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Original Article

Forecasting Indonesia's Life Expectancy During the Covid-19 Period 2021-2026

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Abstract *- The Life Expectancy Rate (AHH) indicates the degree of public health and reflects the success rate of development in the health sector. The higher the AHH, the better the community's health status, and this are supported bye the success in health development. To see how the AHH level will be in the next 5 years, one way that can be done is to predict the time series. The Autoregressive Integrated Moving Average (ARIMA) method has the ability to capture the necessary information about the AHH level. This is because ARIMA is a time series forecasting method that is suitable for predicting a number of variables quickly, simply, and accurately and only requires variable data to be predicted. Based on the ARIMA results obtained, the Life Expectancy Rate (AHH) for the 2021-2026 period experienced a growth of 0.3%, much lower than in the past 5 years; this is due to Covid-19 in Indonesia. It is hoped that the relevant government can anticipate the decline in AHH from time to time, and related to the Covid-19 case, it is hoped that policies can anticipate the spread so as to reduce the death rate in Indonesia.*

Keywords *- AHH, ARIMA, Covid-19, Forecasting, Time Series.*

I. INTRODUCTION

According to Indonesian statistics, life expectancy at birth is the average year of life a newborn baby will live in a certain year. The Life Expectancy Rate (AHH) is a tool to evaluate government performance in increasing health status in particular. Life expectancy describes the average age that a person reaches in a mortality situation prevailing in the community. Increased life expectancy is an indicator of the success of health development in Indonesia. In terms of AHH, health development in Indonesia has been quite successful because life expectancy has increased significantly, namely 71.28 years in 2017 to 71.51 years in 2018. However, this increased life expectancy has brought a burden on society. Because the population of the elderly population (elderly) is increasing, it results in a higher risk group in the community.

Table 1. Indonesian Life Expectancy (years) 2000-2020 period

Data source: World Bank (processed data)

WHO (World Health Organization) has calculated that in 2025, Indonesia will experience an increase in the number of elderly people by 41.4 percent, which is the highest increase in the world. Even the United Nations estimates that in 2025 the number of elderly people in Indonesia will reach ± 60 million people. The increasing number of the elderly population raises problems, especially in terms of the health and welfare of the elderly. If this problem is not handled, it will develop into a more complex problem for the elderly National Commission (2010).
Based on data from BPS and Susenas in 2012, information was obtained about the most common types of health complaints suffered by the elderly, namely cough (17.81%) and colds (11.75%). From the result of the LITBANGKES agency report for registration of causes of death in 15 districts/cities in 2011, the proportion of causes of death for the elderly (aged 55-64 years and> 65 years old) was the highest, namely stroke and coronary heart disease. Ministry of Health (2013).

Health is one of the factors that greatly determine the quality of human resources. Therefore to create a healthy Indonesian society is to empower the community. By involving community members or cadres who are willing to voluntarily get involved in health problems is an empowerment effort. RI Ministry of Health (2011).

In 2020, covid-19 was attacked by the country of Indonesia, and Covid-19 is a very dangerous virus as proven

by the WHO statement, which said that this virus was a global pandemic after the number of infections worldwide reached more than 121,000 cases. With this statement, the current condition should not be underestimated because, throughout history, there have only been a few diseases that were classified as pandemics. The term pandemic is indicated at the level of its spread, not to indicate the severity of a disease. In Indonesia, on April 10, 2020. There were 3,512 positive cases, 282 recovered, and 306 people died with a fatality rate of a death rate of 9.1%. Ministry of Health of the Republic of Indonesia (2020). The cases that occur in Indonesia are not as many as other countries, especially in the future, but there is an opportunity that there will be a continuous increase in the near future. The large number of deaths that are increasing day by day due to the coronavirus does not only cause symptoms and physical illness but has a major effect on the welfare of the Indonesian people, which includes mental health. Such as having an impact on the socio-economic conditions of families left behind, this can have a significant effect if someone who is infected with the coronavirus and then dies is the backbone of the family. Then the impact on society is to make it easier to panic, worry, and stress. This can have a significant effect if someone who is infected with the coronavirus and then dies is the backbone of the family. Then the impact on society is to make it easier to panic, worry, and stress. This can have a significant effect if someone who is infected with the coronavirus and then dies is the backbone of the family. Then the impact on society is to make it easier to panic, worry, and stress.

Covid-19 causes the death rate to persist every day. Quoting from the journal Proceedings of The National Academy of Science, the researchers project that the Covid-19 pandemic will cause the average life expectancy in the United States in 2020 to drop 1.13 years and drop to 77.48 years, the largest drop at least. In 40 years. The number of Covid-19 cases in Indonesia is also increasing in the level of safety projects, a decline in life expectancy in Indonesia.

II. EMPIRICAL AND THEORETICAL STUDIES

A. Concept of mortality

Death or mortality is one of the three components of the demographic process that affects the population structure, and the other two components are birth (fertility) and population mobility (Mantra, 2000). Death can be interpreted as an event of permanent loss of all signs of life, which can occur at any time after live birth (Utomo, 1985). According to the United Nations and WHO, mortality or death is the permanent loss of all signs of life that can occur at any time after live birth. Miscarriage and stillbirth are not included in the definition of death (Mantra, IB; 2000). So after seeing some of the definitions above, a state of death can only occur when a person has been preceded by a state of life, or in other words, that is, death never exists if there is no life.

Events of death or mortality can be divided into two, namely those that occur in the uterus (intra-uterine) and outside the uterus (extra uterine). When the fetus is still in the mother's womb, there are several events of fetal death such as abortion, namely fetal death before and up to 16 weeks, immature, namely fetal death between the gestational age of over 16 weeks to the gestational age of 28 weeks, and premature, namely the death of the fetus inside. Uterus at over 28 weeks of age until birth. Furthermore, extra uterine death is divided into stillbirth, namely the death of a baby that is quite due when it comes out of the womb, and there are no signs of life, newborn death (neonatal death), namely the death of a baby before the age of one month. But less than a year,

There are several factors that influence death divided into two, namely direct factors or factors from within and indirect factors or factors from outside. First, the direct factor can be influenced by several variables such as age, and a human being has the capacity or limit to live in this world. The older a person is, the more limited his ability will be and ends in death disease; WHO in 2014 showed that cardiovascular disease (diseases related to the heart and blood vessels) is the highest cause of death in Southeast Asia, including Indonesia amounting to 37%. Cardiovascular disease accounts for more than 80% of deaths and obstructive pulmonary disease by 90% on average in low-middle income countries (WHO, 2014). This shows that disease is the most common factor that causes death, accident, violence, and commits suicide.

Furthermore, the indirect factors are influenced by several variables such as pressure (both psychological and physical); there are many cases of bullying in Indonesia that usually occur among children and adolescents, starting with trivial things such as mocking, insulting, taking pocket money, threatening, kicking and so on, the longer it will make a person feel depressed and the worst situation the victim of bullying will be depression and then commit suicide; socioeconomic position, a person who is in the middle to lower economic condition and is unable to fulfill his / her basic needs will cause several problems that lead to death.

B. Life Expectancy

(Mils and Gilson, 1990) define health economics as the application of economic theories, concepts, and techniques to the health sector, so that health economics is closely related to matters, namely the allocation of resources among various health efforts, the number of resources used. In health services, the organization and financing of various health services, the efficiency of allocating and using various resources, and the impact of prevention, treatment, and health recovery efforts on individuals and communities.

(Mils and Gilson, 1990) also define health economics as the application of theories, concepts, and techniques of economics to the health sector, so that health economics is closely related to matters, namely the allocation of resources among various health efforts, the number of resources consumed use in health services, organizing and financing of various health services, the efficiency of allocating and using various resources and the impact of prevention, treatment and health recovery efforts on individuals and communities.
AHH, Life Expectancy Rate indicates the degree of public health and reflects the success rate of development in the health sector. The higher the AHH, the better the community's health status, and this is supported by the success in health development. On the other hand, the development of the health sector, which is not successful, has an impact on the low level of public health so that the AHH is low.

Life expectancy at age x is the average number of years of life that a person who has succeeded in reaching age x, in a certain year, will still live under the prevailing mortality situation in the community. Life expectancy is a tool for evaluating the government's performance in improving the welfare of the population in general and increasing the degree of health in particular. Low life expectancy in an area must be followed by health development programs and other social programs, including environmental health, adequate nutrition, and calories, including poverty eradication programs.

Life expectancy (AHH) is used as an indicator in measuring the health of an individual in an area. AHH is the approximate average number of years that a person can live during. AHH is defined as the age that a person who is born may reach at a certain time. AHH is calculated using the indirect estimation approach. There are two types of data used in the calculation of AHH, namely, children born alive (ALH) and children still alive (AMH). Meanwhile, to calculate the life expectancy index used the maximum value of life expectancy according to UNDP, where the highest number as the upper limit for the index calculation is used 85 years and the lowest 25 years (UNDP standard). Life expectancy can be long if the health status, nutrition, and environment are good.

III. RESEARCH METHODOLOGY

This research uses quantitative research methods, where the data obtained is realized in the form of numbers, and the analysis uses statistics. Quantitative methods are systematic scientific research on parts and phenomena and their relationships. The type of data used in this study is secondary data in the form of AHH data from the BPS and data on life birth expectations from the world bank. AHH, data used is from 1996-2020 to predict AHH Indonesia 2021-2026.

Forecasting is a statistical method that plays an important role in decision-making. Forecasting server to predict what will happen in the future based on past data. One of the methods used in forecasting is the time series method. Prediction of the future based on past information from a variable or past errors is called a periodic series or time series Makridakis (2002). The forecasting method commonly used is the Auto-Regressive Integrated Moving Average (ARIMA) or Box Jenkins.

A. Auto Regressive (AR) Process

AR (ρ)

$(1\phi_1 B - \phi_2 B^2 - -- - \phi_p B^p)\, Y_t = \delta + \varepsilon_t$

Where:

δ = Constant Value
ϕ_p = Autoreggresive Parameters
ε_t = Error value at the time *t*

*B. Moving Average (*MA) Process

MA (q)

$Y_t = \mu + (1- \theta_1 B - \theta_2 B^2 - -- - \theta_q B^q)\, \varepsilon_t$

$Y_t = \mu + \theta q\, (B)\varepsilon_t$

Where :

μ = Constant Value
θq = *Moving average* Parameters
ε_t = Error value at the time *t*

C. Proses ARIMA

Based on AR (1) and MA (1), the following general forms will be obtained:

ARMA (1,1)

$Y_t = \mu + \phi_1 Y_{t-1} + \varepsilon_t - \phi 1\, \varepsilon_{t-1}$

$(1- \phi_1 B)\, Y_t = \mu + (1- \phi_1 B)\, \varepsilon_t$

If non-stationarity is added to the ARMA process mixture, then the general ARIMA model (*p,d,q*) is fulfilled. Simple equations for AR (1) MA (1) and differencing (1- *B*) or ARIMA (1,1,1) is as follows:

$(1- B)(1-\phi B)Y_t = \mu + (1- \theta_1 B)\, \varepsilon_t$

D. ARIMA Model Identification

a) Autocorrelation function (ACF) Autoregressive Process (AR)

To determine the Autoregressive (*p)* autocorellation equation, the first thing to do nis to multiply AR (1) by Y_{t-k} on both sides of the equation, and to simplify the problem δ is considered zero and then the expected value is searched as follows:

$E[Y_{t-k}Y_t] = E[\phi Y_{t-k}Y_{t-1}] + E[\phi Y_{t-k}Y_{t-2}] + \ldots\ldots + E[\phi_p Y_{t-k}Y_{t-p}] + E[Y_{t-k}\, \varepsilon_t]$

$Yk = \phi_1 Y_{k-1} + \phi_2 Y_{k-2} + \ldots.. + \phi_p\, Y_{k-p}, k>0$

where $E[Y_{t-k}Y_t] = 0$ to $k > 0$ then devide the above equation by y_0 to get:

$$\frac{Yk}{Yo} = \frac{\phi 1 \mathrm{Yk} - 1 \; + \; \phi 2 \mathrm{Yk} - 2 \; + \; \ldots\ldots + \phi p\, \mathrm{Yk} - \mathrm{p},}{Yo}$$

$p_k = \phi_1 P_{k-1} + \phi 2 P k_{-2} + \ldots.. + \phi_p\, P_{k-p}, k>0$

the above equation is the autocorrelation equation for auto regressive *(p)*

b) Auto Correlation Function (ACF) Moving Average (MA) Process

To find *Auto Correlation equations, Moving Average* equation (*q*) multiplied by Y_{t-k}, then look for the expected value as follows:

$E\,[Y_{t-k}\,Y_t] = E\,[\,(\varepsilon_1 - \theta_1\,\varepsilon_t - \ldots.. - \theta_q\,\varepsilon_{t-q})\,(\varepsilon_{t-k} - \theta_1\,\varepsilon_{t-1-k} - \ldots.. - \theta_q\,\varepsilon_{t-q-k})]$

So, in general for $k = k$ the following equation is obtained:

$Yk = (-\theta_k + \theta_1\,\theta_{k+1} + \ldots.. + \theta_{q-k}\,\theta_q)\,\sigma_\varepsilon^2$

So, MA (q)

$p_k = \frac{Yk}{Yo} = \frac{(-\theta k + \theta 1 k + 1 + \cdots + \theta q - k \theta q)\sigma 2\varepsilon}{1 - \theta 1 + \cdots + \theta q)\sigma\varepsilon 2}$, $k = 1, \ldots..,q$

***c) Partial Auto Correlation Function* (PACF) *Auto-Regressive* (AR) Process**

Apart from the autocorrelation function, the partial autocorrelation function is used together to identify the ARIMA model from time-series data. Partial autocorrelation measures the level of closeness between Y_t dan Y_{t-k}, assuming the effect of time *lag* 1,2,3,….. and so on until k-1 is considered separate. The equation below shows that the last coefficient of each equation is the partial autocorrelation coefficient.

***d) Partial Auto Correlation Function* (PACF) *Moving Average* (MA) Process**

PACF is a combination of the overall exponential function, and the sine function decays depending on the roots of:

$C\,(z) = 1 + b_1Z + b_2Z + \ldots.. + b_qz_q$

IV. RESULTS

A. Stationary Test

In the first stage, the identification of the model is carried out, and the data will be tested using a stationary unit root test.

Table 2. Stationary Level Test Results

		Critical Value			
Variable	ADF T-statistik	1%	5%	10%	Inference
AHH	-1.593591	-3.752955	-2.998066	-2.638755	No Stationer

Source: Data Processed

In the stationary test, the data level shows that it is not stationary because the critical value at α=5% is -2998064, which means it is greater than the *t*-statistical value of -1.593591. This means that differencing is necessary so that the data becomes stationary. After differencing, the unit root test is performed again to see the stationarity.

Table 3. First Difference Level Stationary Test Results

		Critical Value			
Variable	ADF T-statistik	1%	5%	10%	Inference
AHH	-10.0714	-3.75295	-2.99806	-2.63875	Stationer

Source: Data Processed

The unit-root test results showed that the critical value at α=5% was -2998064, which means it is smaller than the *t*-statistical value of 10.0714. This means that the data is stationary. After the data is stationary, the next step to do is to identify ACF and PACF to identify ACF and PACF can be done looking at the following correlogram.

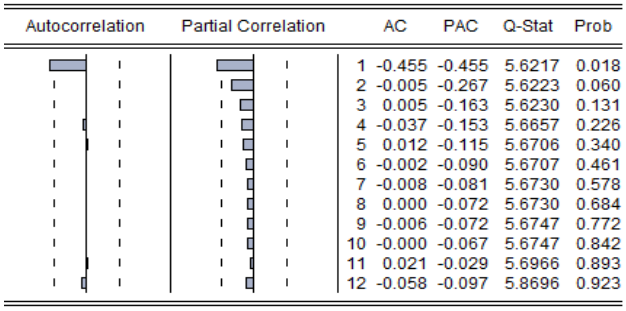

Fig. 1 Correlogram Result

From figure 1, the data in the PACF (Parcial Correlation) column is used to determine the maximal order AR (p). from the PACF (Partial Correlation), it turns out that the first time lag period exits the boundary line (begins to decrease in value to near zero after the first lag). Meanwhile, the ACF (Auto Correlation) column is used to determine MA (q). from the ACF (Auto Correlation) in the first time lag period, and it also comes out of the boundary line (begins to decrease in value to near zero after the first lag). This means that the possible choice of ARIMA is ARIMA (1,1,1).

The third stage is the selection of the best ARIMA model. Therefore, the possible ARIMA selected from the Life Expectancy Rate (AHH) data is ARIMA (1.1.1).

Table 4. ARIMA Estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.282970	0.135641	2.086176	0.0500
AR(1)	-0.811814	0.513764	-1.580132	0.1298
MA(1)	-0.363076	0.543722	-0.667759	0.5119
SIGMASQ	0.283472	0.094841	2.988918	0.0073

Source: Data Processed

After the model is selected, the next step is to forecast the Indonesian Life Expectancy (AHH).

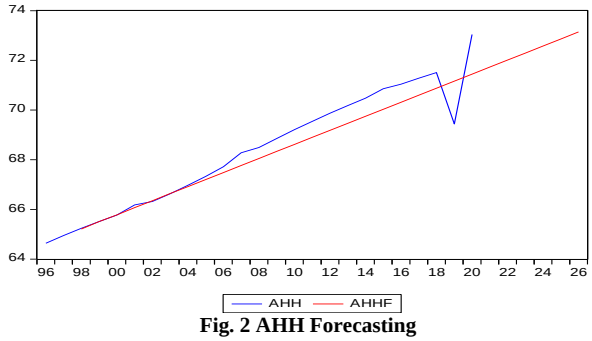

Fig. 2 AHH Forecasting

Figure 2 shows a graph of the comparison between actual life expectancy and forecast life expectancy. As for the results of forecasting the ARIMA model (1.1.1), it shows that AHH movement data for the next 5 years, each increasing by 0.3 years per year so that in 2026 life expectancy in Indonesia will increase to 73.1 years.

V. DISCUSSION

Life expectancy is predicted in 2021 to increase to 71.7 years, and until 2026 it will increase to 73.1 years. This is good in the future when the state or condition of Indonesia is free from covid, but the focus in this forecast is the growth of life expectancy, from 2021-2026, an average of 0.21 percent until 0.29 percent. Cases like this way are due to the outbreak of the covid-19 virus in Indonesia; as of January 27, 2021, cases of covid-19 in Indonesia have increased to 1 million people who have contracted the virus, and it's growing every day. Not only have cases of positive covid-19 patients increased, but the death rate in Indonesia that was caused by covid has increased to 29,728 people. BPS (2021)

VI. CONCLUSION

Based on the results of research on forecasting using the Auto-Regressive Integrated Moving Average (ARIMA) for Indonesian Life Expectancy (AHH) data of 71.7 years or an increase of 0.3 percent. Based on the data graph, it can be seen that the forecasting result uses the ARIMA method or follow the ARIMA method or follow the actual data movement of the AHH rate. However, in 2026 the AHH growth rate will only increase by 0.3 percent, much lower than the AHH growth rate in the last 5 years, which has increased to 0.26 percent per year.

SUGGESTION

For the government regarding the covid case that attacks the state of Indonesia, it is necessary to pay more attention to what policies should be done to reduce the death rate due to covid-19. And for the public to be pro towards what policies the government has taken to improve the situation as before or at least minimize the spread and death rate due to the Covid-19 virus.

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