

Critical Examination of Optimal Portfolios on Basic Materias Sector Stocks on the IDX Through the Markowitz Approach

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Abstrak. This study aims as a critical review of optimal portfolio formation using the Markowitz model on basic materials sector stocks on the Indonesia Stock Exchange. The population in this study are all basic materials sector stocks based on the IDX IC division on the Indonesia Stock Exchange for the period October 2021 - March 2022, namely 93 stocks, while the sample is 71 stocks. Data analysis is carried out with the Markowitz model stages starting with collecting stock price data per day during the study period, calculating realized return, expected return, variance, standard deviation, covariance, to get the optimal portfolio with risk and expected return. The results showed that, the formation of an optimal portfolio with the Markowitz model in basic materials sector companies for the period October 2021-March 2022, there were 30 stocks included in the optimal portfolio with an expected return of 0.022% and a risk of 0.342%.

This study aims as a critical study of the optimal portfolio formation by using the Markowitz model on basic materials sector stocks on the Indonesia Stock Exchange. The population in this study is all shares of the basic materials sector based on the distribution of IDX IC on the Indonesia Stock Exchange for the period October 2021 - March 2022, which is 93 shares, while the sample is 71 shares. Data analysis was carried out with the stages of the Markowitz model, starting with collecting stock price data per day during the study period, calculating the realized return, expected return, variance, standard deviation, covariance, and to get the optimal portfolio with risk and expected return. The results showed that in the formation of an optimal portfolio using the Markowitz model in basic materials sector companies for the period October 2021-March 2022, it was found that there were 30 stocks included in the optimal portfolio with an expected return of 0.022% and a risk of 0.342%.

Keywords: Optimal Portfolios, IDX, Markowitz.

INTRODUCTION

In 2020 it was a very difficult year for everyone with the Covid 19 pandemic affecting all sectors in our daily lives, from the economic sector this impact can be seen from the economic growth in 2020 which is in a negative position, namely -2.07%. Seeing these conditions, the government has formulated policies to deal with this situation. In the economic sector, the Ministry of Finance as reported by CNN Indonesia has released three stimuli, the first stimulus is the acceleration of state spending so that the domestic economy can become stronger, the second stimulus is focused on supporting people's purchasing power and encouraging ease of export-import, and the third stimulus focuses on public health and social protection. With this stimulus, it is a driver of economic growth in 2021, which grew by 3.69%.

Investment activity is one of the drivers of economic growth, OJK in a press release said that stock exchange activity experienced positive growth as seen from the JCI

performance which moved stably and tended to increase compared to the third quarter, as an illustration as of December 29, 2021 the JCI was at the level of 6,600.68, an increase of 10.40% year to date (Ytd). This year, trading activities were also very good, including on August 9, 2021, there were 2.14 million transactions, which became the highest daily transaction frequency record. On November 9, the highest daily transaction volume reached 50.98 billion. The number of investors in 2021 was 7.41 million, an increase of 92.7% compared to 2020.

Someone who invests is called an investor, an investor invests with the hope of getting a return, but of course there are risks that must be borne. Return and risk have a unidirectional or linear relationship or the greater the expected return the greater the level of risk considered and vice versa, therefore it is important for investors to recognize and understand the risk profile (Safelia, 2012, p. 221). With this relationship, investors need to diversify their investments. Diversification is a combination of a number of stocks to minimize portfolio risk, with this diversification it is hoped that investors can form an optimal portfolio. Before determining the optimal portfolio, the first thing that needs to be done is to form an efficient portfolio. An efficient portfolio is a portfolio with the greatest expected return among equal-risk portfolios or a low-risk portfolio among portfolios that expect the same return (Halim, 2015, p. 41). The optimal portfolio is a portfolio that investors choose from a collection of efficient portfolios (Wijaya, 2021, p. 29).

One way to determine the optimal portfolio is the Markowitz model. The basis of the Markowitz portfolio is to provide input to investors to avoid risk and provide maximum returns on each investment decision. This theory is known as investment diversification or making investments that are not concentrated in one field, but more than one field, as said by Harry Markowitz "Don't put all your eggs in one basket" (Markowitz, 1952, p. 79).

There are various types of stocks in Indonesia, and the Indonesia Stock Exchange (IDX), which has the authority to regulate the Indonesian capital market, publishes indices to help investors classify stocks. A stock index is a statistical measure that reflects the general price development of a group of stocks, selected based on certain criteria and methods and evaluated periodically. The IDX itself has 40 indices and one of them is IDX Basic. IDX Basic is an index that measures the price of all stocks in the basic materials sector in reference to the IDX Industrial Classification (IDX-IC). The basic materials sector includes companies that sell products and services used by other industries to produce final products, such as companies that produce Chemical Goods, Construction Materials, Containers & Packaging, Mining Metals & Non-Energy Minerals, and Wood & Paper Products.

Previous research by Mahayan and Surjaya (2019), Sari (2020), Dewi (2021) and Wijaya (2021) are some of the studies that use the Markowitz model, but the research topics are different, including infrastructure companies, the Jakarta Islamic Index (JII), Pefindo Index 25 and the banking sector. In previous studies, the formation of the optimal portfolio is still lacking using the classification according to IDX-IC, because this division can be said

to be new where previously it used the Jakarta Stock Industrial Classification JASICA classification. This study analyzes the formation of an optimal stock portfolio in the basic materials sector according to the IDX-IC classification using the Markowitz model. This sector is suitable for use in this model because stocks come from different industries such as Chemicals, Construction Materials, Containers and Packaging, Metals and Minerals, Forestry and Paper, which allows obtaining stocks from various commodities in a portfolio.

METHOD USED

This research uses a quantitative descriptive method, namely a research method that describes existing phenomena with numbers to explain existing phenomena accompanied by statistical research support. The object of this research is stock price data for companies that are the population whose data is accessed through www.idx.id, www.investing.com, and www.finance.yahoo.com. The descriptive research design used in this study aims to determine the stocks that are worthy of entering into the determination of the optimal portfolio with the Markowitz model with the data used collected by the documentation method so as to produce a combination of stocks that include the optimal portfolio.

The population of this study are all basic materials sector stocks based on the IDX IC division on the Indonesia Stock Exchange during the April 2022 evaluation period. The period used in this study is October 2021 to March 2022 where the price data is taken per day.

The population used in this study are all basic materials sector stocks based on the IDX IC division on the Indonesia Stock Exchange in the October 2022 evaluation period. In determining the sample using purposive sampling method, namely the sampling technique based on certain considerations or criteria in accordance with the research objectives. Companies taken as samples in this study must meet the following criteria:

1. The company was not suspended by the Indonesia Stock Exchange during the research period.
2. The company is listed on the Indonesia Stock Exchange or Initial Public Offering (IPO) before October 2021.
3. The company did not conduct a stock split during the study period

From the above criteria, the number of samples in this study were 71 stocks out of 93 stocks in the basic materials sector on the IDX as a population.

ACTIVITY IMPLEMENTATION AND RESULTS

a. Realized Return

Realized return is a return that has occurred or exists, calculated by reducing the period t stock price by the period $t-1$ stock price and then dividing by the period $t-1$ stock price. Stock returns are calculated by the formula (Hartono, 2017: 284)

$$R_{it} = \frac{P_t - P_{t-1}}{P_{t-1}}$$

Description:

R_{it} = Stock return i in period t

P_t = Stock price i in period t

P_{t-1} = Stock price i in period t-1

Table 1
 Realized Return

No	Stock Code	Stock Return	No	Stock Code	Stock Return	No	Stock Code	Stock Return
1	ADMG	-12,263%	26	GGRP	62,045%	51	PNGO	12,551%
2	AGII	6,594%	27	HKMU	5,623%	52	PSAB	-12,709%
3	AKPI	59,438%	28	IFII	4,584%	53	PURE	-22,978%
4	ALDO	43,413%	29	IGAR	0,092%	54	SMBR	-29,564%
5	ALKA	33,347%	30	INAI	1,826%	55	SMCB	-1,200%
6	ALMI	22,355%	31	INCF	-168,781%	56	SMGR	-16,682%
7	ANTM	15,128%	32	INCI	-8,051%	57	SMKL	43,456%
8	APLI	4,115%	33	INCO	43,280%	58	SQMI	-33,048%
9	STEEL	-23,276%	34	INKP	-2,875%	59	SULI	0,000%
10	BMSR	57,473%	35	INRU	7,482%	60	SRSN	11,481%
11	BRMS	84,693%	36	INTP	10,819%	61	SWAT	15,316%
12	BRNA	-34,339%	37	IPOL	2,310%	62	TALF	12,174%
13	BRPT	-1,701%	38	ISSP	37,357%	63	TBMS	9,418%
14	BTON	-29,597%	39	WOOD	-26,355%	64	TINS	25,731%
15	CITA	12,877%	40	KDSI	16,350%	65	TIRT	69,705%
16	CLPI	0,735%	41	KMTR	-15,370%	66	TKIM	-7,788%
17	CTBN	-22,850%	42	KRAS	-34,329%	67	TPIA	38,715%
18	DKFT	6,233%	43	LTLS	22,843%	68	TRST	8,555%
19	DPNS	7,996%	44	MDKA	66,472%	69	UNIC	35,633%
20	EKAD	1,670%	45	MDKI	0,567%	70	WTON	-22,406%
21	EPAC	1,733%	46	NIKL	-11,474%	71	ZINC	-23,683%

22	ESIP	67,234%	47	OKAS	-25,666%
23	ESSA	152,552 %	48	OPMS	-35,358%
24	FPNI	68,427%	49	PBID	3,487%
25	GDST	-1,387%	50	PICO	7,721%

Source: Data processed 2022

Based on table 4.12, it can be seen that there are 29 stocks that have a negative total realized return and 42 stocks that have a positive total amount, therefore the 42 stocks will be candidates for inclusion in the optimal portfolio. It can be seen that the shares of PT Surya Esa Perkasa Tbk (ESSA), a public company engaged in the Energy and Chemical sector through LPG (Liquefied Petroleum Gas) refineries and ammonia plants have the largest number of realized returns of 152.55%, then PT Bumi Resources Minerals (BRMS) 84.69%, PT Tirta Mahakan Resources Tbk (TIRT) 69.71% and PT Lotte Chemical Titan (FPNI) 68.43%.

PT Indo Komoditi Korpora Tbk (INCF) is a company that has the business of development, trade, land transportation, workshop, agriculture and services has the largest negative return of -168.78%. Only stocks that have a positive total realized return will be included in the calculation in the next step.

b. Expected Return Shares

Expected Return is the level of profit expected by an investor on the investment made, which can be calculated using the formula. Expected return is calculated by dividing the daily realized return by the number of research periods, where in this study using a daily period between October 2021 and March 2022, namely 247 days or can be calculated using the formula:

$$E(R_i) = \frac{\sum_{i=1}^n R_{it}}{n}$$

Description:

$E(R_i)$ = Expected Return on stock i

R_{it} = Stock return i in period t

n = Number of Observation Periods

Table 2
 Expected Return

No.	Stock Code	Expected Return (%)	No.	Stock Code	Expected Return (%)	No.	Stock Code	Expected Return (%)
1	AGII	6,59%	16	ESIP	67,23%	31	MDKA	66,47%
2	AKPI	59,44%	17	ESSA	152,55%	32	MDKI	0,57%
3	ALDO	43,41%	18	FPNI	68,43%	33	PBID	3,49%
4	ALKA	33,35%	19	GGRP	62,05%	34	PICO	7,72%
5	ALMI	22,35%	20	HKMU	5,62%	35	PNGO	12,55%
6	ANTM	15,13%	21	IFII	4,58%	36	SMKL	43,46%
7	APLI	4,11%	22	IGAR	0,09%	37	SRSN	11,48%
8	BMSR	57,47%	23	INAI	1,83%	38	SWAT	15,32%
9	BRMS	84,69%	24	INCO	43,28%	39	TALF	12,17%
10	CITA	12,88%	25	INRU	7,48%	40	TBMS	9,42%
11	CLPI	0,74%	26	INTP	10,82%	41	TINS	25,73%
12	DKFT	6,23%	27	IPOL	2,31%	42	TIRT	69,71%
13	DPNS	8,00%	28	ISSP	37,36%	43	TPIA	38,71%
14	EKAD	1,67%	29	KDSI	16,35%	44	TRST	8,55%
15	EPAC	1,73%	30	LTLS	22,84%	45	UNIC	35,63%

Source: Data processed 2022

Based on the table above, it shows that among the basic materials sector stocks that have the highest expected return is PT Surya Perkasa Tbk (ESSA), which is 0.62%, which means that investing in ESSA will provide an expected return of 0.62% of 100% of the funds invested. The company that provides the lowest expected return is PT Barito Pasific Tbk (BRPT), which is 0.01%.

c. Stock Variance and Standart Deviation

Variance and standard deviation are one way to calculate stock risk. The variance and standard deviation are the spread of the expected value with reality and the spread of the probability distribution. This measure of spread is intended to determine how far the possibility of the value to be obtained deviates from the expected value. Can be calculated using the formula:

$$\sigma_i^2 = \frac{\sum_{i=1}^n (R_{it} - E(R_i))^2}{n} \quad (3.3)$$

$$\sigma_i = \sqrt{\sigma_i^2} \quad (3.4)$$

Description:

σ_i^2 = Stock Variance

σ_i = Stock Standard Deviation

N = Number of historical data observations for large samples with n (at least 30 observations) and for small samples use (n-1).

Apart from the above formula, it can also be calculated using an excel formula with the formula =VAR for variance and =STDEV for standard deviation. stock risk is calculated from companies included in the sample that have a positive expected return.

Table 3
 Variance and Standard Deviation

No	Stock Code	Variance (%)	Standard Deviation (%)	N	Stock Code	Variance (%)	Standard Deviation (%)	N	Stock Code	Variance (%)	Standard Deviation (%)
1	AGII	0,10%	3,13%	16	ESIP	0,39%	6,21%	31	MDKA	0,09%	2,98%
2	AKPI	0,18%	4,26%	17	ESSA	0,27%	5,22%	32	MDKI	0,03%	1,61%
3	ALDO	0,23%	4,76%	18	FPNI	0,23%	4,78%	33	PBID	0,01%	1,14%
4	ALKA	0,25%	5,00%	19	GGRP	0,18%	4,26%	34	PICO	0,13%	3,56%
5	ALMI	0,15%	3,92%	20	HKMU	0,21%	4,56%	35	PNGO	0,09%	2,95%
6	ANTM	0,09%	3,08%	21	IFII	0,04%	2,09%	36	SMKL	0,23%	4,76%
7	APLI	0,05%	2,27%	22	IGAR	0,02%	1,31%	37	SRSN	0,14%	3,79%
8	BMSR	0,33%	5,75%	23	INAI	0,08%	2,76%	38	SWAT	0,47%	6,88%
9	BRMS	0,15%	3,85%	24	INCO	0,06%	2,54%	39	TALF	0,13%	3,57%
10	CITA	0,12%	3,50%	25	INRU	0,15%	3,85%	40	TBMS	0,03%	1,66%
11	CLPI	0,00%	0,64%	26	INTP	0,05%	2,17%	41	TINS	0,07%	2,58%
12	DKFT	0,09%	3,04%	27	IPOL	0,03%	1,67%	42	TIRT	0,37%	6,10%
13	DPNS	0,05%	2,23%	28	ISSP	0,11%	3,31%	43	TPIA	0,04%	2,10%
14	EKAD	0,00%	0,68%	29	KDSI	0,06%	2,44%	44	TRST	0,05%	2,30%
15	EPAC	0,14%	3,74%	30	LTLS	0,03%	1,80%	45	UNIC	0,07%	2,59%

Source: Data processed 2022

The variance and standard deviation above are calculated with the help of Microsoft Excel, based on table 3 it can be seen that PT Sriwahana Adityakarta Tbk (SWAT) is a company that has a business in the field of carton boxes, paper tubes, and paper come, has the

highest risk, namely a variance of 0.47% and a standard deviation of 6.88%. While the lowest risk is PT Colorpak Indonesia Tbk (CLPI) with a variance of 0.004% and a standard deviation of 0.64% which is a company engaged in the printing ink industry, coatings, adhesives, and trading of other printing equipment such as BOP film and PET film.

d. Covariance Between Two Stocks

The next step in the formation of the optimal portfolio with the Markowitz model is to calculate the covariance which is a calculation to measure the extent to which two variables change together. Covariance can take any value between $-\infty$ to $+\infty$, where negative values are indicators of unidirectional relationships and positive values are indicators of unidirectional relationships. Covariance can be calculated using the formula:

$$\sigma_{RA, RB} = \sum_{i=1}^n \frac{(R_{At} - E(R_A)) \cdot (R_{Bt} - E(R_B))}{n}$$

Description:

$\sigma_{RA, RB}$ = Covariance between two stocks in the portfolio

R_{At} = Return at the expected time of stock A

R_{Bt} = Return at the expected time of stock B

$E(R_A)$ = Stock expectation return A

$E(R_B)$ = Stock expectation return B

In addition, the covariance can also use the help of Microsoft Excel with the formula (=COVAR (Stock realization return a; Stock realization return x)), based on the covariance calculation it can be seen that there are 1035 pairs of stocks. 402 pairs that are negative mean that 402 pairs have an unidirectional relationship, that is, if one increases, the other decreases. In addition, there are 633 pairs of stocks that are positive, meaning that 633 pairs have a unidirectional relationship, that is, if one increases, the other also increases. The largest covariance value is the relationship between SWAT and SWAT with a value of 0.0046, meaning that the directional relationship between SWAT and SWAT is very large compared to other stock relationships. While the smallest covariance value is the relationship between ALDO and FPNI with a value of (0.0004), meaning that the unidirectional relationship between ALDO and FPNI is very large compared to other stock relationships.

e. Variance, Expected Return and Portfolio Risk

In calculating the variance, expected return and risk of the optimal portfolio, previously determined the allocation of the proportion of funds evenly, in this case of 45 stocks each stock gets a fund allocation of 2.222%. The calculation results show that when

the proportion of funds is evenly distributed, the expected return is 0.110% with a portfolio variance of 0.005% and a standard deviation of 0.739%, meaning that of all investor funds that have been invested with the same proportion of funds in 45 stocks, the expected return is 0.110% with a risk of 0.739%.

f. Variance, Expected Return and Risk of Optimal Portfolio

Formation of the optimal portfolio by minimizing investment risk with the help of a solver program in Microsoft Excel, so that the variance, expected return and risk can also be seen in table 4 below.

Table 4
 Variance, Expected Return and Portfolio risk

No	Code	Company Name	Weight
1	AKPI	Argha Karya Prima Industry Tbk.	0,677%
2	ALDO	Alkindo Naratama Tbk.	0,659%
3	ALMI	Alumindo Light Metal Industry Tbk.	0,002%
4	BMSR	Bintang Mitra Semestaraya Tbk	0,504%
5	BRMS	Bumi Resources Minerals Tbk.	0,120%
6	CITA	Cita Mineral Investindo Tbk.	0,542%
7	CLPI	Colorpak Indonesia Tbk.	28,135%
8	DKFT	Central Omega Resources Tbk.	0,233%
9	DPNS	Duta Pertiwi Nusantara Tbk.	0,745%
10	EKAD	Ekadharna International Tbk.	24,515%
11	EPAC	Megalestari Epack SentosarayaTbk.	0,099%
12	FPNI	Lotte Chemical Titan Tbk.	0,589%
13	HKMU	HK Metals Utama Tbk.	2,255%
14	IGAR	Champion Pacific Indonesia Tbk.	5,435%
15	INAI	Indal Aluminum Industry Tbk.	3,145%
16	INCO	Vale Indonesia Tbk.	1,234%
17	INTP	Indocement Tunggal Prakarsa Tbk.	0,687%
18	IPOL	Indopoly Swakarsa Industry Tbk.	0,373%
19	KDSI	Kedawung Setia Industrial Tbk.	1,213%

20	LTLS	Lautan Luas Tbk.	1,438%
21	MDKI	Emdeki Utama Tbk.	5,892%
22	PBID	Panca Budi Idaman Tbk.	5,010%
23	PICO	Pelangi Indah Canindo Tbk	0,276%
24	PNGO	Pinago Utama Tbk.	3,430%
25	SULI	SLJ Global Tbk.	1,381%
26	SWAT	Sriwahana Adityakarta Tbk.	0,466%
27	TALF	Tunas Alfin Tbk.	1,546%
28	TBMS	Copper Mulia Semanan Tbk.	5,649%
29	TRST	Trias Sentosa Tbk.	3,748%
30	UNIC	Unggul Indah Cahaya Tbk.	0,006%
Total Weight			100%
Expected Return			0,022%
Variants			0,001%
Standard Deviation			0,342%

Source: Data processed 2022

Of the 45 stocks included in the optimal portfolio are 30 stocks, because after going through the solver program 15 stocks get 0% proportion of funds. Based on table 4, the solver has divided the proportion to minimize the risk from 0.739% to 0.342% in period p with the largest proportion is PT Colorpak Indonesia Tbk (CLPI) with 28.135% and the smallest proportion is 0.002% which is PT Alumindo Light Metal Industry Tbk (ALMI). With this risk, the expected return changes from 0.110% to 0.022% with a period per day or in one semester (estimated working days 124 days) 2.77%.

PT Sriwahana Adityakarta Tbk (SWAT) is a company that has a business in the field of carton boxes, paper tubes, and paper come, has the highest risk, namely a variance of 0.47% and a standard deviation of 6.88%.

The solver program plays an important role in the formation of the optimal portfolio with the Markowitz model, this program allows investors to choose the level of risk and return that investors are ready to take, but the weakness of this model is that it does not take into account the period of time until when we invest in these stocks.

CONCLUSION

The basic materials sector stock with the highest total return is PT Surya Esa Perkasa Tbk (ESSA), namely 152.55%, one of the influencing factors is the company's success in obtaining net profit during 2021 due to an increase in the price of ammonia and LPG which are the company's main products. The expected return of ESSA stock is 0.62%. The stock with the smallest return is PT Indo Komoditi Korpora Tbk (INCF), which is -168.78%.

Stocks that are included in the next step are stocks that have a positive total return where out of 71 stocks in the sample only 45 stocks have a positive return, the remaining 25 stocks have a negative return and one stock has no return, namely SULLI, because its price does not move at all during the study period.

PT Sriwahana Adityakarta Tbk (SWAT) is a stock that has the highest risk, namely a variance of 0.47% and a standard deviation of 6.88%, one of the reasons is that the price movement is very volatile. While the lowest risk is PT Colorpak Indonesia Tbk (CLPI) with a variance of 0.004% and a standard deviation of 0.64%, one of the reasons is that the price of this stock during the study period was relatively stagnant.

The covariance analysis shows that there are 1035 pairs of stocks, with 633 pairs that are positive, which means that they move in the same direction, that is, if one stock has an increase in return, the other stock will also increase and vice versa. In addition, there are 402 pairs that are negative, meaning that they move in the opposite direction, that is, if one stock experiences an increase in return, the other stock will experience a decrease in return.

In the portfolio with the same proportion of funds each share gets a proportion of funds of 0.222%, so that the expected return is 0.110% with a portfolio variance of 0.005% and a standard deviation of 0.739%. In the formation of the optimal portfolio carried out with the help of a solver program on Microsoft Excel to minimize risk, 30 stocks are obtained that enter the optimal portfolio, the remaining 15 stocks get a 0% proportion of funds with a return of 0.110%, a portfolio variant of 0.001% and a standard deviation of 0.342%.

Based on the results of this study, the formation of the optimal portfolio is done by diversifying investment so as to reduce risk compared to investing in just one stock, but diversification is not able to eliminate risk, as evidenced by a portfolio variance of 0.005% and a standard deviation of 0.739% in a portfolio with the same proportion to a portfolio variance of 0.001% and a standard deviation of 0.342% in the optimal portfolio. This strengthens the Markowitz theory that says investors need to diversify in investment to reduce risk but cannot eliminate it but rather minimize the risk.

Based on the results of the research conducted, it can be concluded that the formation of an optimal portfolio with the Markowitz model in basic materials sector companies for the period October 2021-March 2022 shows that out of 93 stocks in this

sector, only 30 stocks are included in the optimal portfolio with a risk of 0.342% and a return of 0.022% per day

DAFTAR PUSTAKA

- Bodie, Z., Kane, A., Marcus, A. J., & Jain, R. (2014). *Investments*. New York: Mc Graw-Hill Education.
- CNN Indonesia. (2020, October 23). List of kemenkeu stimulus for economy amid pandemic. Retrieved from CNN Indonesia:
<https://www.cnnindonesia.com/ekonomi/20201023203928-532-562192/daftar-stimulus-kemenkeu-untuk-ekonomi-di-tengah-pandemi>
- Dewi, M. P. (2021). Portfolio optimization on pefindo 25 stocks using the markowitz model. *Warmadewa Management and Business Journal*, III(1), 32-41. doi:<https://doi.org/10.22225/wmbj.3.1.2021.32-41>
- Financial Services Authority. (2021). Press release: Indonesia's capital market strengthens to boost economic recovery. Jakarta: Financial Services Authority. Retrieved from <https://www.ojk.go.id/id/berita-dan-kegiatan/siaran-pers/Pages/Pasar-Modal-Indonesia-Menguat-Dorong-Pemulihan-Ekonomi.aspx>
- Government of Indonesia. (1995). *Capital Market Law Number 8 of 1995*. Jakarta: State Secretariat.
- Halim, A. (2015). *Business Financial Management: Concepts and Applications*. Jakarta: Mitra Wacana Media.
- Hartono, J. (2013). *Portfolio theory and investment analysis 8th edition*. Yogyakarta: BPF.Indonesia Stock Exchange. (2021). *Idx stock index handbook v1.2*. Jakarta: Indonesia Stock Exchange. Retrieved from idx.
- Indonesia Stock Exchange. (2021). *New IDX Industrial Classification (IDX-IC) No. :Peng-00007/BEI.POP/01-2021*. <http://www.idx.co.id>.
- Mahayani, N. P., & Surjaya, A. G. (2019). Determination of optimal portfolio based on markowitz model on infrastructure companies in Indonesia stock exchange. *E-Journal of Management*, VIII(5), 3057-3085. doi:<https://doi.org/10.24843/EJMUNUD.2019.v08.i05.p17>
- Marcus, A. J., Bodie, Z., & Kane, A. (2014). *Portfolio and investment management global edition book 1 9th edition*. 2013: Fourth Edition.
- Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, VII(1), 77-91.
- Nuzula, N. F., & Nurlaily, F. (2020). *Fundamentals of investment management*. Malang: UB Press.
- Samsul, M. (2006). *Capital markets and portfolio management*. Jakarta: Erlangga.
- Tandelilin, E. (2010). *Portfolio and investment theory and application*. Yogyakarta:

Kanisius.

- Safelia, N. (2012). Basic concepts of investment and portfolio decisions. *Jambi University Online Journal*, 1(3), 217-226.
- Sari, D. P. (2020). Optimal portfolio analysis of Jakarta Islamic Index (JII) sharia stocks for the period 2015-2017. *Journal of Management and Organization*, XI (1), 8-21. doi:10.29244/jmo.v11i1.30492
- Sitompul, W. J. (2020). Comparative analysis of optimal portfolio formation using the Markowitz model and the single index model in investing decisions in LQ45 stocks on the Indonesia Stock Exchange. Medan: University of North Sumatra.
- Susilo, W. A. (2016). Comparative analysis of optimal portfolio performance of markowitz model and treynor-black model based on the results of single index model selection of cut-off rate method. Jakarta: UIN Syarif Hidayatullah.
- Syam, S. (2021). Markowitz model transition to single index model for investment projection on LQ45 stocks on the Indonesia Stock Exchange. Makassar: Makassar State University.
- Wijaya, M. N. (2021). Optimal portfolio analysis with the markowitz model in the banking sector included in LQ45. Makassar: Makassar State University.
- Yasa, D. A. (2020). Optimal portfolio formation using a single index model. Malang: Brawijaya University.