Value at Risk Analysis for Investment Decisions Using Historical Simulation

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Abstract– This study aims to determine the value at risk for investment decisions in empirical research on the Building Construction Sector, which is included in the LQ45 index listed on the IDX for the 2016-2020 period. This study uses a descriptive quantitative research approach, and the data used are secondary data, with data sources coming from www.idx.co.id and www.finance.yahoo.com. This study used a purposive sampling technique. The analytical method used in this research is the Value at Risk Historical Simulation approach at a 99% alpha level using stock prices and the prices of the Construction, Property, and Real Estate Sector Index for the 2016-2020 period. The portfolio measurement method uses the Capital Asset Pricing Model (CAPM) model of 3 issuers listed in the LQ45 index: In this study, the proportion of the same investment in each stock is 33.33%. This study uses a regression test to determine the relationship between sector stock returns and the returns index tool used to measure investment risk with the help of software Microsoft Excel 2019. The results of the VaR calculation show that the most negligible risk of the three stocks during the 2016-2020 period is WSKT shares, and the most prominent risk is PTPP shares, with VaR values of 34.71% and 36.72%, respectively. Investors with a risk-averse preference can invest their funds in WSKT shares, and investors with a risk taker can invest their funds in PTPP shares. The highest 5-year portfolio VaR results were PTPP shares of Rp 12,239,066, and the lowest was WSKT shares of Rp 11,571,282. The results Significance F of three stocks for five years indicate a significant influence between sector stock returns and returns index.

Keywords: *Value at Risk, Historical Simulation, CAPM, LQ45, Portfolio, Construction Sector Index, Property and Real Estate*

1. Introduction

Economic growth in Indonesia is improving because it is driven by the improvement in the global economy, which impacts more robust export performance and increases domestic demand and investment. Economic growth shows how economic activity changes society's social structure and generates additional value for income and welfare. The increase in economic growth can be seen from the realization of development that has been carried out and is reflected in the Composite Stock Price Index (JCI) (Intan et al., 2019).

Covid-19 has dramatically impacted economic growth in all countries, not only in Indonesia. Covid-19 infects the respiratory system, causing the common cold to become more severe illnesses. The impact of the Covid-19 pandemic on Indonesia's macroeconomic conditions has experienced instability that affects the stock market and poses risks that require a better estimate. Various industrial sectors have experienced a profound impact due to Covid-19 because many business activities and mobility have been disrupted. The industrial sector in Indonesia, which is one of the drivers of economic growth, is the building construction sector, where infrastructure development results in economic expansion to increase the flow of goods, mobility of people throughout the economic cycle, and economic equity in Indonesia.

Risk and return become the benchmark considerations when someone invests. Knowledge of risk is a substantial capital that every investor and a potential investor must own to invest (Sarpong et al., 2018). Before making an investment decision, an investor must consider the expected return and risk borne from the investment. Risk measurement is

increasingly needed because the development and growth of trading and market activities are increasingly widespread and uncertain. Market participants, especially investors, need more accurate and reliable risk measurement techniques (Sarpong et al., 2018). Investors can manage risk if investors can measure the size of the risk obtained when investing (Sultra et al., 2021).

The most famous market risk measurement is Value at Risk (VaR) (Gunay, 2017). Value at Risk (VaR) is a method that has become the standard for measuring risk by calculating market risk and determining the maximum risk of loss that can occur in a portfolio (Sarpong et al., 2018). According to Sultra et al. (2021), Value at Risk (VaR) could be used to measure risk quantitatively to estimate the maximum potential loss that may occur in the future and which will be faced in a certain period at a certain level of confidence. Investors generally carry out measurements using VaR to estimate potential losses due to market risk. The VaR method can be easily used by various other financial institutions, especially for stocks (Amin et al., 2018). Value at Risk (VaR) has been designed and used by financial institutions as a standard tool for reporting risk (Astuti & Gunarsih, 2021). Thanh et al. (2018) state that VaR can use three main approach methods, namely, the variance-covariance method (parametric), the Monte Carlo simulation method (semi-parametric), and the historical simulation method (non-parametric). Each approach has advantages and disadvantages; generally, Value at Risk (VaR) is used by investors to determine the level of return and risk they will receive on their investment.

The parametric approach is based on the assumption that returns are normally distributed. There is a linear relationship between changes in the instrument's value and the impact of changes in risk factors (risk factors). The non-parametric approach is based on historical data. It does not require data normality, considering the actual past returns (Astuti & Gunrsih, 2021). The advantage of using the VaR method is that it focuses on downside risk, which does not depend only on distribution and return assumptions. Investors must understand the fundamental trade-offs and risks in making investment decisions according to their preferences (Astuti & Gunarsih, 2021). Value at Risk (VaR) also has a weakness; VaR only measures the percentile of the distribution of profits and losses without paying attention to any losses that exceed the VaR level (Saepudin et al., 2017).

Putri Endah Astuti and Tri Gunarsih., (2021) analyzed Value at Risk (VaR) to estimate investment risk and optimal portfolio formation in banking stocks using the Mean-VaR method based on the Markowitz approach.

Susanti, Sukono, and Verrany (2020) discussed the analysis of single stock risk and portfolio returns with the Value-at-Risk Estimation Method Based on Normal Distribution, Logistics Distribution, and Historical Simulation. This research uses BNI, BRI, and Portfolio stock data. This study will estimate the value at risk (VaR) calculation using the normal distribution approach, logistic distribution, and historical simulation.

Andrianto, and Khairunnisa (2019), explain the calculation of value at risk using the historical and monte Carlo methods on shares of the cigarette sub-sector. The data analysis technique used is the quantitative data analysis technique using Microsoft Excel software.

Ridha and Khoirudin (2018) this study aimed to determine the consistency of risk measurement using value at risk using the historical method on Islamic stocks covering the short-term, medium-term, and long-term periods.

2. Literature Review

Value at Risk (VaR)

Value at Risk (VaR) is a statistical risk measurement method that estimates the possibility of maximum loss from a portfolio at a specific time frame and a certain level of confidence in normal market conditions (Salsabila & Hasnawati, 2018). J.P Morgan popularized the concept of Value at Risk as a measuring tool for measuring risk in 1994. VaR illustrates how much

investors lose in a specific investment period with the confidence level (1-Alpha) expressed as the quantile of the return distribution. Value at Risk (VaR) measures the maximum loss that may occur on the next day, the next week, and so on according to the desired period (Astuti & Gunarsih, 2021). According to Mostafa et al. (2017), financial institutions have designed and adopted Value at Risk (VaR) as a standard tool for reporting risk.

Historical Simulation Method

The Historical Simulation Method is a non-parametric approach based solely on historical market data and does not depend on any particular thought statistical distribution. This approach is the simplest and easiest to determine VaR because it only uses historical data directly. This approach assumes that the distribution of past take is a good and complete reference of the expected return in the future (Amin et al., 2018). This approach can help to solve the problem of data normality. Astuti and Gunarsih (2021) state that this approach does not assume a normal data distribution but is based on the assumption that the distribution is likely to change due to market factors during the next period, which is identical to the observed distribution from the previous period.

Portfolio Theory

A portfolio is a combination of several securities that are the choice for investment in a certain period with a specific weight on each security, aiming to minimize risk (Iasha et al., 2020). The purpose of portfolio formation is to reduce risk by diversifying, i.e., allocating some funds to various investment alternatives whose assets are correlated. Identifying the portion of funds to be invested in an asset to maximize profit with minimal risk is essential. Abrami and Marsoem (2021) stated that a portfolio collects several invested assets from individuals and institutions to minimize risk and maximize the expected return. Optimal portfolios have an excellent combination of expected return (expected return) and risk (risk). In contrast, efficient portfolios offer the most significant expected return for the same risk level or a portfolio with the lowest risk with a high level of risk—the same return or at a specific rate of return (Astuti & Gunarsih, 2021).

***Capital Asset Pricing Model* (CAPM)**

Calculations to calculate the benefits and risks of security generally use the CAPM (Capital Asset Pricing Model). CAPM is a model of the balance of the relationship between risk and return, which is used to measure the risk of determining stock returns during the investment period. According to Susanti et al. (2021) explained that this CAPM is an estimation model used to estimate the return of a security and is very important in its field. This model relates the expected return level with a risky asset's return in a balanced market condition (market equilibrium). The CAPM model is generally used to calculate the undiversified risk of a single portfolio and compare it with the diversified risk of a well-diversified portfolio. The CAPM is based on the portfolio theory proposed by Markowitz. Based on the Markowitz model, each investor is assumed to diversify his portfolio and choose the optimal portfolio based on the investor's preference for return and risk. CAPM is used to estimate risk related to the expected return and determine the price of an asset. The CAPM includes an element of equity risk in the minimum return. The higher the risk of the stock, the greater the expected minimum stock return. The CAPM is a balanced model that can help simplify the relationship between benefits and risks occurring over highly complex periods.

3. Method

This study uses a descriptive quantitative approach using a non-probability sample regarding the sampling technique, namely purposive sampling. The data used is secondary data.

Report on the share price of building construction listed in LQ45 with data sources from www.idx.co.id and www.finance.yahoo.com. During the period 2016-2020. This study aims to calculate the level of risk generated by each stock and the VaR value generated by a portfolio consisting of three stocks, WSKT, WIKA, and PTPP. Calculate the estimated rate of return expected from an investment using the CAPM (capital asset pricing model) formula and the geometric return of each stock and the Construction, Property, and Real Estate Sector Index to find market returns. Furthermore, calculating the value at risk with a 99% confidence level means that the risk probability at the time of the loss (event) is 1%.

Monthly Stock Return

Realized return, calculated using historical data. This realized return is crucial because it is widely used as data for portfolio analysis. Expected return can be calculated in several ways, namely as input from portfolio analysis (Hartono, 2017, p. 19).

$$R_t = \frac{P_t - P_{t-1}}{P_t} \quad (1)$$

Information:

R_t : *return time t*
P_t : *investment price at time t*
P_{t-1} : *investment price at time t-1*
T : *investment time*

Sector Index (JKPROP)

The formula for calculating the Stock Market Index (RM), according to Hartono (2017:85)

$$R_M = \frac{RM_t - RM_{t-1}}{RM_{t-1}} \quad (2)$$

Information:

R_M = *Stock market rate of return*
RM_t = *Market Price Index in period*
RM_{t-1} = *Market Price Index in period t-1*

Capital Asset Pricing Model **(CAPM)**

$$E(R_i) = Rf + \beta_i . E(R_M - Rf) \quad (3)$$

Description:

R_i = *return* of the i-th security

Rf = *Risk-free rate return.*
β_i = *Beta of the i-th company in the t-period*
R_M = *The return from the market index in the t-th estimation period is calculated by the Sector Index (JKPROP) with the formula.*
Rm = (RMt –RMt-1)/RMt-1

Geometric Average

$$G = \sqrt[n]{x_1 X\, x_2 X \ldots X\, x_n} \quad (4)$$

G = *Measuring average*
x_1 = Data x to-i
x_2 = Data x to-i
n = *Number of data*

VaR Calculation

VaR is defined as the maximum loss value of the portfolio (Hartono, 2017, p. 250). The VaR value can be calculated using the historical simulation method.

$$VaR_{(1-alpha)} = Q * \sqrt{t} \quad (5)$$

Information:

$VaR_{(1-a)}$ = *VaR with confidence level (1-Alpha) after (t) period*

$Q * \sqrt{t}$ = *quantile of return of distribution*

4. Research Results And Discussion

Simple Linear Regression Analysis

Simple linear regression analysis was used to determine the effect of the independent variable partially on the dependent variable. According to Sugiyono (2018:261), Simple regression is a statistical tool based on functional or causal relationships of independent variables with one dependent variable. In this study, the regression test used the help of the Microsoft Excel 2019 software tool. The simple regression formula is as follows:

$$Y = a + bX \quad (6)$$

Description:

Y = *Return stock*

a = *Regression Constant*

b = *Regression Coefficient*

X = *Return Sector Index*

Risk-Free Rate

The Risk-Free Rate in this study uses the BI Rate obtained from the Central Statistics Agency (BPS) from 2016-2020 as follows:

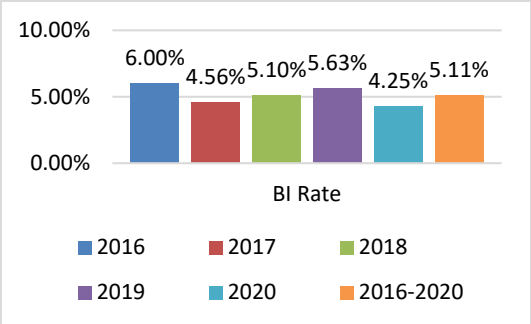
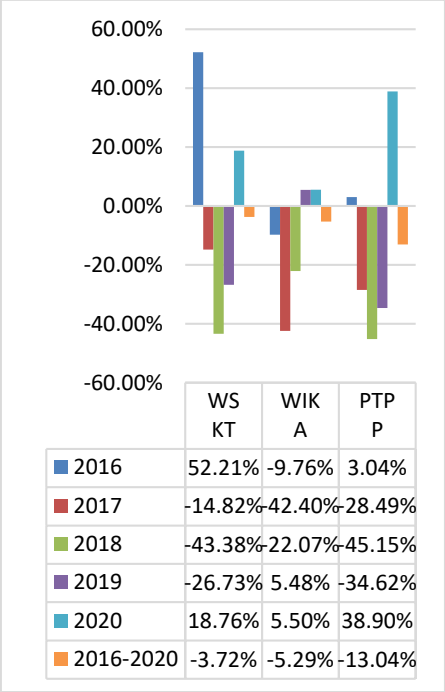


Figure 1. Risk-Free Rate

Stock Geometric Return

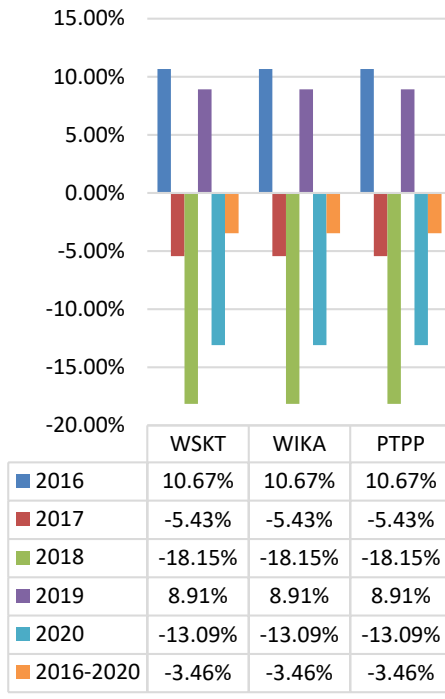


	WSKT	WIKA	PTPP
2016	52.21%	-9.76%	3.04%
2017	-14.82%	-42.40%	-28.49%
2018	-43.38%	-22.07%	-45.15%
2019	-26.73%	5.48%	-34.62%
2020	18.76%	5.50%	38.90%
2016-2020	-3.72%	-5.29%	-13.04%

Figure 2. Stock Geometric Return

Stock geometric returns fluctuate. In WSKT stock, the highest return was in 2016, 52.21%, indicating that historically WSKT stock gave a return of 52.21% in that year. The most negligible WSKT stock return was in 2018 of -43.38% indicating that in that year, WSKT stock was only able to provide a return of -43.38%, and during the 2016-2020 period, WSKT stock could provide a return of -3.72%. In WIKA's stock, the highest return was in 2020, which was 5.50%, indicating that historically WIKA's stock could provide a 5.50% return in that year.

Sector Index Geometric Return



	WSKT	WIKA	PTPP
2016	10.67%	10.67%	10.67%
2017	-5.43%	-5.43%	-5.43%
2018	-18.15%	-18.15%	-18.15%
2019	8.91%	8.91%	8.91%
2020	-13.09%	-13.09%	-13.09%
2016-2020	-3.46%	-3.46%	-3.46%

Figure 3. Sector Index Geometric Return

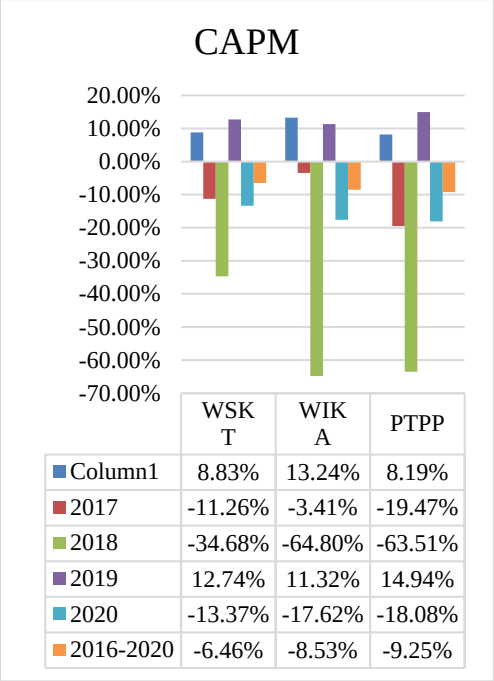
The geometric return of the Sector Index for each stock remains unchanged, indicating that the movement of the Construction, Property, and Real Estate Sector Price Index (JKPROP) is the reference for the stock market index return rate or the percentage result can be used as the market return value in the CAPM equation.

CAPM Calculation Results

CAPM is used to find out or predict the value of the return on a stock or asset that is valuable and risky. The results of CAPM calculations on shares of building construction sector companies in 2016-2020 listed in the LQ45 index using Microsoft Excel 2019 software are as follows.

Table 1. CAPM Calculation Results

Share	Year	VaR %
WSKT	2016	-5,75%
	2017	-18,75%
	2018	-16,85%
	2019	-20,59%
	2020	-47,66%
	Accumulated years 2016-2020	**-34,71%**
WIKA	2016	-13,21%
	2017	-13,70%
	2018	-20,53%
	2019	-12,84%
	2020	-51,09%
	Accumulated years 2016-2020	**-35,28%**
PTPP	2016	-5,65%
	2017	-17,00%
	2018	-22,38%
	2019	-23,34%
	2020	-50,42%
	Accumulated years 2016-2020	**-36,72%**



	WSKT	WIKA	PTPP
Column1	8.83%	13.24%	8.19%
2017	-11.26%	-3.41%	-19.47%
2018	-34.68%	-64.80%	-63.51%
2019	12.74%	11.32%	14.94%
2020	-13.37%	-17.62%	-18.08%
2016-2020	-6.46%	-8.53%	-9.25%

Figure 4. Capital Asset Pricing Model (CAPM)

The average CAPM calculation results have decreased fluctuations from year to year. In WSKT stocks, the highest expected return CAPM was obtained in 2019, which was 12.74%, while the lowest was in 2019 at -34.68%, and during the five years from 2016-2020, it was -6.46%. In WIKA stocks, the highest expected return CAPM was obtained in 2016, which was 13.242%, while the lowest was in 2018 at -64.80%, and during the five years from 2016-2020, it was -8.53%. In PTPP stocks, the highest expected return CAPM was obtained in 2019, which was 14.94%, while the lowest was in 2018 at -64.51%, and during the five years from 2016-2020, it was -9.25%.

VaR Calculation

The results of the VaR calculation for each share vary, where in WSKT, the most significant VaR value in 2020 is -47.66%, while the smallest VaR value occurs in 2016 of -5.75%. For five years, WSKT shares had a VaR value of -34.71% lower than other stocks, namely WIKA and PTPP. In WIKA shares, the highest VaR value in 2020 was -51.09%, while the smallest VaR value occurred in 2019 at -12.84%. In PTPP shares, the highest VaR value in 2020 was -50.42%, while the smallest VaR value occurred in 2016 at -5.65%. For five years, PTPP shares have a VaR value of - 36.72% higher than WSKT and WIKA shares, indicating that the losses that will be obtained if investing in these shares will not exceed 36.72% for PTPP shares, 34.71% for WSKT shares, and 35.28% for WIKA shares.

5. Conclusion

The calculation of risk using the VaR method with a historical simulation approach can provide results of the amount of potential loss that will be received if investors invest their funds in WSKT, WIKA, and PTPP shares with an investment proportion of 33.33% in each share. Using a 99% confidence level, it indicates that losses that exceed the maximum losses will only occur once in an interval of time each year and accumulate from 2016-2020. Based on the CAPM calculation of each share during the 2016-2020 period. WSKT stock has a higher return than the expected return, PTPP stock has a lower return than the expected return, and

WIKA stock has a higher return than the expected return. Based on the calculation of the VaR of each share, it can be concluded that the largest VaR is PTPP shares, and the smallest VaR is WSKT shares. Based on the results of the regression test on each stock, there is a correlation from weak to strong enough between stock returns and sector index returns. During five years, all stocks have a significant effect.

Reference

Abrami, Rizkar, and Bambang Santoso Marsoem, *Optimal Portfolio Formation with Single Index Model Approach on Lq-45 Stocks on Indonesia Stock Exchange*, *International Journal of Innovative Science and Research Technology*, 2021, VI. www.ijisrt.com.

Amin, Farah Azaliney Mohd, Nurulhazwan Izumi Othman, Mohamad Khairil Amri Khairuddin, and Muhammad Haikal Muhaimin Hazahar, '*Measuring Value at Risk for Kijang Emas Investment Using Historical Simulation Approach*, *International Journal of Academic Research in Business and Social Sciences*, 9.9 (2019). https://doi.org/10.6007/ijarbss/v9-i9/7003.

Amin, Farah Azaliney Mohd, Siti Fatimah Yahya, Siti Ainazatul Shazlin Ibrahim, and Mohammad Shafiq Mohammad Kamari, 'Portfolio *Risk Measurement Based on Value at Risk* (VaR),' in *AIP Conference Proceedings* (American Institute of Physics Inc., 2018), MCMLXXIV. https://doi.org/10.1063/1.5041543.

Astuti, Putri Endah, and Tri Gunarsih, '*Value at Risk Analysis in Risk Measurement and Optimum Portofolio Formation in Banking Shares JBTI : Jurnal Bisnis : Teori Dan Implementasi*, 12.2 (2021), 103–14. https://doi.org/10.18196/jbti.v12i2.12263.

Bodie, Z., Kane A., & Marcus, A. J. (2014). Dasar-Dasar Investasi (9th ed.). Jakarta : Salemba Empat.

Djohanputro (2012). Manajemen Risiko Korporat Terintegrasi (11st ed). Jakarta: PPM.

Günay, Samet, '*Value at Risk* (VaR) *Analysis for Fat Tails and Long Memory in Returns*,' *Eurasian Economic Review*, 7.2 (2017), 215–30. https://doi.org/10.1007/s40822-017-0067-z.

Iasha, Dian, Ahmad Faisol, and Universitas Lampung, *Capital Asset Pricing Model sebagai Penentu Portofolio Optimal pada Indeks Saham LQ-45* (Lampung, 2020).

Intan Sari, Widya, 'Analisis Pengaruh Inflasi, Suku Bunga SBI, Nilai Tukar Terhadap *Return* LQ 45 Dan Dampaknya Terhadap Indeks Harga Saham Gabungan (IHSG) Di Bursa Efek Indonesia (BEI) *ARTICLES INFORMATION ABSTRACT*', *Jurnal Sekuritas*, 3.1 (2019).

Mostafa, Fahed, Tharam Dillon, and Elizabeth Chang, *Computational Intelligence Applications to Option Pricing, Volatility Forecasting and Value at Risk*, by Poland Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, 2017th edn (Australia: Springer Nature, 2017), DCXCVII. https://doi.org/DOI 10.1007/978-3-319-51668-4.

Naufal, Muhamad, Nur Ridha, and Moh Khoiruddin, *Management Analysis Journal Konsistensi pengukuran Value at Risk pada Saham Syariah dengan Metode Historis*, *Management Analysis Journal*, 2018, VII. http://maj.unnes.ac.id.

Sultra, I Wayan Eka, Muhammad Rifai Katili, and Muhammad Rezky Friesta Payu, 'Metode Simulasi Historis untuk Perhitungan Nilai Value at Risk pada Portofolio dengan Model Markowitz', *Euler : Jurnal Ilmiah Matematika, Sains Dan Teknologi*, 9.2 (2021), 94–102. https://doi.org/10.34312/euler.v9i2.11518.

Salsabila, A, and S Hasnawati, '*Value At Risk and Expected Returns of Portfolio (Companies Listed on* LQ45 Index Period 2013–2016)', *KnE Social Sciences*, 3.10 (2018). https://doi.org/10.18502/kss.v3i10.3407.

Sarpong, Peter Kwasi, Jones Osei, and Samuel Amoako, *Historical Simulation (HS) Method on Value-at-Risk & Its Approaches*, *Dama International Journal of Researchers* (Ghana:

www.damaacademia.com Historical, 2018), III. www.damaacademia.com.
Susanti, Dwi, Sukono Sukono, and Maria Jatu Verrany, '*Value-at-Risk Estimation Method Based on Normal Distribution, Logistics Distribution and Historical Simulation*', *Operations Research: International Conference Series*, 1.1 (2020), 13–18. https://doi.org/10.47194/orics.v1i1.19.
Sugiyono. (2018). Metode Penelitian Kuantitatif. Bandung: Alfabeta.