

Software Development For Optimal Portfolio Selection Using The Markowitz Method

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ABSTRACT

Investors could invest their funds in a collection of financial assets (portfolio). The optimal combination of the portfolio will optimize the return. The purpose of this research is to develop software that supports investment decisions using the model of Markowitz. The method used in developing this software is the System Development Life Cycle method, where in this method there are three stages of system development, namely the Definition Stage, the Construction Stage, and the Implementation Stage. The result of this development is software that can be used to determine the optimal portfolio. The software will support the decision-making of the investment. The output of this research is software, that is validated by expert judgment.

Keywords: Investment Management Learning, Investment Decision Making, Markowitz Methods Software, Optimal Portfolio, Portfolio.

INTRODUCTION

There are various sources of fund in the capital market that provides various alternative sources of funds, such as stocks, mutual funds, and derivatives that can be used by investors. Every investment has risks that cannot be avoided. Investors expect to minimize risks and maximize profit, to get capital gains or dividends. For this purpose, investors need a strategy to create a profitable investment portfolio. The portfolio is a set of financial assets which are owned by investors. When the investment is only in one type of stock and there is a loss, the investor will lose all the funds invested. However, if the investor invests their fund in a portfolio, there are a lot of possibilities. The investor will not suffer large losses. When the investors invest their funds in stock X, stock Y, and risk-free assets (government bond), they will not get a lot of losses if the price of stock X falls, because the price of stock Y rises, they have risk-free assets too.

There is a need to get a good portfolio combination. In order to optimize the return, the investors must pay attention to the combination of the highest risk and lowest risk of financial assets. The higher the possible risk resulting from a decision, the higher the expected return of the decision. On the other hand, the smaller the risk inherent in a decision, the smaller the return that can be expected (Sugeng, 2017). Investors will get an optimal return when they choose an optimal portfolio. There are numerous methods to determine the optimal portfolio. Investors can calculate the best combination of portfolios by using the single index method, the Markowitz method, and others. The optimal portfolio used is the perfect composition of the highest return and the smallest risk. The best result is generated from the finest composition among return and risk (Hartono, 2014).

Investors need the best information to make investment decisions, Decision-maker requires software that can provide optimal portfolio. In addition, this software can also be a good medium of learning for students. Good accounting learning media can create high motivation for students to study accounting, especially investment management. Currently, various kinds of media have been developed, especially those that are visual or audio-visual. This software tries to encourage students to participate in learning enthusiastically, easier, and more interesting. Learning media is not only a complement in the learning process but also one of the determining factors for the success of the learning process in the class (Aghni, 2018). Interactive multimedia such as this software is suitable for use in learning (Novana & Sukaesih 2012; Susanto, Dewi, & Irsadi, 2013). This software development Markowitz method is expected to make it easier for students to understand the basic concepts of investment management.

LITERATURE REVIEW

Portfolio Theory

The optimal portfolio growth shows the portfolio performance (Le & Platen, 2006). To maintain optimal portfolio performance, it must be monitored and analyzed. The change in market conditions will affect portfolio performance and need to be rebalanced. Portfolio theory tries to maximize profit and minimize risk. The mathematical formulation used by portfolio theory selects various investment instruments and is expected to reduce collective risk. Rational investors look for a combination of investments in a portfolio that will provide the best comparison between return and risk. There are two main issues of the portfolio performance evaluation, such as (1) Evaluation of whether the portfolio returns can provide returns that exceed another portfolio return and (2) Evaluation of whether the returns meet the risk (Tandelilin, 2010).

Learning Media

Daryanto (2013) explains several uses of learning media, namely 1) Clarifying the instruction not so verbalized. 2) Transcending the boundaries of space, time, energy, and senses 3) Increase enthusiasm for learning and direct interaction between students and learning resources. 4) Let students learn independently according to their visual, auditory, and kinesthetic talents and abilities. 5) Provide a stimulus experience and the same perception. 6) The learning process contains five components of communication, teachers (communicators), learning materials, learning media, students (communicants), and learning objectives.

Kemp, Dayton, and Diane (1985) explain that there are very important contributions to media utilization in learning(namely: 1) Delivery of learning messages can be more standardized, 2) Study can be more interesting, 3) Studying becomes interactive with the application of accepted learning theory and psychological basis in case of student cooperation, evaluation, and enrichment, 4) The time for implementing learning can be shortened, 5) The quality of learning can be improved, 6) The study process can take place anytime and anywhere. wherever needed, 7) The positive attitude of students towards learning materials and the learning process can be improved, 8) The role of the teacher changes in a positive direction.

Risk Investment

Investment risk is about the probability of failure to realize the level of income and return of funds. Hence, Teoh et al. (2021) declared that investores should updating through the market share application to know the price and risk at a time. Sugeng (2017) divides investment risk into two: investment risk from business risk and financial risk. Business risk is more complex than financial risk, due to competition between business actors, both in the product and raw material markets. Financial risk is related to the company's probability of defaulting on investors. This financial risk arises because of financial distress. Financial distress is caused by the large portion of debt in the company's capital structure.

Optimal Portfolio Markowitz Method

The optimal portfolio is the portfolio that has the best performance. The portfolio with the best performance can be measured by the portfolio that has the largest angle at the point of risk-free assets (Hartono, 2014). Subsequent developments emerged as a portfolio performance measurement index based on risk-adjusted returns developed by Sharpe (1965), Treynor (1966), and Jensen (1968). The Sharpe index calculates the standard deviation of total risk, the Treynor index emphasizes systematic risk as measured by beta, the Jensen index emphasizes the difference between the actual rate of return obtained by the portfolio and the expected rate of return if the portfolio is on the capital market line (Hartono, 2014).

The Markowitz method was developed by Sharpe (1965) and is often referred to as the reward-to-variability ratio (RVAR). This method measures the excess return of a portfolio against its total risk. The measurement of the RVAR method is carried out by the formula: Sharpe Ratio Formula:

Sharpe Ratio = $(R_x - R_f) / \text{StdDev } R_x$

Where:

R_x = Expected Portfolio Return

R_f = Risk-free rate of return

StdDev R_x = Standard Deviation of portfolio return (or volatility)

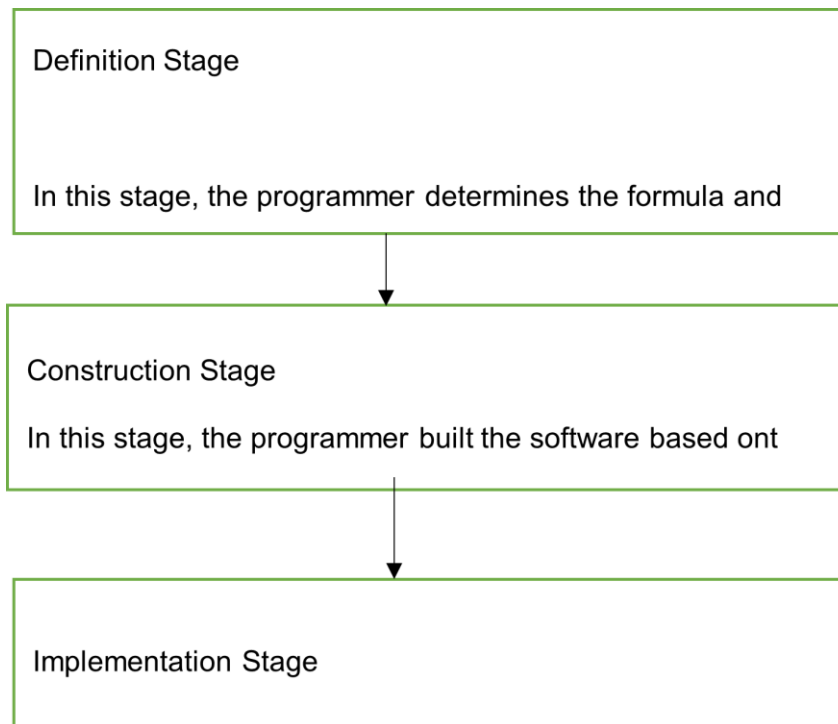
The results of the calculation of portfolio performance using the RVAR method that is positive and above the market indicate that the portfolio has good performance. If the

results of the calculation of portfolio performance using the RVAR method show a number that is smaller than the market portfolio value, then the portfolio has poor performance.

RESEARCH METHOD

Software development uses the System Development Life Cycle approach (SDLC) (Martin, Brown, DeHayes, Hoffer, & Perkins, (1994); McLeod (1995); Bodnar & Hopwood (1995)). McLeod (1995) divided SDLC into three stages, such as the definition stage, the Construction stage, and the Implementation stage. In the Definition stage, the programmer conducted feasibility analysis and requirements definition in order to get a clear understanding of the need of the user. In the Construction stage, there are several activities, such as system design, system building, and system testing,. The last step is the implementation stage, which consists of three activities, such as installation, operations, and maintenance. Each stage has an output to support the software development, as illustrated in figure 1 below.

Figure 1. Development of Markowitz Methods Software



The description for each phase in figure 1. is as follows:

The Definition Stage

This stage designates the system in detail, so the programmer can build the system. The definition phase consists of feasibility analysis and requirement definition.

- a. Feasibility Analysis, The activities are defining the scope of the system, such as the outputs, inputs, the main database needed, costs, and benefits of the system. At this stage, an observation of benefits and costs is carried out. System development is carried out as best as possible, but all costs incurred must not exceed the benefits. The important thing that needs to be applied is that the benefits must exceed the existing costs.
- b. Requirements definition. The system is defined precisely and comprehensively. The result of this phase is a document of system needs. The document encloses an output and the converting process of the input and must be approved by the user. The

later phase is the requirements definition stage. At this stage, the system developer will seek as much information as possible so that the system to be developed later fits the user's needs. Various actions taken include observation, observation of existing documents, as well as interviews with all parties involved. This is done to find out how the existing system works so far, as well as the various weaknesses that exist so that the system to be developed can be more useful because it is in accordance with user needs and can overcome the weaknesses of the old system.

The Construction Stage.

There are several phases in the stages, such as:

- a. System Design. The programmer will design the system based on the system requirements document in the Definition Stage, The design includes the decisions of the hardware and software, content planning, the structure of the database, and the connection between modules. The output is a document that describes the system in detail. The programmers will build a computer code and database, based on the document
 - b. Building and Testing the System.. The programmer verified the module and attempted the full system. The system is made in accordance with existing plans. After the system has been created, testing of the system is carried out. System testing also involves experts in the fields of material and software. These experts will provide comments and suggestions regarding the feasibility of the existing system. Improvements will be made in accordance with the advice of these experts. The repair will be stopped if the expert has stated that this system is valid. Final testing will engage users to convince them that the system can run precisely.
3. Implementation Stage. These phases in the Implementation stages include:
- a. Installing the System. The primary activities in this phase are data conversion and training for the system operators
 - b. Application and Maintenance. Modify the system to the needs of the users.

Validation by Experts

Expert validation is done to test the validity of the software. Questionnaires were distributed to material experts and software experts. The indicators used are the adequacy and certainty of the software. The formula is

$$P = \frac{\sum x}{\sum x1} \times 100\%$$

notes:

P = percentage

$\sum x$ = The grade of experts' answers

$\sum x1$ = Maximum grade

Table 1 indicates the criteria for accuracy

Table 1. Validation Criteria

Score	Result
80 – 100	Accurate
60 – 79	Largely Accurate
40 – 59	Fewer Accurate
0 – 39	Not Accurate

Source: Sudjana (2005)

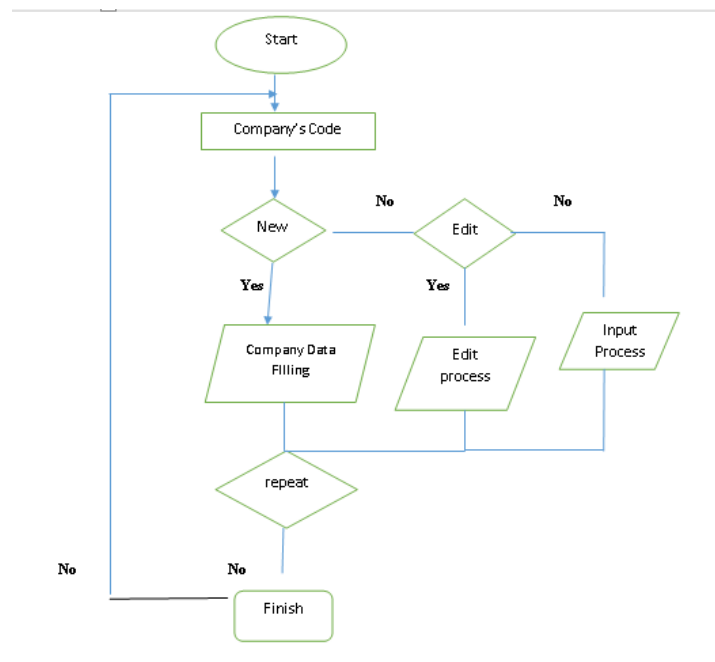
RESULTS

Flowchart and Storyboard of the development of making Markowitz methods software to support investment management learning are roadmap designs to develop in the design stage of this study, The flowchart is designed to adjust the flow to operate the software. Storyboards describe various software window displays in detail.

Firm Data Entry

On the Data Entry menu, companies listed on the Indonesia Stock Exchange are inputted. The data is downloaded from the official IDX website.

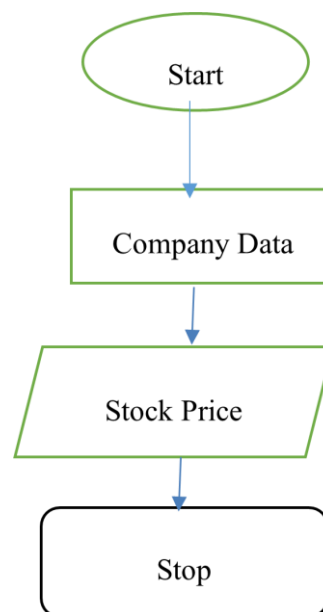
Figure 2. Firm Data Entry



Stock Price Entry

After inputting company data, the software can download the existing stock prices. The download of the stock price is carried out based on the closing price per day.

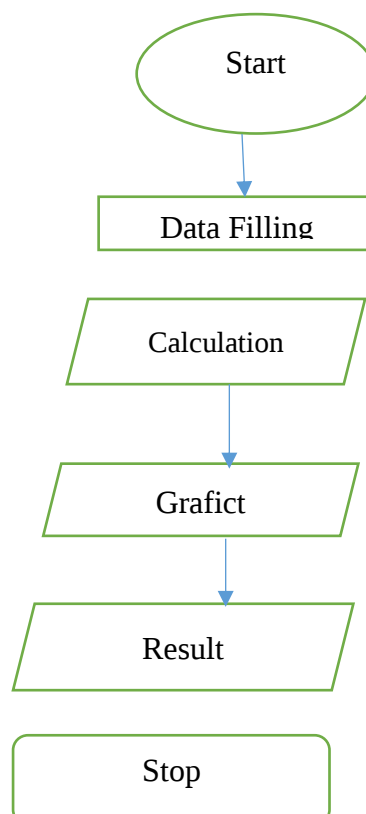
Figure 3. Stock Price Entry.



Calculation

Calculation of the optimal portfolio can be done after all daily stock prices have been input into the software. The software will automatically calculate the optimal portfolio according to the Markowitz formula.

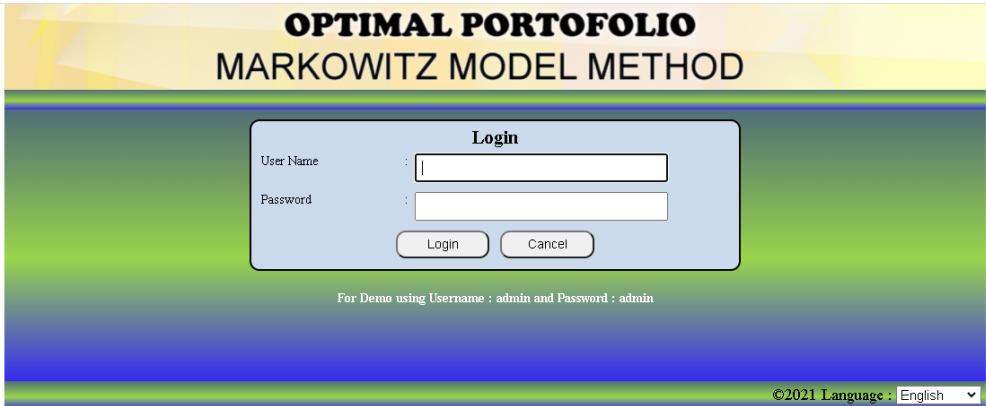
Figure 4. Flow Diagram of Portfolio Calculation



The product development of Markowitz methods software to support investment management learning is executed by using the SDLC (System Development Life Cycle) approach. The scope of menus that will be displayed in the Research and development of the Markowitz method software to support an investment decision includes 1). First menu – Company Data; 2). Second menu– Daily Stock Price Data; (3) Third menu – Markowitz Model Method; (4) Fourth menu – User Data.

OPERATING THE SOFTWARE.

The first step is Login. In this step, the user must enter the username and password.
Figure 5. Login



The next step is to enter the firm data, daily stock price, and calculation of the portfolio.

Figure 6. Main Menu



Figure 6 shows the main menu of this software. In this second stage, there are several menu options, namely:

- a. Data input. The software requires data input that is downloaded from the Indonesia Stock Exchange (IDX). The input data contains the names of companies listed on the Indonesia Stock Exchange. All of these company names are entered into the system because stock prices will be filled in every day. Filling in the stock price will be done automatically in this system. The system will download stock prices, so they

- can be used for optimal portfolio calculations. After the company names have been entered into the system, the next step is to download the stock prices.
- b. Daily stock Price, is a menu to download information about stock prices from day to day. This input will be done automatically after this software is connected to IDX, Stock prices will be downloaded every day in real-time so that investors can find out the movement of stock prices for making investment decisions.
 - c. Calculating the portfolio is an optimal calculation performed by software based on existing data. After the company data and daily stock price data have been inputted into the software, the optimal portfolio calculation is ready. Users just need to select the calculate button, the software will automatically perform calculations to get optimal portfolio results. These results are expected to assist investors in making investment decisions.

Figure 7 shows a menu for filling in company data taken from IDX. In addition, you can see a list of various companies that have been included in the portfolio calculation company data.

Figure 7. Data Filling

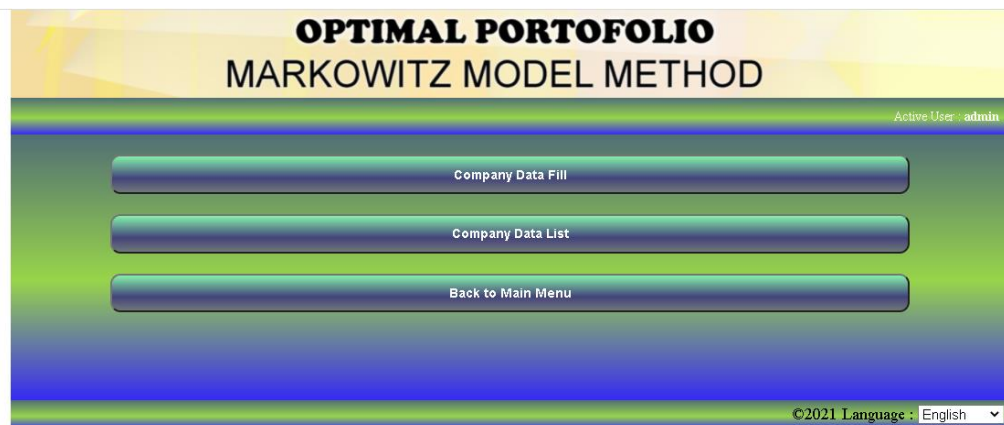


Table 2 shows the validation score from the material expert. The items contain the formula's validation and the optimal portfolio calculation.

Table 2. Material Proficient Recognition

	Question	Result		Percentage (%)	Accuracy
		X	Xi		
1	Formula accuracy	3	4	75	Quite Accurate
2	The accuracy of portfolio selection results	4	4	100	Accurate
	Mean	3,5	4	87,5	Accurate

Table 3 shows the validation of experts. The items contain technological quality, the button operation, and the presentation effectiveness of the software.

Table 3. System Proficient Recognition

	Question	Result		Percentage (%)	Accuracy
		X	Xi		
1	Technological Aspect				
	Easily operated	3	4	75	Quite Accurate
2	Button Operation				
	Key accuracy	4	4	100	Accurate
	Reaction speed	3	4	75	Quite Accurate
	Mean	3,5	4	87,5	Accurate
3	Presentation effectiveness				
a	Coloring	3	4	75	Quite Accurate
b	layout	3	4	75	Accurate
c.	Letter shape	3	4	75	Accurate
d	Integrity	4	4	100	Accurate
	Mean	3,75	4	81,3	Accurate

Based on the suggestion from the expert, the modification of the software is related to the compatibility of color selection. There are suggestions for the addition of entry and exit buttons, and for changing the color to a brighter color. Based on the results of various steps such as literature review, analysis stage, design stage, development stage, and validation by software experts, it has been successfully used as a learning medium related to investment management using the Markowitz method. This software is expected to support learning activities for students.

DISCUSSION

Investors in making investment decisions can use Markowitz software to get the most optimal portfolio choice. This software can also be used in the learning process in class, especially on subjects that discuss the best portfolios. Every stage of system development must be passed properly so that the software created is in accordance with the existing goals. For this software to be used in accordance with existing purposes, it is necessary to examine each existing stage. Often the software cannot be used because the software does not meet the user's expectations. For this reason, from the initial stage to the final stage of system development, it must be in accordance with user needs. All criteria for optimal portfolio testing must be met from the Definition to the Implementation stage. The definition stage is an important stage because at this stage the system planning to be developed is carried out. The system to be developed must be in accordance with the user's needs. The observation was carried out by interview, observation, and documentation methods. Interviews were conducted with system users. In developing this software, interviews were conducted with stock brokers and investors, to find out clearly about the need for software in making investment decisions, on stocks listed on the Indonesia Stock Exchange. In addition, a literature review was also carried out related to the portfolio calculation mechanism. This activity is carried out so that the system developed later can be useful and in accordance with the needs of investors and stock brokers as users of the system

After passing through the definition stage, software development is carried out in accordance with the information obtained in the definition stage. Making this software refers to defining the needs that have been done in the early stages. After the software

is finished, it is reviewed by experts. The definition of experts here are capital market and investment theorists (called material experts) and database experts. These two things are done so that the software that has been developed is indeed appropriate, both in terms of the method of calculation and the appearance of the software. Various improvements were made according to the advice of the expert. The improvements made are related to key functions in the software so that it can be operated easily.

Expert validation plays an important role in system testing so that the created software can be used and get optimal results. To make this software better, various revisions are needed to be related to the display presented, the content of the material, and resources. After the experts stated that the existing software was valid, the software portfolio development process was ready to be tested in the field.

CONCLUSION

The research aim is to develop Markowitz Methods Software to support the decision-making of investors and the student to obtain the optimal portfolio. The software was designed to complement the learning media of the investment management course. Development research of Markowitz methods software to support investment management learning has been successfully out using the SDLC (System Development Life Cycle) approach. After several revisions on the advice of media experts, the appearance of this software has become more interesting and getting better. Finally, the use of this software is used to assist lecturers in giving lessons on investment management using the Markowitz methods. Various inputs are needed to make this software better.

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DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest.

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