both countries.

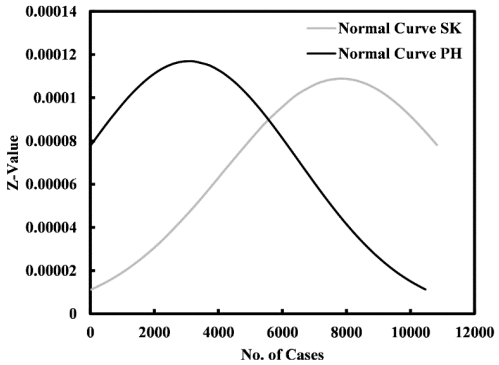

Fig. 1. Normal curve comparison based on confirmed cases between South Korea and Philippines.

Based on the first figure, the shape of the curve, in relation to its standard deviation, may be similar with one another, but the mean values are different. This implies that the number of cases in both countries are similar in quantity, but the rate of change is different from each other. South Korea had a rapid increase of cases in February 15 of 2020, while the Philippines had an increase of cases in the second week of March.

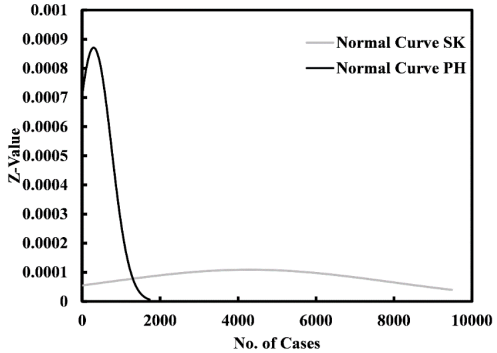

Fig. 2. Normal curve comparison based on recovery cases between South Korea and Philippines.

With regards to the second figure, the normal curve of South Korea had already flattened due to the significant increase of their recovery cases. On the other hand, Philippines had a significant spike in the curve, shifting to

the left. This implies that Philippines has low recovery cases.

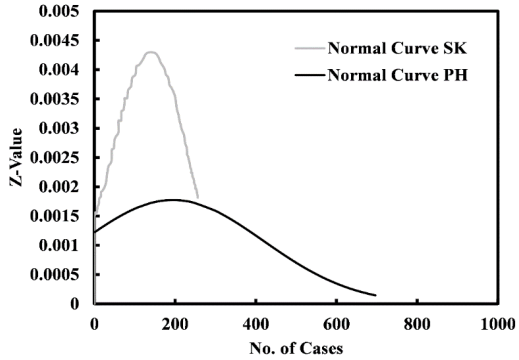

Fig. 3. Normal curve comparison based on death cases between South Korea and Philippines.

Based on the shape of the curve in the third figure, South Korea had a slimmer curve than the Philippines since it has lower death cases than the latter. The slimmer curve implies that there were lesser number of death cases occurred.

Overall, the results showed that there were significant differences between the Philippines and South Korea when it comes to recoveries and deaths, therefore, the countries are somewhat contrasting and PH is likely not on the same page as SK. The standard deviations show how that the countries have similarities in number of cases, but the means proved that there are dissimilarities. Each country, averagely, shows a change in different factors such as its rate. Due to the results, South Korea is found to be in a good condition regarding COVID-19 while the Philippines has to exert more effort to reach the goal of flattening the curve. The probability of having a recovered case in the Philippines is found to be 15.37% which is less than half. With this, PH is at the risk of having more deaths than SK in between February to March. Statistically speaking, death cases in the Philippines would have high chances of increasing in the next months. There are many factors that differentiate both countries in terms of strategic plans and response.

IV. DISCUSSION

Generally, Philippines and South Korea have extensive comparisons with their methods of handling the pandemic. Although the population density of SK is larger than PH and that there are more human traffic occurring in the country, they still maintained a lower number of positive cases. This could possibly be the results of their effective implementation of preventive measures. As supported by their high life expectancy, the provision of proper healthcare system is also evident.

TABLE VII
BASIC INFORMATION FOR PH AND SK

Country	Population Density	Life Expectancy
Philippines	368 per km^2	71.28 years
South Korea	510.96 per km^2	83.06 years

Table VII shows the population density and life expectancy in the Philippines and South Korea.

SK's response strategy was known to be fast through employing expansive tracing technology and zero tolerance isolation [12]. The country was never on lockdown and citizens were efficiently following the rules. It is clear that their government has considerable reliance on the public. Its economy was also widely open [12]. Also, SK's status and foundation to adapt to the virus will add to their quick financial recuperation [13].

The Philippines, on the other hand, has a major issue to handle; they tend to focus on humanitarian response plans and health system support interventions, and these disproportionately affect the least fortunate and most marginalized communities' networks and further exacerbate pre-COVID 19 social disparities as well as financial ones [14]. Its public health risk centers prioritize the vulnerable like the elderly with wide cases of hypertension, heart and respiratory disease and the frontline health workers [14]. It is also expressed that mass testing may not be open for everybody except the vulnerable excluding the people under monitoring (PUMs). In relation to the findings of the study, PH must increase the number of conducted tests. In addition, the country's economy was completely stalled and there has been a delay in inadequate inclusion of social assurance measures which determine the worsening public tension, hunger, and disconnection of poor people [15]. There were reports that masks were not distributed immediately and had lacking PPEs for health workers [16].

Indeed, comparing the number of cases of both countries equates to their respective government's plan on addressing the up surging pandemic. Moreover, this would also assess their efficiency of handling not just the health crisis, but also the country's economy. Obviously, during the specified time, SK and PH has roughly the same statistics for positive cases. However, it differs on the active cases, recoveries and fatalities. With this comparison, it would give a sense of emergence not just to PH but also to its people and the world leaders. A pandemic must be addressed abruptly to avoid future drastic causes to a country – micro and macro aspects. Lastly, SK's implementation would be a standard for other countries battling the health crisis.

Since COVID-19 is a communicable disease linked to the same family of viruses under Severe Acute Respiratory Syndrome, it leads to a stimulation that would undertake when symptoms are detected [17]. In a more fatal case, pneumonia or difficulty in breathing takes place [18]. Dr. Cowl also dictates that COVID-19 is more contagious than other viruses as this may be new to humans and our immune systems may not be ready for it [19]. It is true that these aforementioned activities could also be applicable to other diseases but these are also currently specific to COVID-19 since these measures are the best solutions for addressing the said pandemic. While there are still no cure for the disease, the optimal answer for the problem is proper handling and prevention [18].

V. CONCLUSION

The objectives of this study which were to analyze and compare the state of the Philippines and South Korea in the current pandemic was fulfilled. With reference to the performed statistical analyses, it was determined that SK has currently a better situation in the pandemic than PH. This is possibly due to their initiation of mass testing, imposition of proper social distancing and preventive measures, and installation of isolation and quarantine systems. On the other hand, PH faces challenges in addressing the problem because they focus more on humanitarian response plans. The nation is also limited to testing and confining vulnerable and severe cases only.

In essence, this study can be an eye opener to the Philippine government such that they can follow the measures performed by South Korea. Also, this could also help other countries that are having difficulties in handling the spread of COVID-19 since the research provides information about how a country must stop the spread of the virus as well as what steps and procedures they must apply. This paper informs what the government should be prioritizing and what the people of the country must do to help to stop the spreading of the virus.

In relation to the findings of this study, the researchers recommend the implementation of mass testing, so that the majority of positive cases would already be traced. Also, the lifting of community quarantines must be carefully decided. Possible consequences, such as the increase in cases, must be considered. Lastly, the government should improve preventive measures that limits interactions; they must also promote good health, physical wellness, immunity, and proper hygiene. Indeed, good governance and people's cooperation could together prevent the spread of the Novel Coronavirus.

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It was such a fulfilling endeavor that despite the current situation, this study became successful. Moreover, we took this writing as a great opportunity for the group to become part of an undertaking which is relevant to today's COVID-19 pandemic.

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