Analysis of Optimal Portfolio Allocation Using Sharpe Ratio Before and During Covid-19 Pandemic: A Case Study of PT Jasa Raharja

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ABSTRACT

The COVID-19 pandemic faced by the world has greatly affected human life. There are new habits that humans must adapt in order to coexist with this virus. The spread of COVID-19 throughout the country also has an impact on the community's economic sector due to social restrictions imposed by the government. Many companies have been affected by the spread of the COVID-19 virus. During the pandemic, from March 2020 to August 2021, the company's investment returns decreased, which was also caused by market movements. Investment returns that have decreased and unstable during the COVID-19 pandemic are an issue that must be resolved by companies because investment returns will also be used to finance general costs for the following year whose graph continues to increase, while the graph of investment returns continues to decline. It will widen the gap between expenditure and income. In this study, we will determine the optimal allocation of each selected financial asset instrument during the COVID-19 pandemic in order to obtain maximum investment returns. The instruments used in this study are stocks, bonds, mutual funds and time deposits. This study uses Markowitz theory to determine the optimal portfolio allocation and Sharpe ratio for the main method.

Keywords: Modern Portfolio Theory, Sharpe Ratio, Optimal Allocation, COVID-19 Pandemic

1. INTRODUCTION

PT Jasa Raharja is a state-owned enterprise engaged in social insurance. Jasa Raharja is a business entity that has been assigned by the Government to administer an accident insurance program for general passengers and road traffic based on Law No.33/1964 concerning the Mandatory Passenger Accident Coverage Fund and Law No.34/1964 on the Road Traffic Accident Fund. In December 2019, the whole world was shocked by the presence of the corona virus which first appeared in the city of Wuhan, China. This virus spreads very quickly between humans and causes concern for all countries because China is one of the countries visited by many foreigners. This virus attacks the respiratory system and the disease caused by this virus is called COVID-19. "Virus Corona." *Alodokter*, www.alodokter.com/virus-corona. accessed on September 17, 2021, symptoms of this virus are fever above 38 degrees Celsius, dry cough, shortness of breath and over time there are several other symptoms of this virus, namely diarrhea, headaches, loss of sense of taste and smell, even rashes on the skin, this disease can also cause death.

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The spread of this virus can occur through droplets that come out when a person with COVID-19 sneezes and coughs, holds the mouth and nose without washing hands after touching a surface that contains droplets from a person with COVID-19, and close contact with a person with COVID-19. This virus is stronger than severe acute respiratory syndrome (SARS) in 2003 according to Indrastuti (2021).

The very fast transmission of the COVID-19 virus caused this virus to be detected in Indonesia in just a few months. In March 2020 the government officially announced that the first two Indonesian citizens had contracted COVID-19. Furthermore, the government took mitigation steps to break the chain of virus spread by locking in several areas, so that economic activity was greatly affected by this decision. The impact of the spread of this virus is also experienced by the financial market which is one of the sources of company funding. The drastic decline in economic activity has caused companies in Indonesia to experience a decrease in income, a decrease in the amount of production while the operational costs that must be incurred remain the same, so that many companies have to cut off their employment relationship with their employees, and the demand for goods and services has decreased significantly.

The impact of the spread of COVID-19 also affected Jasa Raharja's premium income from the Law no. 33/1964 as well as Law no. 34/1964, this was due to the limitation of public activities in public places to break the chain of spread of COVID-19. The limitation of community activities has resulted in a decrease in the number of people's trips using public transportation such as tourism buses, so that the mandatory contribution from public transport passengers has also decreased. Meanwhile, from the sector of Law no. 34/1964 where the collection of premiums for private motor vehicle owners through SAMSAT (Satuan Manunggal Satu Atap) also decreased because people were reluctant and afraid to come to public places crowded with visitors, so many people preferred to delay paying premiums. In addition, during activity restrictions it also affects people's income, so that people will prioritize meeting their basic needs first and delaying the obligation to pay premiums to Jasa Raharja.

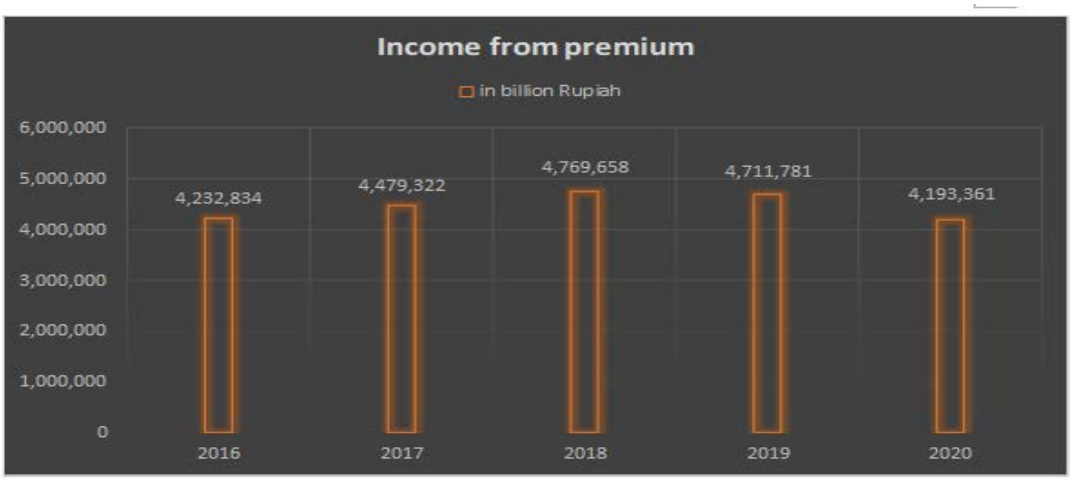

Figure 1. Income of Jasa Raharja from Premium 2016 – 2020

(Source: Jasa Raharja's Annual Report)

The decrease in premium income also resulted in a decrease in the amount of funds that could be allocated by Jasa Raharja for its investment portfolio. The allocation of funds for investment in Jasa Raharja is obtained from premium income paid by the community

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which is then reduced by Jasa Raharja's obligation to provide compensation to victims of traffic accidents, and is also reduced by other operational costs. Furthermore, the remaining premium is allocated for investment in financial asset instruments selected by Jasa Raharja. The financial asset instruments selected by Jasa Raharja to obtain investment returns are deposits, bonds, stocks, and mutual funds. A decrease in the amount of funds that can be allocated to financial instruments will affect the investment returns to be obtained.

Investment returns that have decreased and are unstable during the COVID-19 pandemic are an issue that must be resolved by companies because investment returns will also be used to finance general costs for the following year whose graph continues to increase, while the graph of investment returns continues to decline, if it left behind, it will further widen the gap between expenditure and income. Jasa Raharja must be able to determine the optimal allocation of each selected financial asset instrument during the COVID-19 pandemic in order to obtain maximum investment returns by always adhering to the rules set by the government which not defined before. Placement of investment funds must also implement good risk management to avoid investment failure. Jasa Raharja experienced decreased investment development result due to the decline in premiums and returns, but this study will focus on the decline in company returns.

The financial instruments selected by Jasa Raharja for investment are deposits, stocks, bonds, and mutual funds. Jasa Raharja must be able to determine the optimal allocation of its investment portfolio to obtain optimal investment returns. In this way, companies can also determine the optimal allocation of their investment portfolio before and during the COVID-19 pandemic. Optimal allocation can also be one of the efforts to mitigate the risk of investment failure at Jasa Raharja. Jasa Raharja has experienced a decline in the value of returns that consist of time deposit, bond, mutual fund, stock, direct investment, and ETF over the last few years, return in 2018 is 13.32%, return in 2019 is 12.29%, and return in 2020 is 11.65%. The return on the portfolio from financial assets consisting of stocks, bonds, mutual funds, and time deposits also decreased where the return in 2018 was 6.91%, in 2019, it was 6.69%, and in 2020 it was 6.11%. Therefore, to increase the portfolio return, portfolio changes are made using financial assets consisting of stocks, bonds, mutual funds, and time deposits.

Investment returns that have decreased and are unstable during the COVID-19 pandemic are an issue that companies must resolve because investment returns will also be used to finance general costs for the following year, whose graph continues to increase. In contrast, the graph of investment returns continues to decline. If left behind, it would further widen the gap between expenditure and income. Jasa Raharja must determine the optimal allocation of each selected financial asset instrument during the COVID-19 pandemic to obtain optimal investment returns by constantly adhering to the rules set by the Government. Currently, Jasa Raharja has not used a certain methodology to determine the allocation of funds carried out. The placement of investment funds must also implement good risk management to avoid investment failure. Investment failure experienced by PT. Jiwasraya can be a lesson for other insurance companies to apply the principle of prudence in allocating funds to financial instruments.

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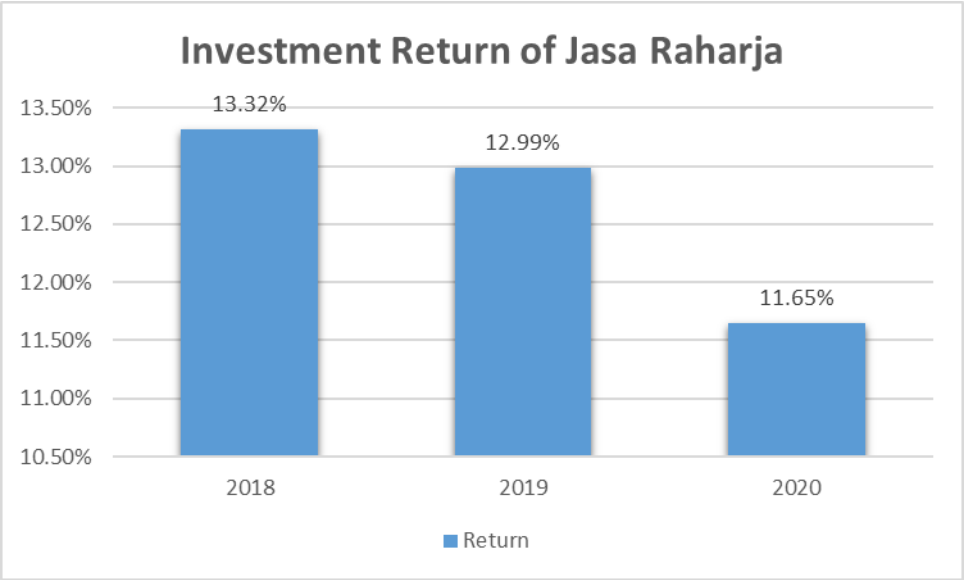

Figure 2. Investment Return of Jasa Raharja 2018 – 2020
(Source: Jasa Raharja's Position and Return Data of Investment)

2. THEORETICAL FOUNDATION

2.1 Markowitz Theory

Markowitz theory, also known as the Modern Portfolio Theory, is a theory used by analysts in the investment sector to determine the most appropriate amount of allocation in an investment portfolio that takes into account the expected rate of return and the level of risk to the owners of capital. This theory is a framework in determining investment portfolios based on the maximum level of expected return and low investment risk (Fabozzi, Gupta, Markowitz, 2002). This theory is also known as mean-variance analysis where the mean reflects the level of expected return and the variance reflects the risk (Mangram Myles E., 2013). In calculating the amount of fund allocation in the portfolio, the required statistical data are as follows:

a. The value of the expected rate of return or E (r) for each financial instrument contained in the portfolio such as stocks and bonds
b. The value of the standard deviation of each selected financial instrument
c. The value of the correlation coefficient between one financial instrument and another that has been selected (Kim and Francis, 2013)

In developing his theory, there are several assumptions put forward by Markowitz as follows:

a. Investors try to get maximum return and low risk or also known as rational thinking
b. Investors will only invest in high-risk assets if they can provide high returns
c. In terms of deciding to invest, investors always get timely information
d. Investors can borrow unlimited capital at a risk-free rate
e. Markets are very efficient

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f. Markets does not include transaction costs or taxes
g. It is possible to select securities whose performance depends on the investment portfolio

2.2 Risk and Return

According to Markowitz's theory, an important aspect related to the risk of assets is how big the contribution of each asset to the aggregate portfolio, not the risk of each asset. The total risk in the portfolio is divided into two components, namely systematic and unsystematic risk. Systematic risk is the risk that affects assets in large numbers and at the macro level (Ross, Westerfield, & Jaffe, 2002). Risk in investment is the possibility of an actual return that is not in accordance with the expected return which can technically be measured by standard deviation. The higher the standard deviation, the higher the risk of the investment.

In Markowitz's theory of portfolio selection, risk is reflected by volatility. "milenomic/jangan salah paham yuk kenali volatility saham di lantai bursa". *IDX Channel*. www.idxchannel.com. accessed on October 8, 2021, Volatility is a change in asset prices that occurs too quickly, both in rising and falling asset prices, causing a large gap in a certain time. This volatility can be measured in several ways, that are calculating the expected return, the variance of the expected return, the standard deviation of the expected return, the covariance of the investment portfolio, and the correlation between assets in the investment portfolio by Wecker, nd; Ross, Westerfield, Jaffe (in Myles, 2013: 62). Stock and bond returns can be calculated using the following formula:

$$r_1 = \frac{P_1 - P_0}{P_0}$$

Where:

$P_0 = price\ of\ stock\ at\ the\ beginning\ of\ holding\ period$

$r_1 = one\ period\ rate\ of\ return$

$P_1 = price\ at\ the\ end\ of\ holding\ period$

2.3 Expected Return

Expected return is a return in the future that can be predicted through historical data returns. The calculation of expected return is the first step in Markowitz's theory. According to Markowitz, an efficient portfolio is an efficient asset and consists of one or many assets. The collection of efficient portfolios is also known as the efficient frontier. The efficient frontier (in Myles, 2013: 66) reflects the best combination of securities that provide the maximum expected return at a certain level of risk in the investment portfolio. Kim and Francis (in Myles, 2013: 66) explain that the points on the efficient frontier curve have the maximum return for each level of risk. The optimal investment portfolio is at a point along the curve by McClure (in Myles, 2013: 66). On the curve below, the point between the letters E and F is the efficient frontier.

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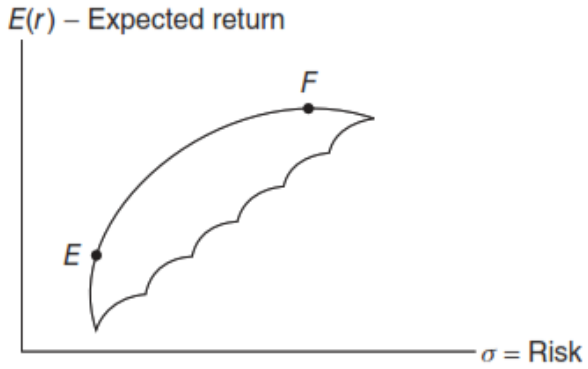

Figure 3. Efficient Frontier

Investors will choose at which point they will invest to get optimal investment returns according to the level of risk that is acceptable to investors. Thus, the optimal investment point for each investor will be different, at point E the investor is someone who is risk averse, while investment at point F indicates the investor is a person who likes risk. Investment risk can be minimized by diversifying investments, by calculating the means of Markowitz, we can reduce risk without reducing the return that will be obtained by paying attention to the correlation between investment assets. So, an efficient portfolio is a portfolio that has a higher return than other portfolios at the same risk level or has a lower risk than other securities with the same return. The expected return value can be calculated using the following formula:

$$E(X) = \sum_{S=1}^{S} p_s x_s$$

$$= p_1 x_1 + p_2 x_2 + \cdots + p_s x_s$$

Where:

X = *random variable*

x_s = *actual outcome of X*

S = *number of states*

p_s = *probability states s will occur*

2.4 Portfolio Return Variance

The risk in the asset is the distribution of the results around the expected value. Volatility or risk calculations that are widely used are variance and standard deviation. Bradford, Miller, Ross and Westerfield (in Myles, 2013: 63) explain that variance is calculated from the squared deviations of stock returns from expected returns or it can be concluded that it is the average squared of the difference between actual returns and average returns. The greater the number of assets in the portfolio, the lower the variance of the portfolio because it will increase the Efficient Frontier (Franz & Payne, 2009). Markowitz's theory also emphasizes asset diversification that can maximize returns and minimize risks that may occur. Another method that can be used to measure volatility or the level of risk is the Standard Deviation. The standard deviation of return is the square root of the

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variance (Bradford, J. & Miller, T., 2009; Ross, Westerfield & Jaffee, 2002). The calculation of variance can be done with the following formula:

$$\sigma_i^2 = E[r_i - E(r_i]^2 = \sum_{s=1}^{S} p_s[r_s - E(r_i]^2$$

2.5 Covariance of Return

Covariance return measures the relationship between two random variables or in this case is the relationship between one stock return and another. In a portfolio there are several securities, the relationship between one securities and another is also known as covariance. If the returns are positively related to each other, then the covariance will be positive and vice versa, but if the returns are not related then the covariance value is zero (Ross, Westerfield & Jaffee, 2002). Markowitz argues that it is better not to invest in securities with high covariance (Markowitz, 1952), this is done in order to reduce investment risk. If securities have a high relationship, then when one securities suffer losses, losses will also be experienced by other securities, thereby increasing the impact of risk. The covariance between two securities can be calculated using the following formula:

$$\sigma_{ij} = E\{[r_i - E(r_i)][r_j - E(r_j)]\}$$
$$= \sum_{s=1}^{S} p_s\{[r_{is} - E(r_i)][r_{js} - E(r_j)]\}$$

2.6 Correlation Coefficient of Returns

Furthermore, after calculating the risk with variance and standard deviation and covariance return, the correlation coefficient will calculate the level of relationship between the two variables. The correlation coefficient is calculated by dividing the covariance by the standard deviation of the securities pair. If the correlation is positive, then the existing variables are positively correlated and vice versa, and the variable has no correlation if the correlation value is zero (Ross, Westerfield & Jaffe, 2002). The smaller the correlation value between securities, the better the risk reduction in the portfolio (High, 2010). In diversifying assets in the portfolio, we must pay attention to the positive correlation of returns. Therefore, investment analysts must know the correlation coefficient between all securities in the portfolio. Investors must also be careful in certain cases, the selection of risk factors must be done properly because the correlation between assets and risk factors is not clearly visible (Amu & Millegard, 2009). Correlation of two variables can be calculated by the following formula:

$$\rho_{XY} = \frac{\sigma_{XY}}{\sigma_X\, \sigma_Y}$$

2.7 Sharpe Ratio

Sharpe ratio is one of the measurements used to obtain the maximum amount of allocation and the investment portfolio to get the maximum return that maximizes the value of return and minimizes risk. Sharpe ratio is a ratio that compares the value of the risk premium portfolio (excess return) and the standard deviation. Sharpe ratio can be calculated using the following formula.

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$$Sharpe\ ratio = \frac{Portfolio\ Risk\ Premium}{Standard\ Deviation\ of\ Portfolio\ Excess\ Return}$$

$$S = \frac{E(r_p) - r_f}{\sigma_p}$$

Where,

$E(r_p)$ = *expected return*

r_f = *risk free rate* = *return from investment in non-risky assets*

σ_p = *standard deviation* = *risk*

The higher the Sharpe ratio value, the better because it reflects that the reward is better per standard deviation and in other words the portfolio will be more efficient. Calculation by comparing return and risk is also known as mean-variance analysis. Sharpe with the maximum value is in the mean-variance efficient frontier (Kourtis, 2016).

2.8 The COVID-19 Pandemic

Novel coronavirus (COVID-19) which was first detected in the seafood market in China (Wuhan) spread quickly throughout the world, thus becoming a pandemic. Huanan seafood market is a market known for selling live animals and meat from a variety of unusual animals such as rabbits, hedgehogs, bats, snakes, and badgers. The COVID-19 virus is known to originate from animals sold in the market, so direct contact with animals infected with the virus and contact with their products is suspected to be the cause of the spread of the virus to humans. The spread of the virus from human to human is very fast caused by aerosol droplets and attacks human health, the mortality rate caused by this virus is 2.5 - 35%.

A person exposed to the COVID-19 virus will experience difficulty breathing, fever, cough, loss of the sense of smell, diarrhea, and nausea. Symptoms in patients will be more severe if they have congenital diseases such as heart disease, asthma, obesity, hypertension, and in old age (Weiner et al., 2021: 2). However, there are also patients who do not experience any symptoms at all, thereby increasing public concern about the spread of this virus. Boosting the body's immune system is a way to prevent someone from getting infected with the COVID-19 virus.

The COVID-19 virus which was detected in all countries resulted in the government having to intervene to minimize the spread of this virus. One of the ways used by various countries to prevent the spread of COVID-19 is by carrying out social restrictions, prohibition on going home, stay at home, work from home, school from home, and closing public places that have the potential to cause crowds. Currently, the efforts made by the government are maximizing the provision of vaccines to all Indonesian people. Vaccination is an easy, safe, and effective method to protect a person against the COVID-19 virus (Tavilani, 2021). The COVID-19 vaccine can help the body recognize the COVID-19 virus and form antibodies against the virus, so that when a person is exposed to the virus, the body has recognized the virus and immediately forms antibodies. However, the challenge for the government in using vaccines is that the resistance of the vaccine in a person's body is only 6 months, so vaccinations must be carried out periodically. There is no research that can know how long the COVID-19 virus will

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continue to grow, so humans are forced to be able to coexist with this virus so that human life can continue as usual.

2.9 Investment Rules in Jasa Raharja

As a state-owned company, the investments made by Jasa Raharja adhere to regulations that pay attention to the safety of investing for the company. The company's investment is based on several principles, namely prudent (taking into account the level of risk), yield (providing optimal returns), and liquid (easiness in disbursing funds and investment returns, except for investments in direct investment, buildings with strata rights or land with buildings for investment). Investments made by Jasa Raharja must pay attention to investment risks and with the principle of prudence. To maintain Jasa Raharja's solvency level, the allocation of investment assets is regulated with the following composition:

Table 1 Rules of Investment at Jasa Raharja

No.	Type of Investments	Minimum	Maximum
1	Time deposits in Banks	IDR500 billion	50%
2	Stocks listed on the stock exchange	0%	40%
3	Corporate bonds listed on the stock exchange	0%	50%
4	Securities issued by the Republic of Indonesia	20%	80%
5	Securities issued by Bank Indonesia	0%	80%
6	Mutual funds	0%	50%
7	Mutual Funds Exchange Trade Fund Types	0%	50%
8	Direct participation in a limited liability company whose shares are not listed on the Stock Exchange	0%	10%

(Source: Jasa Raharja's Guidelines for Non-Capital Expenditure Investment KEP/139/2019)

3. PREVIOUS RESEARCH

Several previous studies have been conducted to determine the optimal portfolio allocation value using several different portfolio evaluation methods. In Myles E. Mangram's (2013) research entitled A Simplified Perspective of The Markowitz Portfolio Theory, the researcher explains the stages in the application of Modern Portfolio Theory. The result of the research is that the use of this theory can be done in an easier way by using modern computing technology such as Microsoft Excel so that calculations can be carried out efficiently. By calculating the optimal allocation by considering return and risk, investors can diversify their investments so they can beat the market. Markowitz introduced the optimal allocation method by maximizing return or minimizing risk, but there is also a portfolio evaluation method using the Sharpe ratio.

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Wang, Chen, Lian, and Chen in their research in 2020 also suggested a new approach in selecting assets in a portfolio that can increase the Sharpe ratio value, namely by forming an index based on high frequency data with a high frequency Sharpe ratio value and estimate volatility using high frequency data which can minimize overestimation or underestimation. Debasish Biswas (2015) in his research using Modern Portfolio Theory found that by diversifying in investment, it will help investors to minimize risk and increase return compared to investing in only one asset and investing in different industries.

Felix Kircher and Daniel Rosch (2021) in their research explain the optimal shrinkage parameters as an effective way to perform a risk aversion coefficient that can increase the Sharpe ratio value. In determining the optimal amount of allocation, it is very possible for errors to occur. Apostolos Kourtis (2016) in his research found that the expected value of the Sharpe ratio will increase along with the increase in the number of assets and will decrease according to the range of data held.

The COVID-19 virus that spreads throughout the world is a challenge for all companies to stay survive in the face of uncertainty. The pandemic that has occurred has also affected the capital market and caused increased volatility in the capital market. Baris Kocaarslan and Ugur Soytas (2021) stated that stock portfolio volatility is affected by uncertainty in extreme periods such as the occurrence of COVID-19. The decline in funding liquidity during the pandemic has a very significant impact on the volatility of high-risk portfolios compared to low-risk portfolios. In Jie, Hou, Cangyu, and Haiyue (2021) research on the capital market in China, it was found that the COVID-19 pandemic significantly reduced investment value and affected government-owned companies in China and caused a decrease in company income and profits. In a study conducted by Willem Thorbecke (2020) it was also stated that from the results of the study it was known that the US economy in its recovery would be highly dependent on the management of the pandemic and independent of macroeconomics. The economic recovery will restore the investment business. Jin Ray Lu and Xiu Yan Li (2021) found that companies with higher value equity will have low Sharpe ratio values.

4. METHODOLOGY OF THE RESEARCH

The next stage of the issues that have been described in the previous chapter is to determine the methodology that will be used in the research. Methodology describes what stages will be carried out starting from the beginning of the research implementation until the results are obtained. These stages are illustrated in the following chart:

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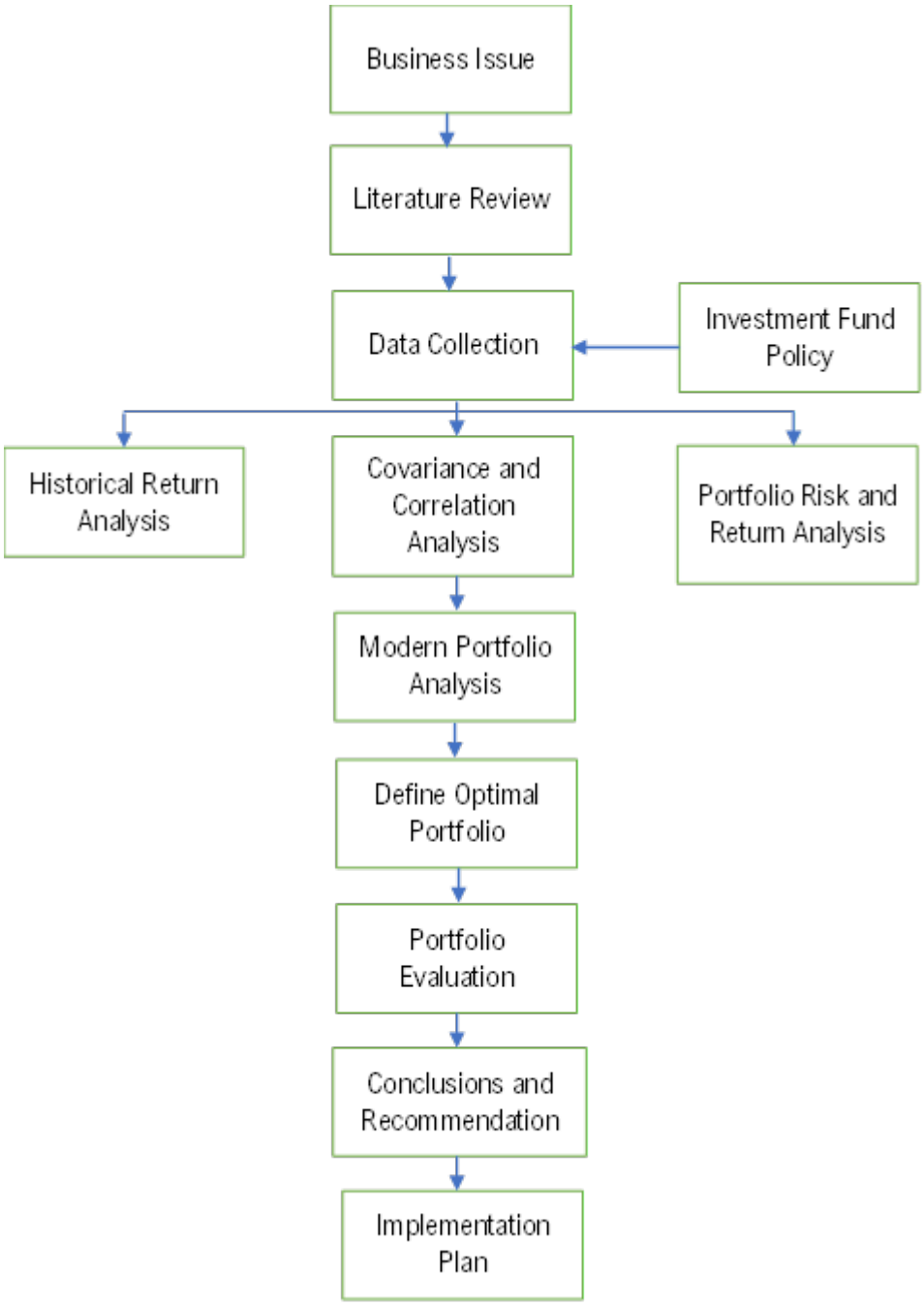

Figure 4. Research Methodology

5. RESULT AND ANALYSIS

5.1 Expected Return of Investment Instruments

In data processing to obtain the optimal portfolio allocation value, historical data returns are needed to obtain the expected return value of each asset, that are stocks, mutual funds, bonds, and deposits. Historical stock prices during the period before the pandemic (October 2018 – February 2020) and after the pandemic (April 2020 – August 2021) can be used to obtain asset returns every month. The average return will be the expected return of each asset, namely stocks, mutual funds, bonds, and time deposits. The expected return will be a component of the return calculation after the allocation of each asset is obtained and then become the basis for calculating the portfolio return. The

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expected return value is used in calculating returns from investments that have been made and the calculation of returns in research conducted using the Sharpe ratio. Based on the calculation results, the expected return is 0.416% for stocks, -0.002% for mutual funds, 0.777% for government bonds, 0.481 for corporate bonds, and 0.583% for time deposits.

5.2 Variance – Covariance Assets

Furthermore, the calculation of the variance - covariance of assets that describes the relationship of the two assets. In the study, the covariance matrix was calculated from stock assets, mutual funds, government bonds, corporate bonds, and time deposits. The calculation is done by using the covariance formula in Microsoft excel.

Table 2. Covariance Matrix of Portfolio Investment

Covariance Matrix	Stock	Mutual Fund	Government Bond	Corporate Bond	Deposit
Stock	0.0016632	0.0000384	0.0000724	-0.00001832	0.00002344
Mutual Fund	0.0000384	0.0000749	-0.0000059	-0.00000056	-0.00000519
Government Bond	0.0000724	-0.0000059	0.0000149	-0.0000007	0.00000180
Corporate Bond	-0.0000183	-0.0000006	-0.0000007	0.00000151	-0.00000042
Deposit	0.0000234	-0.0000052	0.0000018	-0.00000042	0.00000137

From the table it is known that there are assets that have a positive and negative relationship. A positive relationship indicates that the two assets move in the same direction, while a negative value indicates that the two assets move in the opposite direction. The covariance of an asset can indicate the risk involved in an investment portfolio. In an investment portfolio with assets that move in the same direction, it will be riskier because when these assets experience a bad performance, they move in the same direction, the losses incurred will be greater than the diversification of investments.

5.3 Expected Return and Standard Deviation of Portfolio

After obtaining the covariance data from the assets in the portfolio, the next step is to calculate the return value of the portfolio which can be done using the solver program. However, in calculations with formulas in excel, you can use the "sumproduct" formula from the expected return and weight data for each asset. The value of the portfolio expected return will automatically appear when data processing is carried out using a solver by considering the weight of each asset which is also the result of data processing by the solver. The return portfolio value will be used in portfolio evaluation using the Sharpe Ratio.

The standard deviation of the portfolio shows the risk value of the investment made. The standard deviation is one of the components in the calculation of the portfolio Sharpe ratio. The higher the standard deviation value, the lower the Sharpe ratio value will be obtained. The standard deviation can be calculated using the formula in excel, namely "mmult" which is calculated by considering the covariance value of each asset in the

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portfolio and also the weight of the asset. In addition to using formulas in Microsoft Excel, the risk portfolio value will also appear automatically when the weight calculation is carried out using a solver.

5.4 Sharpe Ratio

Markowitz Portfolio Theory suggests the optimal allocation of the portfolio to obtain optimal returns by considering risk and return or also known as mean-variance analysis. With mean-variance analysis, in calculations using the solver we have to determine whether to maximize returns or minimize risk. Another method that can be used in calculating the optimal allocation of a portfolio is to use a Sharpe ratio that has accommodated the value of risk and return. Sharpe ratio has considered maximizing return and minimizing risk. Sharpe ratio compares the value of excess return and standard deviation, so the higher the Sharpe ratio, the better. The excess return is obtained from the difference between the portfolio return and the risk-free rate. The risk-free rate used in the calculation is the Bank Indonesia 7-days monthly repo rate.

The Sharpe ratio value obtained in the calculation is negative in the period before and after the pandemic. This shows that the value of the risk-free rate is greater than the value of the expected return of the portfolio and the negative value does not explain any significant meaning. The Sharpe ratio value before the pandemic also has a greater value compared to the period after the pandemic because the investment risk during the pandemic is higher. In the calculation on the solver, the Sharpe ratio value must be set to get the maximum value.

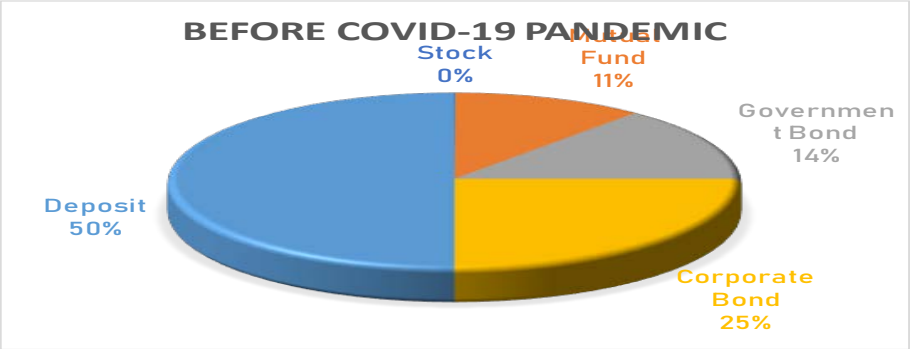

Figure 5. Allocation Optimal of Portfolio Before COVID-19 Pandemic

5.5 Optimal Portfolio

Several stages of previous calculations such as the calculation of expected return, covariance, portfolio risk (standard deviation), risk-free rate and Sharpe ratio were carried out to obtain the optimal allocation value using the solver program in Microsoft Excel. The calculation of the optimal allocation is usually done by maximizing return or by minimizing risk, the Sharpe ratio method can accommodate both of these. Calculations are carried out for the period before and after the COVID-19 pandemic to determine the allocation of investment in several asset instruments to be able to obtain maximum returns during the pandemic. The heightened uncertainty during the pandemic increases asset volatility and becomes even more risky. Therefore, it is necessary to calculate the optimal allocation to maximize return. The period before the pandemic is October 2018 to February 2020 (16 months) and the period after the pandemic is April 2020 to August 2021 (16 months). The results of the calculation of the optimal allocation

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using the Sharpe ratio which has considered both the return and risk components are as follows.

From the optimal allocation results generated in data processing using the solver program, the optimal allocation before the pandemic was 50% allocated to deposits, 11% to mutual funds, 25% to corporate bonds, 0% to stocks, and 14% to government bonds. This optimal allocation has been used constraint which considering the rules of investment at Jasa Raharja. Portfolio evaluation using the Sharpe ratio has accommodated the return maximization and portfolio risk minimization. The initial data processing with the solver was carried out without considering the investment limit rules in Jasa Raharja, so that an allocation of 79.86% was obtained for deposits, 19.78% for corporate bonds, 0.35% for government bonds, and 0% for stocks and mutual funds. In the calculation with Sharpe ratio, the return on deposits is greater than that of other assets. The portfolio return obtained by using the Sharpe ratio calculation in the period before the pandemic was 0.519% per month, with a portfolio risk of 0.000%.

Investments made by the company must be carried out by considering the element of risk and the rules that apply in the company, so that the solver calculation is carried out by entering the constraint, that is the maximum investment limit value of each financial asset. The optimal allocation limit for time deposits is 50% of the portfolio, so that 50% of the investment funds will be allocated to other assets such as stocks, mutual funds, and bonds. The amount of allocation to other assets is also carried out by taking into account the rules for the maximum investment limit on these assets, for example, the allocation limit for corporate bond assets is 50% of the total investment fund, so the constraint of this asset is 0.25%.

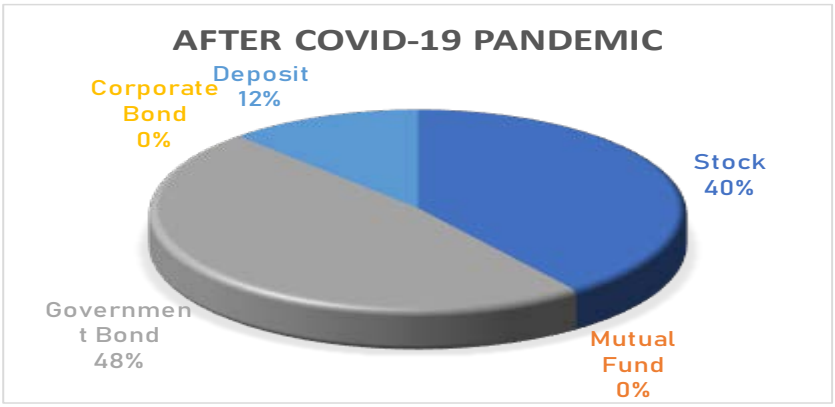

Figure 6. Allocation Optimal of Portfolio After COVID-19 Pandemic

In contrast to the solver calculation results in the period before the pandemic, the optimal allocation using the Sharpe ratio in the post-pandemic period has a different composition between stocks, mutual funds, bonds, and deposits. The optimal allocation during the pandemic is 48% for government bonds, 40% for stocks, 12% for deposits, and 0% for mutual funds and corporate bonds. Investments in government bonds are safer because there is certainty in their payments than stocks that move with uncertainty during the pandemic. From the diagram above, we can see that government bonds provide a higher return during the pandemic than other investment instruments. The portfolio return value

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obtained with the Sharpe ratio in the period during the pandemic is 0.513% per month, with a portfolio risk of 0.030%.

The optimal allocation of investment portfolios after the pandemic occurs without considering the investment limit rules for each investment instrument, which is 100% in shares, so to adjust the optimal allocation with the existing investment limit rules in the company, a recalculation is carried out using constraints in accordance with the limit rules company investment. If you invest 100% in stocks, it will be very risky for the company. Therefore, with the optimal allocation, the company can diversify and minimize the risks that may occur.

5.6 Comparison of Actual Return and Return of Sharpe Ratio

Calculation of the optimal allocation using the Sharpe ratio in this study has provided an estimate of the optimal allocation of the portfolio along with the return and risk of the portfolio. This allocation can be used for the next period so that the company gets the maximum return. The following is a comparative description of the return and risk obtained by the company from the investments that have been made now and the return and risk that can be obtained by the company using the Sharpe ratio.

Table 3. Comparison Return of Real Investment and Sharpe Ratio

	Real Investment		Sharpe Ratio	
	Before Pandemic	**After Pandemic**	**Before Pandemic**	**After Pandemic**
Allocation:				
Stock	8.38%	8.78%	0.05%	40%
Mutual Fund	48.85%	48.98%	11.13%	0%
Bond	25.20%	19.17%	38.82%	48%
Deposit	17.56%	14.85%	50%	12%
Portfolio Return	**0.28%**	**0.34%**	**0.52%**	**0.51%**

In the comparison of returns from real investments that have been made by the company and returns using the Sharpe ratio, the expected return used in calculating the portfolio return from real investment uses the expected return from the calculation of the Sharpe ratio, so that the real calculation investment and Sharpe ratio portfolio return have used the same expected return. From the table, it is known that by applying the optimal allocation value, the company will get greater profits, so that the optimal allocation calculation using the Sharpe ratio can be recommended for use in the next investment period in the company. This method can be implemented at Jasa Raharja because:

1. This method already accommodates risk minimization and return maximization
2. Jasa Raharja, which is a state-owned company, must invest prudently and follow the rules of the OJK, this method can be used while still consider the rules for the

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maximum investment limit and the company's risk profile, so that the company gets the maximum return in its investment portfolio.

3. Through calculations with this method can provide a better return than the current return.

6. CONCLUTION

Based on the results of the calculation of the optimal allocation using the Sharpe ratio, the optimal allocation results are different from the investment that has been made by the company at this time. From the comparison of returns obtained between real investment and Sharpe ratio, it is known that the return obtained by the company by calculating the optimal allocation of the Sharpe ratio is higher than the return from the investment made by the company. Sharpe ratio is a method that is rarely used in calculating the optimal allocation compared to return maximization and risk minimization. The calculation results show that the return on investment based on the Sharpe ratio is higher, so this method is recommended for use by companies.

Based on analysis, in terms of optimal allocation for portfolios using the Sharpe ratio that has accommodated return maximization and risk minimization, the optimal allocation results before the pandemic are obtained for stock assets is 0.05%, mutual fund is 11.13%, bond is 38.82%, and time deposits is 50%. Meanwhile, in the during pandemic period, the optimal allocation for stocks is 40%, mutual funds 0%, bonds 48%, and time deposits 12%. From the calculation results, it is also known that the optimal allocation amount for each investment instrument has a different portion before and during the pandemic to obtain optimum investment returns.

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