JOGTA
Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
Volume: 4
Number: 4
Page: 1111 - 1126
Article History:
Received: 2026-01-29
Revised: 2026-03-29
Accepted: 2026-04-13

APPLICATION OF THE MARKOWITZ MODEL IN DETERMINING THE OPTIMAL PORTFOLIO OF STOCKS LISTED ON THE JAKARTA ISLAMIC INDEX (JII) FOR THE 2022–2024 PERIOD

Muhammad Ammar Hamzah[1], Imron Rosyadi[2]
[1,2]Faculty of Economics and Business, Muhammadiyah University of Surakarta, Indonesia
Corresponding author: Muhammad Ammar Hamzah
E-mail: b100220292@student.ums.ac.id

Abstract:
The continued increase in Indonesia's investor base, accompanied by the broader inclusion of Sharia-compliant equities as reflected in the continued advancement of the Islamic stock market. Nevertheless, participation in capital market investment remains inseparable from risk exposure. Therefore, investors need to carefully consider every investment decision when participating in the stock market. This study is intended to determine the most appropriate stock portfolio composition among companies included in the Jakarta Islamic Index over the 2022–2024 period by employing the Markowitz Model through three portfolio strategies, namely minimum risk, maximum expected return, and maximum Sharpe ratio. The research employs a descriptive quantitative design using secondary data obtained from daily stock closing prices, which are analyzed using mean–variance estimation, covariance and correlation measures, as well as portfolio performance evaluation techniques. Data analysis is conducted using Visual Studio Code with the Python programming language. The results show that the minimum risk portfolio produces the lowest level of risk through diversification across several stocks, while the maximum expected return portfolio offers the greatest return potential, although it is accompanied by a higher degree of risk because the investment is not diversified. By contrast, the portfolio with the largest Sharpe Ratio demonstrates the highest level of efficiency in balancing expected return against risk. Accordingly, a portfolio constructed using the maximum Sharpe ratio approach can be regarded as the most optimal strategy, as it provides the most advantageous balance between risk exposure and return potential.

Keywords: Markowitz Model, Stock Portfolio Optimization, Jakarta Islamic Index

INTRODUCTION

Investment has become an integral part of people's daily lives. In general, investment refers to the activity of allocating a portion of one's current wealth to generate future benefits (Bodie et al., 2011). Individuals' decisions to invest, including in selecting investment instruments, are based on various underlying motives. In addition to generating returns, investment also aims to preserve the value of wealth from being eroded by inflation. According to Noor (2009), investment is an activity undertaken to fulfill the needs and desires of society. The increasing accessibility of investment opportunities in today's market environment has encouraged a rising number of novice investors to engage in capital market activities (Afandi et al., 2023). Among the various investment instruments available to the public, stocks remain one of the most familiar and widely utilized. A stock represents a unit of ownership in a company in the form of shares (Bodie et al., 2011). Based on the Indonesian Capital Market Statistics published by PT Kustodian Sentral Efek Indonesia, the number of capital market investors in Indonesia had risen to 15 million by the beginning of 2025. This figure is largely

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

dominated by individual investors, with more than 6 million investors recorded as having a single investor identification (SID) for stocks and other securities (KSEI, 2025).

In the national investment landscape, sharia-based investment plays an increasingly significant role in Indonesia's financial industry (R. Hidayat et al., 2022). This development is inseparable from Indonesia's demographic profile as a nation in which Muslims constitute the majority of the population, a demographic characteristic that has significantly supported the expansion of the sharia economic system. In parallel, sharia-based investment has exhibited a consistent upward trajectory over time. Statistics published by the Financial Services Authority (OJK) on sharia equities indicate the total of stocks categorized as sharia-compliant and included in the Sharia Securities List (Daftar Efek Syariah/DES) reached 681 securities by the end of 2024, reflecting an increase of approximately 8% compared with the previous year, when the total stood at 629 securities (OJK, 2025). Sharia-compliant stocks listed in the Sharia Securities List (DES) are further grouped into several indices to facilitate the measurement and statistical evaluation of their performance dynamics. Within the Indonesian capital market, five sharia stock indices are commonly used as benchmarks for monitoring the performance of sharia equities, namely the Indonesia Sharia Stock Index (ISSI), the Jakarta Islamic Index (JII), the Jakarta Islamic Index 70 (JII70), the IDX-MES BUMN 17, and the IDX Sharia Growth Index (IDXSHAGROW) (IDX, n.d.-a).

Investors are required to carefully consider every decision when investing in the stock market. Investment activity in the stock market is inherently associated with risk. One of the strategies that investors may employ to minimize risk is diversification (Gunawan et al., 2024). Diversification represents a risk management strategy in which multiple investment instruments are combined within a single portfolio (Rosha & Arnellis, 2021). In the stock market context, this concept refers to the inclusion of several shares drawn from different securities in one portfolio structure. As noted by Jones (2019), diversification plays a crucial role in portfolio risk management as it enables investors to reduce portfolio risk to a considerable extent without materially sacrificing return potential.

One strategy for implementing diversification is to construct a Markowitz-based optimal portfolio. The Markowitz Model facilitates the diversification process in portfolio formation by not only considering the level of risk of each asset, but also taking into account the covariance or relationship among stocks within the portfolio (Maulana et al., 2025). A portfolio is regarded as efficient when it offers the most advantageous combination of risk and return available to investors (Jones, 2019). However, Hartono (2022) states that a portfolio developed merely from investor preferences toward return and risk does not necessarily represent the optimal portfolio. A more comprehensive assessment of portfolio optimality can be achieved through the Sharpe Ratio, which incorporates returns from risk-free instruments as part of the evaluation. Therefore, a portfolio can be considered well-constructed when it is able to produce the most favorable trade-off between potential gain and the level of uncertainty involved.

The Jakarta Islamic Index (JII) was selected as the object of analysis in this study because it comprises 30 sharia-compliant stocks with the highest levels of market capitalization and liquidity within the sharia capital market. Based on these characteristics, the study focuses on stocks that remained consistently listed in the JII throughout the 2022–2024 period. The objective is to identify the optimal portfolio composition by applying three analytical approaches, namely minimum risk, maximum expected return, and maximum Sharpe ratio. It is intended to address the research gap regarding the optimization of the Markowitz Model using these three approaches applied to the Jakarta Islamic Index for the 2022–2024 period. Based on this background, the author intends to

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING OKSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

conduct a study entitled "Application of the Markowitz Model in Determining the Optimal Portfolio of Stocks Listed in the Jakarta Islamic Index (JII) during 2022–2024."

Research Objective. The present study is designed to identify how funds should be distributed across the securities included in the Jakarta Islamic Index over the 2022–2024 timeframe under three investment preferences, namely minimum risk, maximum expected return, and maximum Sharpe ratio.

Investment. According to Jones (2019), investment refers to the placement of capital in one or more assets for the purpose of being maintained over a future time horizon. Broadly speaking, investment activities are divided into two main forms: real investment and financial investment. Real investment is associated with the use of capital to acquire physical assets, including land and industrial buildings. Meanwhile, financial investment relates to ownership of instruments embodied in written contracts, such as stocks (Sharpe et al., 1999).

In undertaking investment activities, investors may choose between two principal alternatives, namely direct and indirect investment. Direct investment refers to the acquisition of financial assets traded directly in the money market, capital market, or derivatives market. By contrast, indirect investment is undertaken through the purchase of shares in investment companies that package their offerings in the form of portfolios (Hartono, 2022). Furthermore, the investment process generally consists of five main stages: establishing investment objectives, formulating investment policy, selecting an appropriate portfolio strategy, and measuring and evaluating portfolio performance (Tandelilin, 2021, as cited in Gunawan et al., 2024).

Stocks. Ownership in a company is represented in the form of stocks (Hartono, 2022). Each common shareholder has voting rights related to corporate governance as well as financial rights, such as dividends. Shareholders are likewise entitled to appoint the company's leadership at the Annual General Meeting of Shareholders (AGM), which is convened annually (Bodie et al., 2011).

Sharia Stocks. Sharia stocks represent equity ownership in companies whose business activities and financial practices conform to Islamic principles (T. Hidayat, 2011). According to the Financial Services Authority (OJK), a stock may be classified as sharia-compliant only if the issuing company does not engage in gambling or activities categorized as gambling, does not conduct trade prohibited under sharia, does not operate as an interest-based financial services institution, does not undertake transactions involving speculative risk, uncertainty (gharar), or gambling (maisir), does not engage in the production, distribution, trading, or provision involving products or services deemed inherently prohibited (haram li-dzatihi), deemed impermissible based on external considerations (haram li-ghairihi) as stipulated by the National Sharia Council of the Indonesian Ulema Council (DSN-MUI), or considered detrimental to morality and public welfare, and is not involved in bribery-related practices (risywah). In addition to meeting these business activity criteria, issuers must also satisfy specific financial thresholds, namely that the proportion of interest-based debt must remain no higher than 45% of total assets, and that interest income together with other non-halal income must not account for more than 10% of total business revenue and other income (IDX, n.d.).

The Jakarta Islamic Index (JII) is an equity index comprising 30 listed companies whose shares satisfy sharia compliance requirements (Hartono, 2022). The index composition is reassessed twice each year, namely in May and November. The determination of JII constituents follows a liquidity-based screening process. To qualify, sharia-compliant stocks must first be included in the Indonesia Sharia Stock Index (ISSI) and have remained listed for at least the previous six months. From this universe, at the first screening stage, 60 stocks are retained according to their mean market capitalization over the prior 12-month horizon. The final 30 are then determined from this group by

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING OKSI
Indexed By : GARUDA Google dimensions Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

considering which stocks record the strongest average daily trading value in the regular market. These selected stocks ultimately constitute the Jakarta Islamic Index (IDX, n.d.).

Markowitz Portfolio Theory. The Markowitz Model, introduced by Harry Markowitz, serves as one of the fundamental approaches underpinning modern portfolio theory. This model was first presented in a scientific publication in 1952 (Jones, 2019). Harry Markowitz's framework is often described as a model that links return expectations with risk measurement, since its portfolio evaluation is built on two core statistical components: the average return anticipated from the portfolio and the variability of that return. Within this framework, portfolio efficiency refers to an investment position that offers investors the most advantageous combination of gain and uncertainty, whether by limiting uncertainty at a chosen return target or by maximizing return at an accepted degree of risk (Jones, 2019). In this sense, portfolio selection always involves reconciling potential gain with the possibility of fluctuation when investment decisions are made. Markowitz (1959), as cited in R. Hidayat et al. (2022), stated that a good portfolio is not merely a collection of high-quality stocks and bonds, but rather a balanced whole that is capable of providing protection and opportunities for investors in facing various possible unexpected conditions.

Previous Research. Several prior studies have explored the use of the Markowitz Model in portfolio optimization. Nisardi et al. (2024) reported that, among the five selected stocks, the proportion of funds with the smallest level of risk was allocated as follows: ICBP at 36.10%, BBCA at 36.28%, TLKM at 17.84%, INCO at 8.39%, and BBNI at 1.39%, yielding an expected return of 8.58% with an associated risk level of 21.52%.

Furthermore, Gunawan et al. (2024) applied both the Markowitz Model and the Single Index Model in determining the optimal portfolio. Their findings showed that the portfolio produced under the Markowitz approach consisted of 12 stocks, namely BBCA, TLKM, UNVR, WSKT, UNTR, BBRI, PTPP, GGRM, SMGR, ICBP, INDF, and PTBA. The proportions of funds allocated to these stocks were 82.22%, 37.50%, 27.21%, 26.33%, 26.14%, 23.37%, 20.59%, 19.10%, 8.51%, 5.65%, 1.81%, and 1.68%, respectively. This portfolio was estimated to generate a monthly return of 44.8% with a risk level of 13.77%. In contrast, the optimal portfolio derived from the Single Index Model comprised nine stocks, namely BBCA, UNVR, TLKM, GGRM, WSKT, BBRI, BMRI, PTPP, and ICBP. The corresponding fund allocations were 66.23%, 10.90%, 8.33%, 7.33%, 4.90%, 0.99%, 0.78%, 0.29%, and 0.25%, respectively. The portfolio generated by this model was projected to yield a monthly return of 1.68% with an associated risk level of 0.43%.

A study on optimal portfolio formation conducted by Jumrahma et al. (2022) found that a combination of 14 stocks from the IDX30 index was used to construct the portfolio. These stocks included ICBP with a fund allocation of 34.17%, MIKA 12.84%, TLKM 11.42%, ACES 9.51%, UNTR 7.51%, CPIN 6.05%, MDKA 4.29%, BBCA 3.76%, TOWR 2.73%, ADRO 2.46%, KLBP 2.27%, PTBA 1.62%, TBIG 1.27%, and ANTM 0.11%. The resulting optimal portfolio was estimated to generate a return of 0.75% with a portfolio risk level of 3.13%.

Irfani and Sudrajat (2023) carried out portfolio optimization using the Markowitz Model on stocks included in the Sri Kehati Index. One of the optimization approaches applied was the Maximum Expected Return approach, which resulted in the portfolio fund allocation being maximized in BMRI stock, as it had the highest expected return during the observation period. The expected return generated was 25.42%, with a risk level of 25.11%.

METHODS

Research Approach. This research was designed as a quantitative study with a descriptive orientation. According to Bougie and Sekaran (2019), descriptive research aims to describe the

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

characteristics of a particular object, population, or phenomenon. In addition, descriptive research can also be used to explain the characteristics of relationships among variables in a correlational form, without emphasizing causal relationships. In this context, the study is directed at identifying the characteristics of stocks included in the Jakarta Islamic Index, among others, through the compilation of quantitative information on stock returns, risks, and performance, so that, based on such information, the proportion of portfolio allocation can be determined according to investor preferences.

Operational Definition of Variables. The operational definitions of the variables applied in this study are presented as follows. Individual Stock Return refers to the gain or loss obtained by investors from holding a particular stock, whether in the form of capital gain or capital loss. Total return is calculated by subtracting the stock price in one period from that of the previous period and then adding the yield, represented by the percentage of dividends relative to the stock price recorded in the preceding period. Expected Return refers to the level of return anticipated to be obtained in the future. According to Hartono (2022), estimating future returns based on expected values is not easy and tends to be subjective, which may lead to inaccuracy in calculation. Therefore, historical data can be used as the basis for expectation. Historical expected return is calculated using the mean method, namely by summing all stock returns over a certain period, after which the total is divided by the number of observation periods. Individual Stock Risk, meanwhile, refers to the degree to which realized outcomes deviate from those expected. In this study, risk is measured using the standard deviation method, which reflects the absolute dispersion of observed values around their expected values (Hartono, 2022). Covariance among Stocks is employed to evaluate the extent to which two variables change together (Jones, 2019). When covariance takes a positive value, both variables tend to exhibit parallel movement. By contrast, a negative covariance value reflects a tendency for the two variables to move in reverse directions. By contrast, a covariance value of zero signifies that no meaningful relationship is observed between the two variables. The correlation coefficient is an element that shows how strongly two variables are related (Jones, 2019). The correlation coefficient is expressed on a scale ranging from −1 to 1. Coefficients greater than zero reflect a direct association, coefficients lower than zero reflect an inverse association, and a coefficient of zero indicates that no linear connection is observed between the variables.

Portfolio Expected Return can be understood as the aggregate expected outcome of the portfolio, obtained by combining the anticipated returns of each constituent asset in proportion to the share of funds invested in them (Hartono, 2022). Its value is derived by assigning a weight to each asset's expected return according to its allocation and then adding the weighted values together. Portfolio Risk reflects the extent of variability in the combined returns of the assets forming the portfolio. Its measurement incorporates several elements, including the variance and standard deviation of each stock as well as the covariance among the stocks within the portfolio (Jones, 2019). The Sharpe Ratio is one of the most frequently applied indicators for assessing portfolio quality and was originally proposed by William F. Sharpe in 1966. This ratio is obtained by comparing the portfolio's return premium above a riskless investment with the overall uncertainty attached to that portfolio. In practical terms, a larger Sharpe Ratio reflects a more favorable level of portfolio performance (R. Hidayat et al., 2022).

Data and Data Sources. This study relies on secondary data, namely data obtained from external sources that had already been made available prior to the research process. The dataset consists of the closing stock prices of 16 issuers that remained consistently that remained listed in the Jakarta Islamic Index (JII) throughout the 2022–2024 period. From this set of issuers, only stocks recording positive Total Return and Expected Return values were retained for subsequent analysis

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

in determining the optimal portfolio. The historical stock price data are sourced from Yahoo Finance. Meanwhile, in calculating the Sharpe Ratio, this study adopts the risk-free rate represented by the SR023 retail sukuk instrument, which offers a fixed annual return of 5.95%.

Sampling Technique. The study applies purposive sampling, a technique in which sample units are selected based on predetermined criteria. Accordingly, the sample consists of 16 companies that remained listed as constituents of the Jakarta Islamic Index throughout the 2022–2024 period.

Data Analysis Method. The data in this study are analyzed using the Markowitz Model to identify the optimal portfolio, through the following stages:

a. Calculating the return of each stock

$R_{i,t}$: $ln\left(\frac{Pi,t}{Pi,t-1}\right)$

$P_{i,t}$: price of stock i in period t

b. Calculating the expected return of each stock

$E(R_i)$: $\frac{\sum_{t:1}^{n} Ri,t}{n}$

c. Calculating the variance and standard deviation of stocks

σ_i^2 : $\frac{1}{n}\sum_{t:1}^{n}[R_{i,t} - E(R_i)]^2$

σ_i: $\sqrt{\sigma_i^2}$

σ_i^2: variance of stock i

σ_i: standard deviation of stock i

d. Calculating the covariance among stocks

$Cov(A,B)$: $\frac{\sum_{t:1}^{n}[R_{Ai}-E(R_A)]\,.\,[R_{Bi}-E(R_B)]}{n}$

$Cov(A,$ B): covariance between stock A and stock B

R_{Ai} : return of stock A in condition i

R_{Bi} : return of stock B in condition i

$E(R_A)$: *expected return of stock A*

$E(R_B)$: *expected return of stock B*

e. Calculating the correlation coefficient among stocks

$\rho_{A,B}$: $\frac{Cov(R_A,R_B)}{\sigma_A.\sigma_B}$

$\rho_{A,}$ B: correlation coefficient between stock A and stock B

$Cov(A,$ B): covariance between stock A and stock B

σ_A: standard deviation of stock A

σ_B: standard deviation of stock B

f. Determining the proportion of portfolio funds with minimum risk

$\min_w \sigma_p^2 = w^T \sum w$

g. Determining the proportion of portfolio funds with maximum expected return

$\max_w E(R_p) = w^T \mu$

h. Determining the proportion of portfolio funds with the maximum Sharpe Ratio

$$\max_w S = \frac{w^T \mu - R_f}{\sqrt{w^T \sum w}}$$

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

RESULT AND DISCUSSION

General Description of the Research Object. The objects examined in this study are companies whose shares were included as constituents of the Jakarta Islamic Index (JII) over the 2022–2024 period. The JII is a stock market index composed of issuers that satisfy sharia screening requirements and demonstrate relatively large trading activity and capitalization levels on the Indonesia Stock Exchange. The material analyzed in this study consists of daily closing prices drawn from every issuer included in the research sample. These data were obtained from the official Yahoo Finance website and subsequently processed using the Python programming language through Visual Studio Code software.

Table 1. List of Issuers Constituting the Jakarta Islamic Index (JII) for the 2022–2024 Period

No.	Issuer Code	Issuer Name
1.	ADRO	PT. Adaro Energy Indonesia Tbk
2.	ANTM	PT. Aneka Tambang Tbk
3.	BRIS	PT. Bank Syariah Indonesia Tbk
4.	CPIN	PT. Charoen Pokphand Indonesia Tbk
5.	EXCL	PT. XL Axiata Tbk
6.	ICBP	PT. Indofood CBP Sukses Makmur Tbk
7.	INCO	PT. Vale Indonesia Tbk
8.	INDF	PT. Indofood Sukses Makmur Tbk
9.	INKP	PT. Indah Kiat Pulp & Paper Tbk
10.	KLBF	PT. Kalbe Farma Tbk
11.	PGAS	PT. Perusahaan Gas Negara Tbk
12.	PTBA	PT. Bukit Asam Tbk
13.	SMGR	PT. Semen Indonesia (Persero) Tbk
14.	TLKM	PT. Telkom Indonesia (Persero) Tbk
15.	UNTR	PT. United Tractors Tbk
16.	UNVR	PT. Unilever Indonesia Tbk

Source: Indonesia Stock Exchange

Calculating the Return and Expected Return of Each Stock. Mathematically, stock return is measured as the change in stock price between the current period and the preceding period, relative to the stock price in the preceding period. In this study, individual stock returns are therefore computed by comparing the stock price observed in the current period with that recorded in the previous period. Meanwhile, the expected return of each stock is obtained by summing the return values across all observation periods and then dividing the total by the number of periods observed, so that the average return is obtained as an estimate of the expected rate of return.

Table 2. Total Return and Expected Return of Each Stock

No.	Stock	∑Ri	E(Ri)

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

1.	ADRO	0,901937	0,001251
2.	ANTM	-0,291641	-0,000404
3.	BRIS	0,479165	0,000665
4.	CPIN	-0,178463	-0,000248
5.	EXCL	-0,281534	-0,000390
6.	ICBP	0,337254	0,000468
7.	INCO	-0,260502	-0,000361
8.	INDF	0,328888	0,000456
9.	INKP	-0,155972	-0,000216
10.	KLBF	-0,115031	-0,000160
11.	PGAS	0,401700	0,000557
12.	PTBA	0,686936	0,000953
13.	SMGR	-0,700978	-0,000972
14.	TLKM	-0,296909	-0,000412
15.	UNTR	0,601030	0,000834
16.	UNVR	-0,694759	-0,000964

Source: Processed Data, 2026

Based on Table 2, ADRO recorded the highest total return as well as the highest expected return during the study period. The total return of ADRO was recorded at 0.901937, while its expected return was 0.001251. Economically, this result indicates that ADRO was able to generate a relatively high cumulative return compared to the other stocks during the 2022–2024 period. The positive expected return also suggests that, on average, ADRO consistently generated positive daily returns throughout the observation period. In contrast, SMGR showed the weakest performance among the stocks over the same period. The total return of SMGR was recorded at -0.700978, with an expected return of -0.000972.

Based on the calculation results, several stocks were found to have negative total return and expected return values during the research period. In the process of constructing the optimal portfolio, this study only includes stocks that exhibit positive total return and expected return values throughout the observation period. Therefore, stocks with negative total return and expected return values are excluded from the determination of optimal portfolio weights.

Table 3. Stocks with Positive Total Return and Expected Return

No.	Stock	∑Ri	E(Ri)
1.	ADRO	0,901937	0,001251
2.	BRIS	0,479165	0,000665
3.	ICBP	0,337254	0,000468
4.	INDF	0,328888	0,000456
5.	PGAS	0,401700	0,000557
6.	PTBA	0,686936	0,000953
7.	UNTR	0,601030	0,000834

Source: Processed Data, 2026

Calculating the Variance and Standard Deviation of Stocks.

Table 4. Stock Variance and Standard Deviation

No	Stock	Variance (σ^2)	SD (σ)

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

1.	ADRO	0,000778	0,027900
2.	ANTM	0,000590	0,024281
3.	BRIS	0,000621	0,024918
4.	CPIN	0,000364	0,019081
5.	EXCL	0,000496	0,022275
6.	ICBP	0,000265	0,016287
7.	INCO	0,000622	0,024935
8.	INDF	0,000159	0,012626
9.	INKP	0,000470	0,021669
10.	KLBF	0,000331	0,018207
11.	PGAS	0,000377	0,019429
12.	PTBA	0,000498	0,022315
13.	SMGR	0,000419	0,020462
14.	TLKM	0,000253	0,015902
15.	UNTR	0,000410	0,020242
16.	UNVR	0,000465	0,021571

Source: Processed Data, 2026

Based on Table 3, it can be seen that ADRO had the highest level of volatility compared to the other stocks during the research period. It can be observed from the stock's variance of 0.000778 and standard deviation of 0.27900. Such relatively elevated values indicate that the stock experienced wider price movements, which in turn implies a greater level of investment risk. This result is in line with Markowitz's modern portfolio theory, particularly the principle that higher return potential is typically accompanied by higher risk exposure. The result becomes even more meaningful because ADRO also posted the highest expected return among all stocks examined during the study period, suggesting that increased risk was associated with greater return expectations.

By contrast, INDF recorded the lowest variance and standard deviation values in the table, amounting to 0.000159 and 0.012626, respectively. These values indicate that INDF had the lowest level of volatility compared to the other securities during the observation period, and therefore, it may be categorized as a relatively more stable security.

Covariance among Stocks.

Table 5. Covariance Matrix among Stocks

Stock	ADRO	BRIS	ICBP	INDF	PGAS	PTBA	UNTR
ADRO	0,196165	0,011411	-0,00253	0,002026	0,043718	0,079739	0,068154
BRIS	0,011411	0,156474	0,015754	0,005903	0,019881	0,010485	0,003856
ICBP	-0,00253	0,015754	0,066851	0,019269	0,002709	-0,000435	0,001131
INDF	0,002026	0,005903	0,019269	0,040174	0,004811	-0,000049	0,000383
PGAS	0,043718	0,019881	0,002709	0,004811	0,095127	0,04134	0,032661
PTBA	0,079739	0,010485	-0,00044	-0,000049	0,04134	0,125486	0,053402
UNTR	0,068154	0,003856	0,001131	0,000383	0,032661	0,053402	0,103254

Source: Processed Data, 2026

Based on the covariance calculation data among stocks presented in Table 5, it was found that several pairs of assets had negative covariance values. Theoretically, a negative covariance value indicates an inverse price movement relationship, whereas a positive covariance reflects a similar or

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dimensions Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

same-direction movement. The magnitude of the covariance values in the table tends to be low, confirming that the synchronization of price movements among the companies is minimal. The stock pairs identified as having negative covariance are ICBP with ADRO, PTBA with ICBP, and PTBA with INDF.

Correlation Coefficient among Stocks.

Table 6. Correlation Matrix among Stocks

Stock	ADRO	BRIS	ICBP	INDF	PGAS	PTBA	UNTR
ADRO	1	0,065129	-0,02212	0,022818	0,320038	0,508232	0,478878
BRIS	0,065129	1	0,154031	0,074454	0,162953	0,074827	0,030332
ICBP	-0,02212	0,154031	1	0,371828	0,033972	-0,00475	0,013613
INDF	0,022818	0,074454	0,371828	1	0,077824	-0,00069	0,005945
PGAS	0,320038	0,162953	0,033972	0,077824	1	0,378375	0,329556
PTBA	0,508232	0,074827	-0,00475	-0,00069	0,378375	1	0,469147
UNTR	0,478878	0,030332	0,013613	0,005945	0,329556	0,469147	1

Source: Processed Data, 2026

The correlation coefficient serves as a statistical tool for identifying both the strength and the direction of a linear relationship between two variables. When the coefficient is positive, the stocks tend to move in a similar direction, whereas a negative coefficient implies that their movements generally occur in opposite directions. By contrast, a value close to zero implies the absence of a meaningful linear association between the variables. Based on the correlation matrix presented in Table 6, the majority of asset pairs exhibit positive correlations with strengths ranging from low to moderate. Meanwhile, negative correlations are specifically identified in the stock pairs of ICBP and ADRO, PTBA and ICBP, as well as PTBA and INDF.

Determining the Proportion of Funds for the Minimum-Risk Portfolio. Within the framework of the Markowitz Model, the minimum-variance approach generates a portfolio with the lowest level of risk among all possible portfolio combinations for a given level of return produced by those combinations. The following are the fund proportions for the minimum-risk portfolio:

Table 7. Fund Allocation Proportion for the Portfolio with a Minimum-Risk Preference

No	Stock	Allocation Proportion w_i
1.	ADRO	0,77%
2.	BRIS	8,31%
3.	ICBP	17,61%
4.	INDF	42,99%
5.	PGAS	10,27%
6.	PTBA	7,22%
7.	UNTR	12,84%

Source: Processed Data, 2026

The results of the fund allocation calculation for the minimum-variance portfolio show that the largest allocation is assigned to INDF at 42.99%, while the smallest allocation is assigned to ADRO at 0.77%. This composition is consistent with the risk characteristics of each security, where INDF has the lowest level of volatility, while ADRO has the highest level of volatility during the

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google ISJD EBSCO

observation period. Based on these fund proportions, the portfolio performance is obtained as follows:

Table 8. Portfolio Performance

	Daily	Annual
Expected Return	0,0576%	14,52%
Standard Deviation	0,9274%	14,72%
Sharpe Ratio	0,0367	0,5823

Source: Processed Data, 2026

The calculation results indicate that if an investor allocates funds to the stocks in the proportions presented in Table 8, the investor is expected to obtain an expected return of 0.0576% per day, equivalent to 14.52% per year. Meanwhile, the recorded level of risk is 0.9274% per day or 14.72% per year. With the risk-free rate set at 5.95% per annum, the portfolio records a Sharpe Ratio of 0.5823. It indicates that each unit of risk undertaken by the portfolio is associated with an excess return of 0.5823.

Determining the Proportion of Funds for the Portfolio with Maximum Expected Return. Determining portfolio fund allocation using the maximum expected return approach is an optimization strategy intended to maximize the expected return achievable at a given level of risk. The following are the fund allocations for the maximum expected return portfolio:

Table 9. Fund Allocation Proportion for the Portfolio with a Maximum Expected Return Preference

No	Stock	Fund Allocation Proportion w_i
1.	ADRO	100%
2.	BRIS	-
3.	ICBP	-
4.	INDF	-
5.	PGAS	-
6.	PTBA	-
7.	UNTR	-

Source: Processed Data, 2026

Based on the optimization results, the portfolio with the maximum expected return is obtained by allocating all funds to the ADRO stock. It occurs because ADRO recorded the highest expected return among all stocks included in the research sample; therefore, the optimization model rationally selects this stock as the sole portfolio component to maximize the rate of return. The following presents the performance of the portfolio constructed under the maximum expected return preference:

Table 10. Portfolio Constructed

	Daily	Annual
Expected Return	0,1251%	31,52%
Standard Deviation	2,7900%	44,29%
Sharpe Ratio	0,0364	0,5774

Source: Processed Data, 2026

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google ROAD ISJD EBSCO

The performance of this portfolio indicates that if an investor allocates one hundred percent of their funds to ADRO stock, the expected return obtained is 0.1251% on a daily basis, equivalent to 31.52% on an annual basis. The level of risk borne by this portfolio is 2.7900% per day or 44.29% per year. This portfolio records a Sharpe Ratio of 0.5774, indicating that each unit of risk borne by the portfolio generates 0.5774 units of excess return. This value is not significantly different from that of the portfolio with the minimum-risk preference discussed previously.

Determining the Proportion of Funds for the Portfolio with Maximum Sharpe Ratio. The Sharpe Ratio constitutes one of the principal indicators for assessing portfolio performance, as it measures the extent of excess return generated in relation to the total risk undertaken. From the standpoint of portfolio theory, rational investors seeking to maximize utility and achieve the most efficient balance between return and risk are generally more likely to choose the portfolio with the highest Sharpe Ratio. The following are the proportions of funds allocated to the portfolio with the maximum Sharpe Ratio:

Table 11. Fund Allocation Proportion for the Portfolio with a Maximum Sharpe Ratio Preference l

No	Stock	Fund Allocation Proportion w_i
1.	ADRO	20,25%
2.	BRIS	12,06%
3.	ICBP	12,14%
4.	INDF	25,59%
5.	PGAS	-
6.	PTBA	16,04%
7.	UNTR	13,93%

Source: Processed Data, 2026

Table 11 presents six stock combinations forming the portfolio with the highest Sharpe Ratio. Based on the results of the calculation, the largest proportion of funds is allocated to INDF at 25.59%. Meanwhile, the smallest proportion is allocated to BRIS at 12.06%. This combination is expected to generate the following portfolio performance:

Table 12. Portfolio Performance

	Daily	Annual
Expected Return	0,0776%	19,55%
Standard Deviation	1,1585%	18,39%
Sharpe Ratio	0,0466	0,7396

Source: Processed Data, 2026

The calculation results indicate that the portfolio with the maximum Sharpe Ratio generates an expected return of 0.0776% per day, equivalent to 19.55% per year. The portfolio risk is recorded at 1.1585% per day or 18.39% per year. The resulting Sharpe Ratio is 0.7396, which is the highest value among the alternative portfolios examined in this study.

Fund Allocation for the Optimal Portfolio with Minimum Risk. The results of the optimization of fund allocation to obtain a portfolio with the minimum level of risk show that the proportion of funds allocated to each stock is presented as follows: ADRO 0.77%, BRIS 8.31%, ICBP 17.61%, INDF 42.99%, PGAS 10.27%, PTBA 7.22%, and UNTR 12.84%. Based on this combination of

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

fund proportions, the portfolio is expected to generate a daily expected return of 0.0576%, equivalent to 14.52% on an annual basis. The portfolio risk, measured using standard deviation, is recorded at 0.9274% per day or 14.72% per year. In addition, the Sharpe Ratio generated by the portfolio is 0.5823.

Based on these calculation results, the largest proportion of funds allocated within the portfolio is allocated to INDF at 42.99%, while the smallest proportion is allocated to ADRO at 0.77%. This fund allocation is consistent with the risk characteristics of each stock, where ADRO recorded the highest level of volatility as reflected in a standard deviation of 0.027900, while INDF exhibits the lowest level of volatility with a standard deviation of 0.012626. Nevertheless, the portfolio optimization process aimed at minimizing risk is not determined solely by the magnitude of each stock's individual volatility, but is also influenced by the covariance relationships among the stocks within the portfolio. A study conducted by Nisardi et al. (2024) on five stocks shows that the smallest fund allocation is not always assigned to the stock with the highest level of volatility. In that study, the smallest fund allocation was assigned to BBNI at 1.39%, while the stock with the highest volatility in the portfolio was INCO, with a standard deviation of 0.176508. Therefore, the direction of price movement and the relationship among stocks are important factors that need to be considered in efforts to minimize overall portfolio risk.

The formation of this portfolio has proven to be effective in minimizing the level of risk faced by investors. By comparison, if an investor were to allocate all of their funds to the stock with the lowest volatility in the research sample, namely INDF, the resulting daily expected return would be 0.0456%, with a daily standard deviation of 1.2626%. Meanwhile, the portfolio formed through the optimization process is able to generate a higher daily expected return of 0.0576%, with a lower daily risk level of 0.9274%. This finding indicates that the strategy is appropriate for investors with a risk-averse preference, namely those who tend to avoid risk and place a greater priority on the stability of investment value.

Fund Allocation for the Optimal Portfolio with Maximum Expected Return. The optimization of fund allocation for the portfolio with a maximum expected return preference results in a 100% allocation to the ADRO stock. Unlike the portfolio optimization approach based on minimum risk, which considers various factors such as volatility and covariance among stocks, the optimization based on maximum expected return is carried out by considering only the return and expected return of each stock without taking other risk factors into account. Therefore, the portfolio weight is fully allocated to the stock that has the potential to provide the highest return. This finding is consistent with the study conducted by Irfani and Sudrajat (2023), which analyzed stocks included in the Sri Kehati Index with constituents during the 2020–2023 period. In calculating fund allocation under the maximum expected return preference, the study found that all funds were allocated to BMRI, which had the highest annual expected return among the observed stocks, amounting to 25.42%.

This portfolio provides the highest expected return compared to the other portfolios, amounting to 0.1251% on a daily basis, equivalent to 31.52% on an annual basis. Although this strategy is capable of generating the highest expected return, the resulting portfolio does not contain any element of diversification because it consists of only a single asset. This condition causes the portfolio risk to become relatively high, namely 2.7900% per day or 44.29% per year. The calculation produces a Sharpe Ratio of 0.5774, which represents the lowest Sharpe Ratio among the portfolios

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google dji Crossref INDEX COPERNICUS ROAD ISJD Indonesia OneSearch EBSCO

evaluated in this study. Given the trade-off between expected return and risk, this strategy is generally better suited to investors with a high risk tolerance, as they tend to place greater emphasis on return potential than on investment stability.

Fund Allocation for the Optimal Portfolio with Maximum Sharpe Ratio. The maximum Sharpe Ratio approach aims to obtain a portfolio combination that is able to generate the highest ratio of excess return to risk. In this method, the optimization process is carried out by simultaneously considering the level of return, the level of risk, and the risk-free rate of return. The calculation results for the research sample produced a portfolio combination consisting of six stocks, namely ADRO 20.25%, BRIS 12.06%, ICBP 12.14%, INDF 25.59%, PTBA 16.04%, and UNTR 13.93%. The proportion of fund allocation in this portfolio is relatively more evenly distributed compared to the minimum-variance portfolio and the maximum-return portfolio. This condition indicates that the assets in the portfolio have been optimally diversified, enabling the portfolio to generate the optimal combination of risk and return (Heykal et al., 2024).

This portfolio combination generates an expected return of 0.0776% on a daily basis and 19.55% on an annual basis. Meanwhile, the level of risk, as measured by standard deviation, is recorded at 1.1585% per day and 18.39% per year. The resulting Sharpe Ratio is 0.7396, indicating that for every one unit of risk borne by the portfolio, it is able to generate an excess return of 0.7396.

Relative to the minimum-variance alternative, this portfolio yields a stronger annual return despite being accompanied by a rise in risk that remains proportionally acceptable. It is also the only portfolio in the present analysis for which the yearly return projection surpasses the yearly risk measure. Viewed from this perspective, the maximum-Sharpe portfolio emerges as the strongest option in terms of efficiency because it produces the most advantageous alignment between return potential and uncertainty exposure. For that reason, this portfolio is better aligned with investors who make decisions by carefully weighing prospective gains against the risks attached to them.

CONCLUSION

Based on the findings of the optimal portfolio analysis using the Markowitz Model on stocks included in the Jakarta Islamic Index (JII) over the 2022–2024 period, several conclusions may be drawn as follows:

1. The portfolio based on the minimum-variance approach produces the fund composition that most effectively minimizes risk. This portfolio generates an annual expected return of 14.52%, with an annual risk level of 14.72% and a Sharpe Ratio of 0.5823. This portfolio is considered suitable for risk-averse investors.
2. Under the maximum-return criterion, the entire investment is concentrated in ADRO, the stock that delivered the strongest expected return in the sample. This allocation produces an annual expected return of 31.52%, but it is paired with a substantially higher annual risk of 44.29%. Its Sharpe Ratio of 0.5774 suggests that the additional return is not matched by equally efficient risk compensation. Accordingly, this alternative is more appropriate for investors who are willing to tolerate substantial uncertainty in pursuit of higher gains.
3. The portfolio selected under the maximum-Sharpe criterion produces a yearly expected return of 19.55% with annual risk measured at 18.39%. Since its Sharpe Ratio reaches 0.7396, the highest value among all portfolio scenarios assessed in this study, this portfolio stands out as the strongest candidate in terms of return generated relative to risk assumed.

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google ISJD EBSCO

4. The overall results reinforce the central proposition of Modern Portfolio Theory that higher return prospects are commonly associated with greater exposure to risk. At the same time, the findings show that diversification and portfolio optimization make it possible to structure asset combinations that improve the efficiency of return generation relative to the level of risk carried.

Suggestions. Based on the results of the study, the following suggestions can be proposed:

1. For investors, particularly those who are oriented toward risk–return efficiency, it is recommended to consider the portfolio with the maximum Sharpe Ratio as an investment alternative, as this portfolio offers a relatively more balanced trade-off between return and risk than the other approaches.
2. For investors with a low-risk preference, the minimum-variance portfolio may be a more appropriate choice because it offers a more controlled level of volatility, although with a more moderate level of return.
3. For investors with a high risk tolerance, a single-allocation strategy in the stock with the highest expected return may provide substantial return potential; however, it is also accompanied by significant risk fluctuations.
4. For future researchers, it is recommended to:
   - extend the observation period so that the research findings become more representative of various market cycle conditions;
   - include macroeconomic variables as factors affecting portfolio performance;
   - Compare the Markowitz Model with other optimization models, such as the Single Index Model or CAPM-based approaches; and
   - Examine the stability of portfolio weights in an out-of-sample period to avoid optimization bias.

REFERENCES

Afandi, I., Niswatin, & Noholo, S. (2023). Pengaruh Pemahaman Investasi, Modal Minimal dan Persepsi Risiko terhadap Minat Investasi Mahasiswa di Pasar Modal (Studi Kasus pada Mahasiswa yang Terdaftar di Galeri Investasi Fakultas Ekonomi Universitas Negeri Gorontalo). *Jurnal Mahasiswa Akuntansi, 1*(4), 208–222.

Bodie, Z., Kane, A., & Marcus, A. J. (2011). *Investment and Portfolio Management.* McGraw-Hill.

Bougie, R., & Sekaran, U. (2019). *Research Methods for Business (8th Ed.).* Wiley.

Dewi, M. P. (2021). Optimasi Portofolio Pada Saham Pefindo 25 Dengan Menggunakan Model Markowitz (Studi Kasus Di Bursa Efek Indonesia). *Warmadewa Management and Business Journal (WMBJ), 3*(February), 32–41.

Gunawan, A., Fajriyah, R., Bimaksa, M. A., & Untari, S. N. (2024). Analysis Of Portfolio Formation on the Lq45 Stocks Index, Using the Markowitz and Single Index Models. *Journal of Mathematics and Its Applications, 18*(4), 2363–2374.

Hartono, J. (2022). *Portofolio dan Analisis Investasi (J. Hartono (ed.)).* Penerbit ANDI.

Heykal, M., Prasetya, S., & Harsanti, P. S. (2024). Pengaruh Kualitas Pelayanan terhadap Kepuasan Pelanggan pada Jasa Wisata (Open Trip) CV Tidung Island. *Jurnal Ekonomi Manajemen Akuntansi, 30*(1), 250-265. https://doi.org/10.59725/ema.v30i1.226

Hidayat, R., Anggraini, D., Riyani, Y., & Endri, E. (2022). Optimal Sharia Portfolio Selection to Outperform the Stock Market in the Post-Pandemic Era. Access to Success. 23(187), 287–294. https://doi.org/10.47750/QAS/23.187.35

Hidayat, T. (2011). *Buku Pintar Investasi Syariah*. mediakita.

CATRA RESEARCH INSTITUTE
JOGTA Journal of Governance, Taxation and Auditing
P-ISSN - 2830-6392 (PRINT)
E-ISSN - 2962-2522 (ONLINE)
JOURNAL OF GOVERNANCE, TAXATION AND AUDITING
PUBLISHING KSI
Indexed By : GARUDA Google ISJD EBSCO

IDX. (n.d.). Produk Syariah. Retrieved March 8, 2026, from https://www.idx.co.id/id/idx-syariah/produk-syariah

Irfani, M. I., & Sudrajad, O. Y. (2023). Portfolio Optimization Using Markowitz Model on Sri-Kehati Index. *International Journal of Current Science Research and Review, 06*(08), 5778–5792. https://doi.org/10.47191/ijcsrr/V6-i8-45

Jones, C. P. (2019). *Investasi Prinsip dan Konsep (12th Ed.).* Penerbit Salemba Empat.

Jumrahma, A. B., Haeruddin, M. I. M., & Anwar. (2022). Using the Markowitz Model in the Analysis of Optimal Portfolio Forming on Idx30 Index Stock on the Indonesia Stock Exchange. *International Journal of Innovative Science and Research Technology, 7*(8), 1233–1239. https://doi.org/https://doi.org/10.5281/zenodo.7063494

KSEI. (2025). Statistik Pasar Modal Indonesia. https://www.ksei.co.id/files/Statistik_Publik_Februari_2025.pdf

Maulana, Y., Meilaniy, W., & Yusuf, A. (2025). Optimal Portfolio Analysis Using Markowitz and the Single Index Model. *Widya Cipta: Jurnal Sekretari Dan Manajemen, 9*, 18–29. https://doi.org/10.31294/widyacipta.v9i1.21894

Nisardi, M. R., Husain, H., & Resky, A. (2024). Penentuan Portofolio Saham Optimal Menggunakan Metode Markowitz Sebagai Dasar Keputusan Investasi. 6(1), 33–40.

Noor, H. F. (2009). *INVESTASI: Pengelolaan Keuangan Bisnis dan Pengembangan Masyarakat (1st ed.).* PT Indeks.

OJK. (2025). Statistik Saham Syariah - Februari 2025. https://ojk.go.id/id/kanal/syariah/data-dan-statistik/saham-syariah/Documents/Pages/Statistik-Saham-Syariah---Februari-2025/STATISTIK SAHAM SYARIAH FEBRUARI 2025.pdf

Rosha, M., & Arnellis. (2021). Portofolio Optimization Through MPT on any Economic Situation on Indonesian Stock Portofolio Optimization Through MPT on any Economic Situation on Indonesian Stock Exchange (2010-2020). *Journal of Physics: Conference Series*. https://doi.org/10.1088/1742-6596/1742/1/012016

Sharpe, W. F., V., B. J., & Alexander, G. J. (1999). *Investments (6th ed.).* Prentice Hall.