Journal of Economics, Finance and Accounting Studies
ISSN: 2709-0809
DOI: 10.32996/jefas
Journal Homepage: www.al-kindipublisher.com/index.php/jefas

JEFAS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

An Assessment of the Philippine Hospital Resources as Predictors of the Case Fatality Rate of COVID – 19

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| ABSTRACT
In the heightened effects of the pandemic, health resources have been in constant limbo as supplies and availability of hospital resources take a toll as COVID-19 cases surge, resulting in shortages. Thus, health systems are overwhelmed, resulting in a higher fatality rate since the capacity to provide medical attention is diminished. In this paper, hospital resources refer to mechanical ventilators, ICU, isolation, and ward beds which are the critical factors of the case fatality rate (CFR) of COVID-19 in the Philippines. Data were retrieved from the Department of Health (DOH) Case Bulletins from October 26, 2020, to June 30, 2021, with 248 total observations. This research used the Ordinary Least Squares (OLS) Multiple Regression to determine if hospital resources are the predictors of the case fatality rate of COVID-19. Furthermore, the results show a significant relationship between the hospital resources and the case fatality rate of COVID-19 in the Philippines. This study can become a framework for further research concerned about hospital resources as the predictors of case fatality rates of different diseases in a pandemic.

| KEYWORDS
COVID-19, Case Fatality Rate, Hospital Resources, COVID-19 Pandemic, Demand for Healthcare, Health Economics

| ARTICLE DOI: 10.32996/jefas.2022.4.18

1. Introduction
1.1. Background of the Study
On January 12, 2020, a new type of coronavirus (SARS-CoV-2) was classified by the World Health Organization (WHO) and was named COVID-19 or Coronavirus Disease 2019. This disease was formally characterized as a pandemic on March 11 of the same year. Since then, the rapid growth in the number of cases has challenged the health care systems of many countries around the world. Several health systems were overwhelmed with the influx of new cases in a short span of time. Travel restrictions were implemented from city to city and from country to country to help curb the spread of the disease.

A strong foundation in the health care system is essential to limit casualties and unproductive days. This system's role is not only to cure and treat ill people but also to keep people from getting sick through preventive medicine. This will be able to keep hospitals from getting overwhelmed as most cases of COVID-19 do not require treatment from health institutions. Vulnerable groups have a higher hospitalization rate, which likely leads to death, but it does not isolate that a healthy person cannot be severely ill from the virus. Healthy patients who contracted the virus are instead connected to their primary care and most likely be directed to self-isolate through a discussion of their symptoms (Karan, 2020).

According to a study by Rossman et al. (2021), the mortality of hospitalized patients with COVID-19 in Israel was related to health care burden, reflected by the concurrent number of hospitalized patients in an extreme condition. Furthermore, the findings emphasized that even in countries that did not reach the level of insufficiency, the increase in hospital workload was associated with the quality of care and patient mortality.
The health care system and capacity play a part in how the pandemic will pan out. Aside from increasing testing capabilities and continuous contact tracing, new cases and fatalities will still exist as the disease continues to spread without a solid solution. As a

rule of thumb, people left untreated due to the lack of available equipment or bed will likely become a casualty that could be prevented.

The availability of hospital-based resources has a relationship with the disease's death rates. Moreover, continuous tracking of this relationship is essential to create a guide for policymakers and hospitals to mitigate and control the disease as the pandemic unravels (Janke et al., 2021).

Countries are avoiding when the health care capacity is overwhelmed due to the continuous rising of COVID-19 cases. With the limited medical resources, such as health care workers, personal protective equipment, and ventilators, effective allocation is needed (Miller, Becker, Grenfell, & Metcalf, 2020).

During the pandemic, vulnerable groups, people with underlying conditions and groups at an old age, are most likely to be hospitalized due to complications of the coronavirus. People with cardiovascular diseases (CVD) have a significant increase in death, with mortality rates reaching high as 10.5% in Chinese populations. In this preliminary study, the global mortality of COVID-19 patients was 17.1%. In detail, generally admitted patients for COVID-19 mortality rate clocks at 11.5%, significantly lower to the mortality in critical illness patients that showed a 40.5% rate. These patients in critical states consume the hospital resources such as beds and ventilators (Macedo, Gonçalves, & Febra, 2021). In China, where the virus was first discovered, the overall fatality rate in the country stands at 2.3%, while fatality rates of hospitalized patients were estimated to be at 7% (Li et al., 2020).

Since there is an influx of COVID-19 cases in the Philippines, hospitalization rates have also skyrocketed. With this increase, people with different causes for hospitalization, such as emergency care aside from the coronavirus and routine check-ups, will cause competition for the available health resources. This ultimately leads to overwhelm the health care systems, which is the insufficiency of health equipment to treat every patient.

This research aims to understand the relationship between the health care system in terms of hospital resources and the COVID-19 case fatality rate. With this, a projection model will also be an essential tool in determining the outcome of the pandemic, which can also serve as a framework for better decision-making when the said relationship has been fully established.

1.2. Objective of the Study

The study aims to enable the determination of the significant relationship between the COVID-19 Case Fatality Rate and the availability rates of ICU, isolation, ward beds, and mechanical ventilators.

Based on the objective, the formulated hypothesis will be that there is no significant relationship between the COVID-19 Case Fatality Rate and ICU availability rates, isolation, ward beds, and mechanical ventilators.

1.3. Theoretical Framework

The researchers identified a relevant model for this study which is the Demand for Healthcare. The Demand for Health discusses how the availability of health resources is connected to health outcomes, specifically, COVID-19 fatality in this study. The Grossman (1972) model discusses how people do not demand health care services for the sake of just consuming resources, but what people ultimately want, which is "good health."

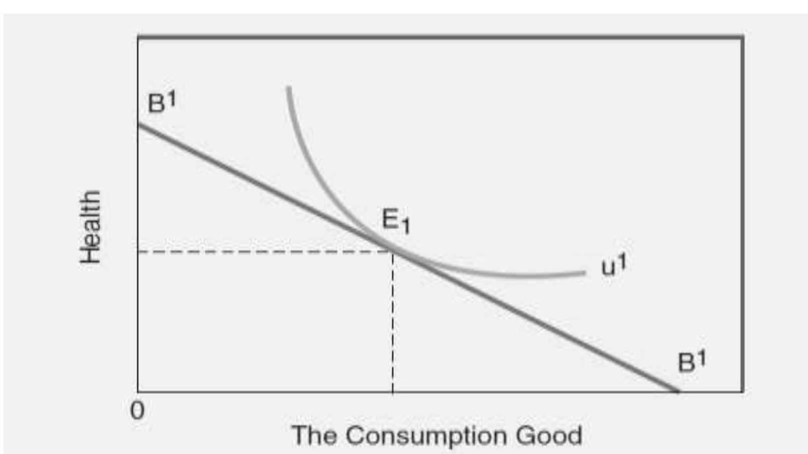

Figure 1. The trade-off between investment good, health, and consumption good

In figure 1, the straight line represents a budget line and shows a different set of combinations of health and consumption, while the *U* line is an individual's indifference curve which shows the utility or satisfaction gained by the consumer (Dewar, 2010).

In connection to health care, the determinants of health care expenditure will guide this research as it exists as a theoretical model for the demand for medical care (Hartwig & Sturm, 2018).
Considering that when the marginal cost of health production matches the marginal benefits of increased health status in the context of 'healthy time,' investment in health production is optimum. Using Grossman's model to account for the demand for healthcare, this study aims to project 'that' demand, and several other factors, the ICU load for hospitals during the COVID-19 pandemic in the Philippines.

1.4. Conceptual Framework

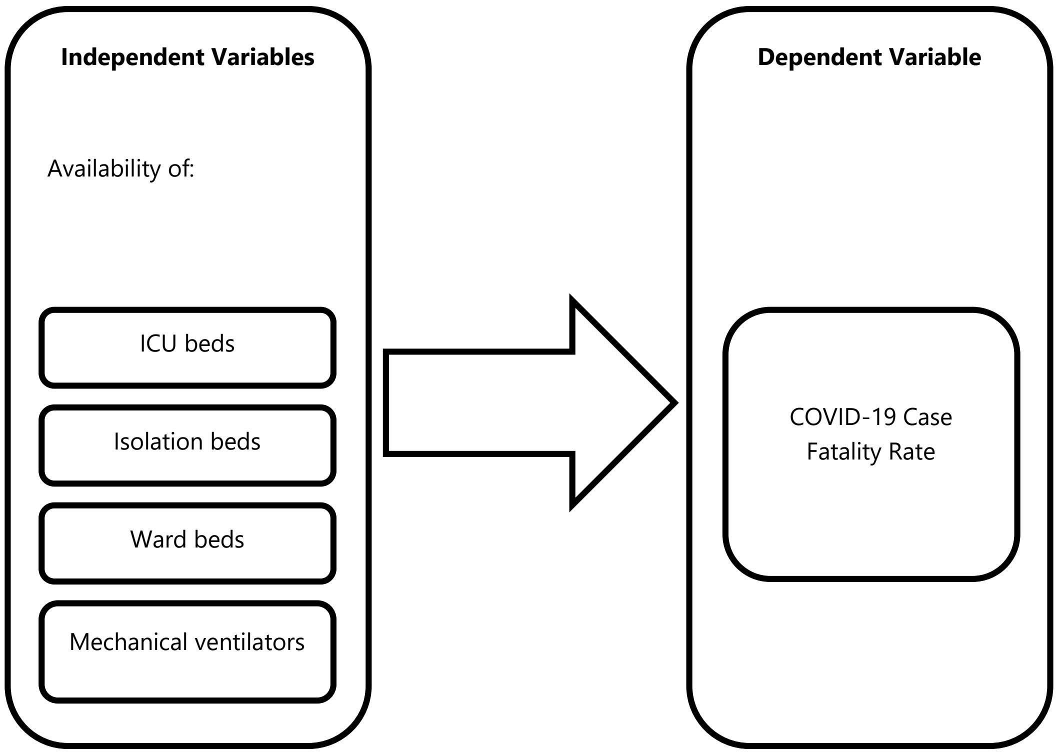

Figure 2. Illustration of the Relationship of Hospital Resources and the COVID-19 Case Fatality Rate

As seen in figure 2, the researcher identified the variables to be used in the study, whereas COVID-19 Case Fatality Rate is the dependent variable while the availability rates of hospital beds and mechanical ventilators serve as the independent variables. The study will determine how these variables are connected on whether the dependent variables are the determinants for the independent variable. Moreover, the data collection for the said variables will be available through the case bulletin of the Department of Health.

1.5. Significance of the Study

This research will be of benefit to the following:

Department of Health. Proper utilization of ICU capacity can lead to a substantial decrease in deaths, as echoed by Alban et al. (2020). This research will be beneficial to the Department as it can give it a 'bird's eye view' regarding its policies moving forward. This research can also be used as a guide for further changes in healthcare policies, if not its structure.

Hospital Administrators. This research will benefit various hospital administrations as it shall serve as a guide on when and how to expect the surge of COVID-19 cases for their ICUs. Hospitals can also utilize data used in this study for future planning and policymaking.

Local Government Units (LGUs). Given the position to implement various strategies for containing the spread of COVID-19, LGUs will benefit from the data and results of this study. These units can make use of this study to guide them in projecting different implementations of lockdowns to alleviate the pressure in hospitals under their direct supervision. Alfano & Ercolano (2020), showing that uninformed responses to the pandemic lead to higher economic prices and overcapacity in hospitals.

Future research. For prospective researchers, the COVID-19 pandemic has created several loopholes and uninformed judgments that must be addressed by analysis that could serve as the basis for developing new concepts relating to the capacity of the health care system in the Philippines.

1.6. Scope and Limitations
This study is bounded on data produced by the Department of Health in its daily COVID-19 Case Bulletins. Moreover, the Case Bulletin numbers that will be used for the study are #226 to #473, totaling 248 observations. The start at a special bulletin was chosen since this was when the availability rate of hospital beds such as ICU, isolation, and ward was reported. Furthermore, the death toll and number of cases were also retrieved from the same bulletins for consistency, and other reports of such would not be used in the study.

2. Literature Review
2.1 Philippine Healthcare System
First off, we need to delve into the organizational structure of the healthcare system implemented in the Philippines to understand better how it tackles the ongoing pandemic. As stipulated in Executive Order No.119 s. 1987, "the Department of Health (DOH) shall take charge of the creation and progress of national health rules, policies, and standard operating procedures for various health allied services and infrastructure, as well as special healthcare programs designed to combat specific problems regarding the health of the populace. It shall also be responsible for the promulgation of directives and the regulation of licenses, and for accreditations. The primary role of the health department is to promote, defend, preserve, or restore people's health through the procurement and distribution of health care, as well as through the supervision and encouragement of suppliers of health products and services" (President of the Philippines, 1987)

The Philippine healthcare setting is organized to incorporate the three-basic level of care. Rural health units, their subsidiary centers, chest clinics, and malaria eradication units are under the administration of the Department. The League of Puericulture Centers operates centers and tuberculosis centers, and hospitals are then operated by the Philippine Tuberculosis Society. Private clinics are governed by the Philippine Medical Association, while clinics run by major industrial companies for their workers, as well as municipal hospitals and health centers, are governed by the Philippine Medicare Care Commission. Voluntary religious and civic groups fall under their respective managements. These all fall under the first level of care. (Dayrit, Lagrada, Picazo, Pons, & Villaverde, 2018).

Smaller, non-departmentalized clinics, such as emergency and regional hospitals, are included in the Level II system of care. The care provided to patients in the symptomatic stage of their illness needs moderately advanced skills and professional resources for proper care. Level III healthcare applies to the increasingly technological and innovative services offered by emergency departments and large hospitals. National speciality hospitals are also available. The programs provided at this stage are for clients suffering from diseases that pose a direct danger to their health and necessitate highly technical and specialist expertise, equipment, and staff to manage successfully. (Dayrit, Lagrada, Picazo, Pons, & Villaverde, 2018).

As mandated by Republic Act No. 7875, “The State shall take an organized and holistic approach to health growth, attempting to make basic commodities, health, and other social services accessible to all citizens. Priority shall be given to the welfare of the underprivileged, sick, frail, disabled, mothers, and girls. Similarly, it shall be the state's responsibility to offer affordable medical services to the poor" (Congress of the Philippines, 1994).

2.2 Challenges for Philippine Healthcare
The Philippine healthcare system also has its fair share of challenges with, according to Oscar F. Picazo in 2018, it being in a "fractured and disorganized governance." health system inefficiencies and health inequalities are still some lingering problems moving forward. Another set of problems that this system has is its lack of innovation and improvement for healthcare facilities. According to a study by the World Health Organization found that the "PhilHealth, DOH and LGU health facilities are spending on the same maternal and child health services while the growing cases of non-communicable and communicable diseases, including the emergency care these conditions often require, are inadequately funded and poorly prioritized" (Dayrit, Lagrada, Picazo, Pons, & Villaverde, 2018, p. xxviii).

2.3 COVID – 19 and healthcare capacity

With the spread of COVID-19 in the Philippines, it is very likely that a significant burden will be put on the healthcare system. Early projections indicate that the peak of the pandemic would require the health sector to have up to 1.51 million daily hospital beds, 456 thousand ICU beds, 246 thousand ventilators, 727 thousand physicians, a million nurses, 91 thousand medical professionals, and 36 million sets of personal protective equipment (PPE) for hospitalized COVID-19 patients (Abrigo, Uy, Haw, Elep, & Francisco-Abrigo, 2020).

The ongoing struggle is to guarantee that the pandemic remains at levels that hospitals can manage, if not totally averted. Extreme cases of pneumonia need to be admitted to an isolated room or ward, while critical cases are admitted to the ICU unit. In general, a mechanical ventilator would be needed in 54% of critical cases suffering from acute respiratory distress syndrome (ARDS) (Zhou et al., 2017).

Projections show the demand for healthcare services attributed to COVID-19 far exceeds the available supply, with the country needing 182,000 beds, 55.5 thousand ICU beds, 30 thousand ventilators, 88 thousand doctors, 118 thousand nurses, 11 thousand medical specialists, and 4.41 million PPE sets by May/June 2021. Current data shows that there are only 61,459 beds available across both level 2 (L2) and level 3 (L3) hospitals (Department of Health, 2019). As of April 8, 2020, 1,921 ICU beds and 2,088 ventilators were allocated to COVID patients among hospitals reporting supply censuses to DOH (36.4 percent response rate) (DOH-HFDB, 2020). Meanwhile, the nation has only 52 thousand doctors and 351 thousand nurses (Abrigo, Uy, Haw, Elep, & Francisco-Abrigo, 2020). We cannot presume that all ward beds, ICU beds, ventilators, and human capital will be allocated to COVID-19 patients and other patients with illnesses (e.g., cancer, cardiac disease, renal failure, stroke) that would need these resources.

As made evident by Goh et al. (2020), the hospitalized patients contracting the Coronavirus disease 2019 (COVID -19) in China reflected high acute respiratory distress syndrome (ARDS) at 17-29% and critical illness at 23 – 32%. Similarly, Goh et al. (2020) also saw the same rates being reported in Lombardy, Italy, at 16% critical illness. These can be attributed to many factors, but most patients with serious diseases credited to COVID – 19 tend not to recover (Ciceri et al., 2020).

A study reported a 28-day ICU mortality rate of 62%. This is cross-referenced with the projected case fatality rate of COVID-19 at 3-4%, Middle East respiratory syndrome (MERS) at 34%, and severe acute respiratory syndrome (SARS) at 11%. This shows that COVID-19 fatalities have now greatly outnumbered the combined MERS and SARS deaths. Further studies also looked at the different factors that might have contributed to the high ICU mortality rate, and the lingering outlier is that of the availability of mechanical ventilators. Due to equipment shortages, the data tabulated by the study from Wuhan, China, indicate that 75% of the fatalities did not get mechanical ventilation (Goh et al., 2020).

ICUs should also be able to increase by at least 20% over baseline volume immediately. However, a substantially greater surge ICU size is needed during medical crises or pandemic cases, with critically ill patients needing treatments outside a conventional ICU. Available materials will determine the expected response, and trigger goals for each phase should be established early on (Goh et al., 2020).

As made evident by Ma &Vervoort (2020), the need for swift, adaptive, and cost-effective emergency response systems, as well as the existence of critical care capability shortages, has become abundantly clear in most countries and territories across the world. Current estimates place the availability of ICU beds to 0.1 to 2.5 per 100,000 population in low- and middle-income countries (LMICs). These countries are at risk for failing to prepare for an expected influx in seriously ill patients of COVID-19. Further specifications show several limitations in their research with; (1) there has yet to be a comprehensive survey of ICU beds worldwide, despite there being several studies evaluating critical care capacity in some regions. (2) Due to a lack of detailed evidence in peer-reviewed publications or white papers, statistics on the number of ICU beds in 52 countries and territories were obtained through the local and national media. Their results are still limited to information that can be published publicly, and the possibility that the numbers are overstated due to underreporting by the media cannot be ruled out. (3) Access to ICU services, which is a barrier in many countries with (partially) private healthcare systems, is not considered when measuring capacity. The provision of an ICU bed does not always imply enough services to care for a chronically ill patient. Lastly (4), to accommodate the growing number of critically ill patients, many countries are increasingly transforming regular hospital wards, operating theaters, and non-clinical spaces into makeshift ICUs. Despite these limitations, conclusions show that their research offers an original, systematic picture of global baseline critical care capability availability (Ma & Vervoort, 2020).

Ma & Vervoort (2020) claimed that ICU beds have already had a high baseline occupancy rate. Based on real-time case data, 5% of COVID-19 cases are expected to need ICU care, mathematically overwhelming a handful of countries while denying the need for ICU beds for non-COVID-19 emergencies. As the globe struggles to deal with the ongoing pandemic, a change in existing global public health policy exposes critical vulnerabilities in global health programs. While critical care capacity in LMICs was insufficient prior to the pandemic, deficiencies have extended to include highly funded health care systems all over the world (Ma & Vervoort, 2020).

A study by Alban et al. (2020) concerning ICU capacity management during the COVID-19 pandemic showed that with 5 COVID patients coming every day or less, nearly all would be admitted with 60 or more COVID beds reserved. With 90 beds, nearly 8 COVID patients will be admitted every day, with just 2% of patients being referred to other hospitals. Alban et al. (2020) concluded that higher bed space means more patients will be admitted; however, variations in hospital arrival rates and length of stay (LOS) mean that certain patients cannot be admitted.

2.4. Synthesis

The researcher used the data as a foundation for interpretation, considering all the collected literature. The researcher also considered the shortcomings of the relevant literature and studies.

The Philippines' healthcare system is organized into three levels of care: Level I, Level II, and Level III. Managed by the Department of Health, it is responsible for national health policies, guidelines, standards, and manual of operations for health services and programs. Priority shall be given to the welfare of the underprivileged, sick, frail, disabled, mothers, and girls, as ordered by Republic Act No. 7875. It shall also be the state's policy to offer affordable medical services to the poor. Levels of treatment range from local health units at Level I and emergency and community hospitals at Level II to increasingly technological and advanced medical facilities at Level III, many of which play an essential part in delivering healthcare services. The Philippine healthcare system is plagued by issues such as "fractured and disorganized administration," inefficiencies, and health inequality. "PhilHealth, DOH, and LGU health facilities all spend the same amount on maternal and child health services," according to the World Health Organization.

With the spread of COVID-19 in the Philippines, the healthcare system is most likely to bear a considerable burden. The health system will need up to 1.51 million regular hospital beds, 456 thousand ICU beds, 246 thousand ventilators, 727 thousand doctors, a million nurses, 91 thousand emergency practitioners, and 36 million sets of personal protection equipment at the onset of the pandemic (PPE) There were only 61,459 beds available in level 2 (L2) and level 3 (L3) hospitals as of April 8, 2020. Most patients with severe diseases caused by COVID – 19 do not survive. Mechanical ventilation was not given to 75% of the victims. ICUs should also be able to rise by at least 20% over baseline volume rapidly. A significantly larger surge ICU size is needed in cases of medical disaster or pandemics (Ciceri et al., 2020)

Current figures put the availability of ICU beds in low- and middle-income countries at 0.1 to 2.5 per 100,000 people. These countries are at risk of failing to plan for an imminent surge of COVID-19-infected critically ill patients. According to (Ma & Vervoort, 2020), their study provides an initial, comprehensive global baseline critical care capacity readiness image. The availability of an ICU bed does not necessarily mean the availability of sufficient facilities to care for a critically ill patient, and many countries are now transforming standard hospital wards, operating theaters, and non-clinical spaces to serve a rising number of critically ill patients.

Five percent of COVID-19 cases are expected to need ICU care, mathematically overwhelming a small number of countries. Research on ICU capacity management during the pandemic by Alban et al. (2020) found that with 5 COVID patients arriving every day or less, almost all would be admitted with 60 or more COVID beds reserved. While critical care capacity in low to middle-income countries (LMICs) was insufficient prior to the pandemic, deficiencies have extended to include highly-resourced health systems all over the world. The authors argue that a change in emerging global public health policy exposes critical flaws in global health systems.

3. Methodology

This chapter tackles the methodology of the study about the Assessment of the Health Care System as predictors of the COVID-19 Case Fatality Rate. This part of the paper discusses the research design, sample and sampling technique, research instruments, data gathering procedure, and the statistical treatment used.

3.1. Research Design

This research will use a quantitative correlational research design to assess the significant relationship between the health care system variables and the COVID-19 case fatality rates. This type of research design tackles the relationship of the variables without the manipulation of different variables as to be conducted in this study. Furthermore, it recognizes the patterns and trends of the data set.

3.2. Research Instrument and Techniques

This study uses quantitative analysis to derive the relationship between the variables. Microsoft Excel will be used to encode and compile the data from the DOH Case Bulletins. To test the data sets, the program (SPSS) EViews 11 Student Version will be used for diagnostic tests and the regression proper of the study.

3.3. Data Gathering Procedure

The researchers utilized a secondary data collection where the source will be the COVID-19 Case Bulletins released by the Department of Health (DOH). Among the different types of data included in the bulletins, the daily total number of cases, total number of deaths, and rate of availability of hospital beds and mechanical ventilators. Moreover, the researchers used books, legal bases, online articles, and journals to improve the study.

3.4. Statistical Treatment of Data

This study utilizes an Ordinary Least Squares (OLS) multiple regression to test the relationship between the variables, testing the study's first hypothesis. In addition, graphs and tables will be used to summarize the gathered data and results.

For the statistical tools and diagnostic tests, the following mathematical tests are utilized in the study: the Jarque-Bera test for normality, the Breusch-Godfrey test for serial correlation, the Breusch-Pagan-Godfrey test for heteroscedasticity, the Variance Inflation Factors (VIF) for multicollinearity.

4. Results and Discussion

In this chapter, the stated problems will be addressed by presenting the results and further discussions to support the interpretations. All statistical treatment and modeling, namely, the graph creations and computations, were executed through EViews and SPSS. Following this, this chapter also includes hypothesis testing on the following statement:

H_0 – There is no significant relationship between the COVID-19 Case Fatality Rate to the availability rates of ICU, isolation, ward beds, and mechanical ventilators.

The compiled Case Bulletins were garnered from DOH-Accredited hospitals and labs, as required by law. Managed by the DOH Central Office's Office for Management Services, the Knowledge Management and Information Technology Service is guided by professional standards in "formulating plans, policies, programs and standards, for management information systems and information technology development" and "developing and managing the health information resources, library services, and document tracking and archiving services for the DOH" (Philippines, 1999). The daily total number of cases, the total number of deaths, and the rate of availability of hospital beds and mechanical ventilators were retrieved from the COVID-19 case bulletins for the months of October 2020 to June 2021.

4.1. Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
constant	0.013126	0.000887	14.79901	0.0000
ICU	-0.001778	0.002444	-0.727475	0.4676
ISO	-0.004673	0.002228	-2.097026	0.0370
WARD	0.020691	0.002071	9.989336	0.0000
VENT	-0.005548	0.001752	-3.167041	0.0017

R-squared	0.872714	Mean dependent var	0.018811
Adjusted R-squared	0.870619	S.D. dependent var	0.001520
S.E. of regression	0.000547	Akaike info criterion	-12.16573
Sum of squared resid	7.26E-05	Schwarz criterion	-12.09490
Log-likelihood	1513.551	Hannan-Quinn criterion	0.0017
F-statistic	416.5232	Durbin-Watson stat	0.135770
Prob (F-statistic)	0.000000		
Note: Confidence interval is at 95%			

Table 1. Regression Table

Using Ordinary Least Squares (OLS) Multiple Regression Analysis, the researchers found that Ward Bed availability has a positive relationship with Case Fatality Rates while ICU Bed, Isolation Bed, and Mechanical Ventilator availability saw a negative relationship due to the negative values of the coefficients. Furthermore, table 1 shows that all variables are statistically significant, having p-values of less than 0.05, except for the availability of ICU beds which resulted in having a p-value of 0.4676. Therefore, rejecting the null hypothesis for ICU beds having no significance on the model. The estimated regression equation is as follows:

$$\mathbf{CFR = 0.011 - 0.002*ICU - 0.005*ISO + 0.021*WARD - 0.006*VENT + \mu}$$

It can be inferred from the values of the coefficients, notably for ICU beds, isolation beds, and mechanical ventilators, that there is a negative relationship between their availabilities with the case fatality rate. On the contrary, ward beds constitute a positive coefficient which signifies a positive relationship with the dependent variable. In detail, a decrease of one unit for every variable translates to a decrease to the case fatality rate value by 0.002, 0.005, and 0.006 for ICU beds, isolation beds, and mechanical ventilators, respectively. At the same time, there will be an increase by 0.021 due to a one-unit increase in the availability of ward beds

Predictors	R	Sig. (2-Tailed)	Decision on H_0	Interpretation
ICU beds Isolation beds Ward beds Ventilators **Case Fatality Rate**	0.934	0.000	Reject	Significant
Note: > .05 (Not Significant) < .05 (Significant)				

Table 2. The behavior of Independent Variables (ICU beds, Isolation beds, Ward beds, Ventilators) to Dependent Variable (Case Fatality Rate)

As shown in Table 2, the computation using multiple regression shows an R-value of 0.934 or 93.4%, which signifies the aggregate percentage accounted by ICU beds, isolation beds, ward beds, and ventilators for case fatality rate. Moreover, the hypothesis determining if there is no significant relationship between the independent and dependent variables is rejected due to a significance value of less than 0.000, meaning there is an almost 100% predicative possibility that the availability of all the independent variables caused the decrease of the case fatality rate of COVID-19 in the Philippines.

4.2. Variance Inflation Factors for Multicollinearity

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Tolerance**	**VIF**
1	**(Constant)**	0.011	0.000		52.085	0.000		
	ICU BEDS	-0.002	0.002	-0.115	-0.727	0.468	0.021	47.391
	ISO BEDS	-0.005	0.002	-0.172	-2.097	0.037	0.077	12.917
	WARD BEDS	0.021	0.002	1.546	9.989	0.000	0.022	45.716
	VENTILATORS	-0.006	0.002	-0.357	-3.167	0.002	0.041	24.240
a. Dependent Variable: CASE FATALITY RATE b. Predictors: (Constant), VENTILATORS								

Table 3. Model Coefficients of all Predictors

In table 3, multicollinearity could be detected using the Variance Inflation Factors (VIFs). It could be said that the variable has multicollinearity issues when the value is greater or equal to 10. In the model, all variables show a VIF value of higher than 10 with 47.391 for ICU beds, 12.917 for isolation beds, 45.716 for ward beds, and 24.240 for ventilators. Even if the model constitutes multicollinearity, this could be explained as these hospital resources are interconnected, wherein an increase in hospital resource usage does not only affect one of the independent variables. At any given time, approximately two-thirds of ICU beds are occupied, and approximately one-third of these beds are occupied by patients requiring mechanical ventilation" (Wunsch et al., 2013, p. 6).

4.3. Jarque-Bera test for Normality

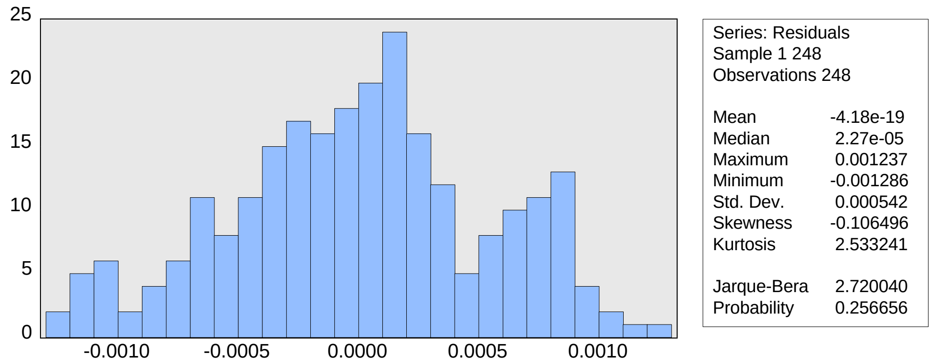

Figure 3. Normality Test of Residuals

The Jarque-Bera test for normality detects if the model's residuals are normally distributed. A p-value of more than 0.05 entails a failure to reject the null hypothesis thus, having a normally distributed data. According to figure 3, Jarque-Bera value is at 2.720040, and the p-value is at 0.256656, which is greater than 0.05. Therefore, the residuals of the regression estimates are normally distributed.

4.4. Breusch-Godfrey LM test for Serial Correlation

NULL HYPOTHESIS: No serial correlation at up to 2 lags			
F-Statistic	892.2675	Prob. F (2, 241)	0.0000
Obs*R-squared	218.4927	Prob. Chi-Square (2)	0.0000
Note: > .05 (Not Significant) < .05 (Significant)			

Table 4. Breusch-Godfrey LM test

In table 4, the Breusch-Godfrey LM test was conducted to determine if the regression model exhibits serial correlation. In this test, the null hypothesis shows that there is no serial correlation at up to 2 lags. F-statistic value is at 892.2675 while the P-value is at less than 0.0000, which is less than 0.05. Therefore, the null hypothesis is rejected, and the regression estimates show that there is a serial correlation at up to 2 lags.

4.5. Breusch-Pagan-Godfrey test for Heteroskedasticity

NULL HYPOTHESIS: Homoskedasticity			
F-Statistic	33.89919	Prob. F (4, 243)	0.0000
Obs*R-squared	88.82273	Prob. Chi-Square (4)	0.0000
Scaled explained SS	65.37530	Prob. Chi-Square (4)	0.0000
Note: > .05 (Not Significant) < .05 (Significant)			

Table 5. Breusch-Pagan-Godfrey test

Heteroskedasticity can be measured using the Breusch-Pagan-Godfrey test, which regresses the squared residuals on the original regressors. As seen in Table 5, the F-statistic is valued at 33.89919 while its P-value is at less than 0.0000, which is less than the significance level of 0.05. As a result, the null hypothesis of the regression estimates being homoscedastic is rejected, thus having a heteroskedastic data set.

4.6. Pearson Correlation

Predictors	Pearson Correlation	Sig. (2-Tailed)	Interpretation
ICU beds **Case Fatality Rate**	0.895	0.000	Significant
Note: > .05 (Not Significant) < .05 (Significant)			

Table 6. Correlation of ICU beds to Case Fatality Rate

Table 6 shows the correlation coefficient between the availability of ICU beds as the independent variable, as opposed to the Case Fatality Rate as the dependent variable. The Pearson Correlation indicates that there exists a strong correlation with its value at .895, or equivalent to 90%. The interpretation is that there is a significant difference between the independent and dependent variables with the significance value being 0.000, that there is a 100% predictive possibility that the rate of availability of ICU beds caused the decrease in Case Fatality Rate of COVID-19 in the Philippines. Furthermore, as presented in Figure 5, the R^2 linear value is 0.801 or 80%, with the increased changing variation being accounted for by the dependent variable towards its effect on the independent variable.

Predictors	Pearson Correlation	Sig. (2-Tailed)	Interpretation
Isolation beds **Case Fatality Rate**	0.880	0.000	Significant
Note: > .05 (Not Significant) < .05 (Significant)			

Table 7. Correlation of Isolation beds to Case Fatality Rate

Following table 7, it can be inferred that there is a strong correlation between the availability of ISO beds and the COVID-19 Case Fatality Rate as shown by the .880 Pearson Correlation value, or 88%. In addition, as exhibited by Figure 6, the R^2 linear value is 0.775, or equal to 78%, with the dependent variable accounting for the increased changing variance in relation to its influence on the independent variable.

Predictors	Pearson Correlation	Sig. (2-Tailed)	Interpretation
Ward beds **Case Fatality Rate**	0.928	0.000	Significant
Note: > .05 (Not Significant) < .05 (Significant)			

Table 8. Correlation of Ward beds to Case Fatality Rate

As shown in Table 8, the Pearson test with a value of 0.928 or 92.8% shows a strong correlation between the case fatality rate (Y) and ward beds (X3). Moreover, Figure 7 depicts that the variables show an R^2 linear value of 0.861, which translates to 86.1% of the changes of the dependent variable being accounted for by the independent variable.

Predictors	Pearson Correlation	Sig. (2-Tailed)	Interpretation
Ventilators **Case Fatality Rate**	0.860	0.000	Significant
Note: > .05 (Not Significant) < .05 (Significant)			

Table 9. Correlation of Ventilators to Case Fatality Rate

In Table 9, the Pearson test with a value of 0.860 or 86% shows a strong correlation between the case fatality rate (Y) and ventilators (X4). Moreover, Figure 8 depicts that the variables show an R2 linear value of 0.740, which translates to 74% of the changes of the dependent variable being accounted for by the independent variable.

Relating the results to the related literature, Michard et al. (2020) believes that while raising the number of ICU beds is one possibility, improving monitoring procedures on hospital wards may also be part of the answer. There have been various innovations across different fields of medicine, including wireless wearable sensors, adhesive patches, necklaces, and finger sensors that can help monitor vital signs such as heart rate, respiratory rate, oxygen level, temperature, and changes in blood pressure. During the COVID-19 crisis, a high number of patients who needed oxygen and were at risk of rapidly deteriorating were hospitalized at the same time. To deal with the influx, some hospitals promptly installed wireless pulse oximeters in their wards. (Sessler & Saugel, 2019)

Moving forward, ICU beds might be set aside for patients who require organ support, such as those on mechanical ventilators. Patients who require close monitoring might remain on the wards safely and benefit from intelligent and continuous monitoring. This technique may contribute to enhancing patient safety and hospital care quality without significantly expanding the number of ICU beds and associated expenditures. (Michard, Saugel, & Vallet, 2020)

5. Summary of Findings

Table 1 shows the calculation using multiple regression between the COVID-19 Case Fatality Rate to the availability of ICU Beds, ISO Beds, Wards Beds, and Ventilators.

- R-value of 0.934 or 93% indicates that there is a significant difference between the stated independent and dependent variables and that there is a 100% predictive possibility that the availability of all independent variables caused the decrease of the COVID-19 Case Fatality Rate in the Philippines between October 26, 2020, to June 30, 2021.
- R^2 linear value of 0.8727 or equal to 87%, which accounted for an increasingly changing variation which is represented by the independent variables towards its impact on the COVID-19 Case Fatality Rate Variable

Table 6 shows the results and findings by use of Pearson R-correlation between the COVID-19 Case Fatality Rate to the availability rate of ICU Beds.

- Pearson Correlation value of .895% or 90% with a p-value of 0.000 shows that the indicators have a significant correlation with a 100% confidence level.
- R^2 linear value of 0.801 or 80%, with the increased changing variation being accounted for by the dependent variable towards its effect on the independent variable.

Table 7 shows the results and findings by use of Pearson R-correlation between the COVID-19 Case Fatality Rate to the availability of ISO Beds.

- Pearson Correlation value of .880 or 88% with a p-value of 0.000 shows that the indicators have a significant correlation with a 100% confidence level.
- R^2 linear value of 0.775 or equal to 78%, with the increased changing variation being accounted for by the availability of ISO beds towards its effect on the COVID-19 Case Fatality Rate.

Table 8 iterates the results and findings by use of Pearson R-correlation between the COVID-19 Case Fatality Rate to the availability of Ward beds.

- Pearson Correlation value of .928 or 93% with a p-value of 0.000 shows that the indicators have a significant correlation with a 100% confidence level.
- R^2 linear value of 0.861 or equal to 86%, with the increased changing variation being accounted for by the availability of Ward beds towards its effect on the COVID-19 Case Fatality Rate.

Table 9 displays the results and findings by use of Pearson R-correlation between the COVID-19 Case Fatality Rate to the availability of Ventilators.

- Pearson Correlation value of 0.860 or 86%, with a p-value of 0.000, shows that the availability of Ventilators and the COVID-19 Case Fatality Rate have a significant correlation with a 100% confidence level.
- R^2 linear value of 0.740 or equal to 74%, with the increased changing variation being accounted for by the availability of Ventilators towards its effect on the COVID-19 Case Fatality Rate.

6. Conclusion

In the heat of the pandemic, different health resources were closely tracked and measured as a proactive tactic to develop policies that could help in fighting the pandemic. Health resources are specified in this paper to be ICU, isolation, and ward beds, and mechanical ventilators. In connection to determining if there is a significant relationship between the COVID-19 Case Fatality Rate to the availability rates of the health resources.

The results show that the availability of ICU beds, isolation beds, ward beds (independent variables), and COVID-19 case fatality rate (dependent variable) has an R-value of 0.934 or 93.4%, which is a basis that would suggest that there is a significant relationship. Furthermore, the p-value is calculated at less than 0.000, which means that there is a failure to reject the null hypothesis. Therefore, there is a significant relationship between the COVID-19 case fatality rate and the availability rates of ICU beds, isolation beds, ward beds, and mechanical ventilators.

Given that all independent variables have a significant relationship with the dependent variable, ward beds (X3) showed the highest correlation significance with an R^2 value of 0.861 and a Pearson correlation value of 0.928 and is followed by ICU beds (X1) with an R^2 value of 0.801 and a Pearson value of 0.895. Then, isolation beds have an R^2 value of 0.775 and an R-value of 0.880. Mechanical ventilators (X4) showed the lowest correlation significance with an R^2 value of 0.740 and a Pearson correlation value of 0.860.

However, these results have a limitation since the values of the availability do not reach extreme values, such as a complete utilization of the hospital resources, which signifies that the health capacity has been maximized and might result in higher levels of case fatality rates. Furthermore, different intervening factors could also affect the result of the study, like the efficiency and skills of the health care workers operating within the hospitals, which is different from only tackling hospital beds and ventilators as the predictors of COVID-19 case fatality rates.

In addition, the global mortality rate admitted to ICU ranged from 2.7% and 65.4%, while non-ICU beds were at only 14% mortality rate. Furthermore, geriatric patients in the ICU account for 80% of all COVID-19 mortality (Sen-Crowe, Sutherland, McKenney, & Elkbuli, 2021). Further findings of Sen-Crowe, Sutherland, McKenney, & Elkbuli (2021) would suggest that the significant relationship between COVID-19 deaths and hospital resources is likely influenced by different factors such as age, existing comorbidities, and disease severity.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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