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Business Sector Financial Performance Evaluation Using Automated Approach in Assisting Investors' Decision-Making

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Abstract. Investors must carefully study and analyze a company's financial performance in order to avoid the risk of financial losses, which takes a lot of time due to the numerous criteria or financial statistics that must be taken into account. The investor's choice of the best company to invest in is further complicated by the limitations of human reasoning when faced with a large selection of choices. This study has proposed an automated system to help investors who plan to make investments by offering features to assess the financial performance of particular businesses within particular industries. The authors have suggested two strategies: TOPSIS and Fuzzy Logic approaches. Successful automated system development has been accomplished using these approaches. The approach allows investors the freedom to select from a range of performance evaluation criteria to establish the rankings. Investors can view the companies' rank in terms of their financial performance. Investors may also avoid getting overwhelmed with complicated, perhaps conflicting web information by employing the existing systems. It is observed that the proposed system is very user-friendly and managed to assist the investors' decision-making in making investments. It should be noted that the developed systems can be useful not only to investors but also to students taking business courses. From our analysis, there is no just one right technique to analyze a company and assess its current standings. Therefore, in the future, we recommend introducing an aggregate method to business appraisal in order to further give potential investors a better depiction of the businesses.

Keywords. Business Sector, Investment, Financial Performance, Decision Making, Automated System

1. Introduction

Knowledge is power in the modern world, and knowing the correct things to do and where to get them may be profitable, especially when it comes to investing. Before making any investment in a certain company, it is strongly advised that investors gain some basic understanding. The investor, especially when lacking in investing knowledge and resources to turn to, carries the danger of losing their investment.

Beattie (2020) claims that "one of the most daunting challenges in making an investment is, obtaining the right resources." It is obvious from this statement that it is difficult to acquire the necessary information to make an investment. Since the Internet's creation in 1983 and the vast amount of knowledge and information it contains, accessing knowledge and resources has become relatively simple. However, finding the correct knowledge and resources is nearly impossible. This is due to the fact that there is an abundance of information and that the knowledge contained in one resource frequently conflicts with that of another.

Barber and Odean (2000) state that "despite households' substantial ownership of stocks, there is little research on the return performance of equities held directly by households." This assertion claims that the majority of investors are not knowledgeable about the standard of returns on their investments.

Additionally, stock market investments do not guarantee a good profit unless the investor has knowledge or a strategy that can assist or direct them in selecting the stock or share that has the potential to produce a good profit (Abd-Rahim et al., 2020; Fahami et al., 2015). The correct investment can enhance banking and entrepreneurial performance (Kristanto, 20221).

In light of the aforementioned issues, it has been determined that a solution should be put out to assist investors in choosing wisely. The objective of this study is to develop an automated application that is designed for calculating the ambiguous factors on the return on investment and lowering the chances of investors losing their invested money in business.

The following is the organization of this paper: The Literature Review is presented in Section 2. The Methodology is explained in Section 3. Results and Discussions are elaborated in Section 4. Lastly, Section 5 summarizes the Conclusion of the paper.

2. Literature Review

This section discusses the important facts related to investments, Fuzzy Logic and TOPSIS methods with regard to their applications in the financial sectors.

2.1.1. Type of Investments. There are numerous investment types available in Malaysia alone, according to the Securities Commission Malaysia Initiative website, InvestSmart. In Malaysia, common investment types include shares, unit trust funds, cash and fixed interest investments, and last but not least, real estate. The most popular type of investment in Malaysia is cash and fixed interest, which includes items like bank savings accounts and fixed deposits. When it comes to this, they are the most trustworthy because there is no possibility that you may lose any money. They give you quick access to your money when you need it.

Investments that indicate ownership in a firm are shares, commonly referred to as equities or stocks. The investment in shares entitles you to a portion of the company's future

worth and profits when you purchase a share. Investors can benefit from company shares in two main ways. First, the value of the shares rises when the company's overall worth does. When a corporation decides to distribute a portion of its revenues to shareholders as an income payment, the investors might profit from dividends.

A collection of individual investors' money, known as unit trust funds, is combined to purchase a wide range of various assets. Professional investment managers decide how much of the fund should be invested in each asset class as well as which nations, industries, and companies have the best chance of making money.

2.1.2. Risk of Investments. All investing options share the same characteristic of risk. Risks might be found in even bank savings books. Many investors who suffered financial losses felt they were not informed of these risks when choosing their investments. Although he is required by law to do so, the investment consultant may have occasionally forgotten to advise clients of the dangers.

Some metrics can be developed to lessen the chance of losing the investment, for instance, the most popular risk measures are volatility and the variation of returns, which are frequently used to alert investors of the risk of bonds. Careful attention to prospective losses is another. With this approach, the worst-case scenario for investment returns is taken into consideration (Sachse et al., 2012).

2.1.3. Financial Ratios as Measurement Instruments for Evaluating Financial Performance. Financial ratios can be used to assess a company's business's financial performance. Ratios can assist investors in becoming more knowledgeable about their investments. For example, there are five different sorts of fundamental financial ratios that can be used to determine a company's value, which are the working capital ratio, quick ratio, earning per share, price-earnings and debt-equity ratio.

Financial ratios provide critical information for analysts and investors to identify the company's financial performance. Fahami et al. (2015) stated that financial ratios also can be categorized into a few parts such as leverage ratio, liquidity ratio, activity ratio, profitability ratio, and market ratio. The liquidity ratios show the relationship between a company's liquid assets and liabilities while profitability ratios show the mix result of liquidity, assets management and debt (Yunus & Malik, 2012).

According to Yunus and Malik (2012), selecting the most suitable ratios that represent the company's performance is vital because the wrong selection of criteria will cause bad quality of accuracy in evaluating business performance. The authors stated that in Malaysia, the rules were applied for all companies to publish their financial statement information by following a standard annual report format. So, through the financial statement data, evaluating financial performance can be done. Fahami et al (2015) have demonstrated the usage of financial ratios in evaluating the financial performance of a number of companies. Setiawan and Sumantri (2020) also claimed that some financial ratios significantly and positively affect stock prices.

2.1.4. Fuzzy Logic Method in the Financial Sector. Fuzzy Logic has been widely used in computer engineering, robotics and industrial engineering. The globalization process has contributed to the creation of a dynamic network of business relationships. In a free-market economy, this means an increase in the complexity and volatility of factors influencing the

financial status of individuals. Nowadays, many financial and economic phenomena are fuzzy, but they are viewed as if they were crisp (Korol, 2012).

In the 1960s, Fuzzy Logic was developed as a paradigm or instrument to address natural language problems. This model placed more emphasis on the "fuzzification" procedure, which is a technique for converting any particular theory from a crisp (discrete) to a continuous form. Fuzzy systems have advanced, making it possible to construct the best computerized model for financial performance, allowing managers or investors to assess stock performance and financial performance more effectively. When it came to the form of reasoning that is estimated rather than exact, Fuzzy Logic was a particularly reliable approach (Konrad & Philip, 1994).

From the literature review, some researchers used the Fuzzy Logic model to evaluate the financial performance of certain companies (Fahami et al., 2015; Baranes et al., 2021; Morozko et al., 2022, Pislaru et al., 2019; Tavakkoli et al., 2010, Ünvan et al., 2022). Criteria that were considered in the Fuzzy Logic model include debt ratio, financial leverage index, return on investment (ROI), quick ratio, return on equity (ROE), current ratio, and price-earnings ratio (P/E). One of the most used models by researchers is the model adopted by Tavakkoli et al (2010) as given below:

Criteria	Types of Fuzzy Number	SUP(x)	Fuzzy Number
ROE	Triangle	$0.7 \leq x < 1$	$\mu_{ROE} = \begin{cases} 1.42x & 0 \leq x < 0.7 \\ 1 & 0.7 \leq x < 1 \\ 0 & \text{others} \end{cases}$
Current Ratio	Tripezoid	$1 \leq x < 2$	$\mu_{CR} = \begin{cases} x & 0 \leq x < 1 \\ 1 & 1 \leq x < 2 \\ 3-x & 2 \leq x < 3 \\ 0 & \text{others} \end{cases}$
Debt Ratio	Triangle	$x = 0.5$	$\mu_{DR} = \begin{cases} 2x & 0 \leq x < 0.5 \\ 2-2x & 0.5 \leq x < 2 \\ 0 & \text{others} \end{cases}$

Figure 1: Fuzzy Logic Model

The above model by Tavakkoli et al (2010) considered Return on Equity (ROE), Current Ratio (CR), and Debt Ratio (DR) in the formula for the evaluation.

2.1.5. TOPSIS Method in the Financial Sector. A multi-criteria decision-making methodology can be used to assess the financial performance of companies. Technique for Choice by Similarity to Ideal Solution (TOPSIS) is the most used methodology. Performance evaluation is becoming more and more important in the financial services industry, particularly for banking operations (Mandic et.al, 2014). Therefore, using a variety of financial ratios, the TOPSIS model is used to assess the financial performance of Malaysian banks. The TOPSIS paradigm also provides a lot of other benefits. The model is simple to operate and straightforward to program. It has a straightforward procedure, and no matter how many qualities there are, there are always the same amount of steps (Tansel, 2012). Among the studies that incorporated the TOPSIS as their methodology in their research include Hussain et al., 2020; Hwang et al., 1981; Yildiz, 2020.

According to the TOPSIS concept, the selected alternative should have the shortest geometric distance from the positive ideal solution (PIS) and the longest geometric distance

from the negative ideal solution (NIS) (Assari et al., 2012). By defining the weights for each criterion, normalizing the scores for each criterion, and calculating the geometric distance between each alternative and the ideal alternative, which has the highest score for each criterion, the TOPSIS method compares a set of alternatives. A bad result in one criterion may be offset by a good result in another criterion under TOPSIS, which allows trade-offs between criteria. Compared to non-compensatory techniques, this will offer a more useful type of modeling that includes or excludes alternate solutions based on difficult cut-offs.

Among the financial ratios used are Current Ratio (CR), Dividend Yield (DY), Price-To-Earning (P/E), Gross Profit Margin (GPM), Return on Equity (ROE), Debt Ratio (DR) and Earnings Per Share (EPS). The TOPIS method, in general, consists of the following steps as depicted in Figure 2.

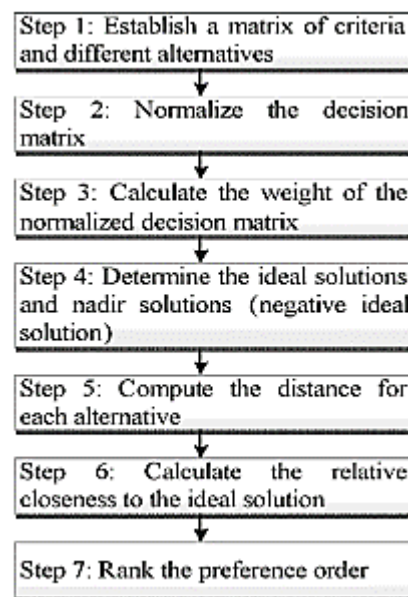


Figure 2: TOPSIS model

There are quite a lot of research works documented in the literature employing the TOPSIS approach in assessing companies' financial performances (Abd Rahim et al., 2020; Azhar et al., 2022; Chakraborty et al., 2023; Hoe et al., 2020; Lam et al., 2022; Sariyer et al., 2021; Ünvan, 2020). Based on their findings, the TOPSIS model was able to assess the companies' financial performance successfully. Some authors consequently ranked the companies and the results from the study are consistent with the study done by other investment agencies (Abd Rahim et al., 2020, Azhar et al., 2022).

3. Methodology

This section describes the Software Development Framework employed in this project to develop the automated system, which was named e-INVEST. We also describe the system architecture, user interface and pseudocodes in brief.

3.1.1. Software Development Framework. The Agile Software Development Life Cycle (SDLC) framework was employed in this project. The Agile methodology is an approach in project management that emphasizes ongoing collaboration and improvement while dividing the project into phases.

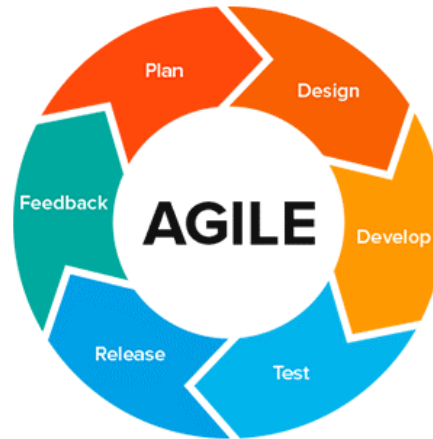


Figure 3: Agile Software Development Life Cycle Framework

As can be seen in Figure 3, the Agile SDLC framework consists of 6 phases: Plan, Design, Develop, Test, Release and Feedback. Important activities carried out during each phase are briefly explained below:

- Plan – In this first phase of the project, the purpose and the goal of the project were defined. The user requirements were also clearly determined.
- Design – In this second phase of the project, the designing of the User Interfaces (UI) and pseudocodes was done.
- Develop – In this third phase of the project, coding was done based on the pseudocodes designed in the previous phase. The first iteration of this software product's development was observed to be the longest phase.
- Test – In this fourth phase of the project, to ensure that every part of the system works properly, the entire system is tested carefully.
- Release – In this fifth phase of the project, the completed system is released to the customers/users.
- Feedback – In this sixth phase of the project, based on the released version, feedback from the customers/users is obtained and the system is improved accordingly

Note that the chosen software development framework is a continuous process, thus a few rounds of the cycle were executed to ensure that the developed system managed to satisfy all the requirements and the system functions properly without any errors.

3.1.2. *System Architecture.* The system architecture of the developed system is illustrated in Figure 4.

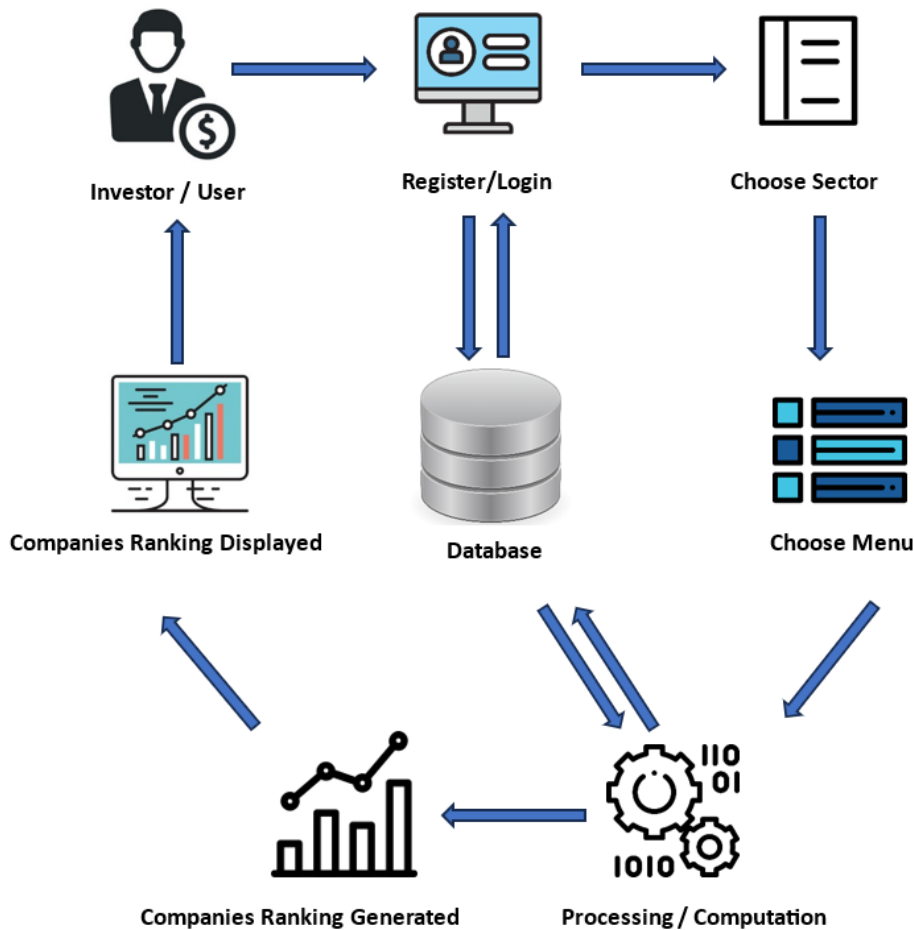


Figure 4: System Architecture of e-INVEST

The investor or user is required to register and log in before they can use the system. Once they have managed to log in to the system, they can choose the sector of business and later they can proceed to choose which function to perform based on the list of options displayed in the menu. After the function has been selected, the required processing or computation will be done and later the results will be generated by the system, for example, the ranking results of the companies according to their financial performance will be generated automatically by the system, and finally, it will be displayed to the investor or user.

3.1.3. *User Interface Design.* The design of the User Interfaces (UI) in this system is based on the user-friendly concept. As such, all the components used in designing the UI are simple and easy to access and understand. For this project, a few versions of the system have

been released. Previous versions were using the Fuzzy Logic approach, whereas the latest version is using the TOPSIS approach.

It is worth noting that the main aim of developing this automated system is to let potential investors use the functions provided to see the ranking of companies generated according to their financial performance. Anyway, the authors also want to give other users the chance to use the system and benefit from it. Another category of target users is the students who are learning business courses. It must be agreed that calculating, evaluating or analyzing manually financial performance of a company involving many financial ratios needs to be taken into consideration is very tedious and time-consuming. As such, we believe that besides investors, students who are learning business courses and want to evaluate the financial performance of certain companies can benefit from this system just like the investors. Apart from using the system directly, students can also use the system to check whether their manual calculations using pen and paper are correct. Due to this reason, we designed the interface using colorful components in order to attract younger age users to use it.

For example and explanation purposes, in this paper, only a few important UI will be illustrated. The screenshots of the UI from both systems (utilizing the Fuzzy Logic approach and TOPSIS approach) will be placed side by side and explained briefly.



Figure 5: The main screen of the user interface of the e-INVEST system

Figure 5 illustrates the main screen of the user interface of the e-INVEST system. The image on the left is the screenshot of the system employing Fuzzy Logic to evaluate the financial performance of the company, while the image on the right is the screenshot of the system employing the TOPSIS approach.

The next figure, Figure 6, illustrates the screenshots of the screen where the investor or user can select the sector of business that he/she is interested in. At the moment, there are 6 sectors available in the system that can be selected by the investor / user, which are the Healthcare, Services, Consumer, Plantation, Construction and Drug Industry. Investors or users can simply click on any of the buttons to select a sector.

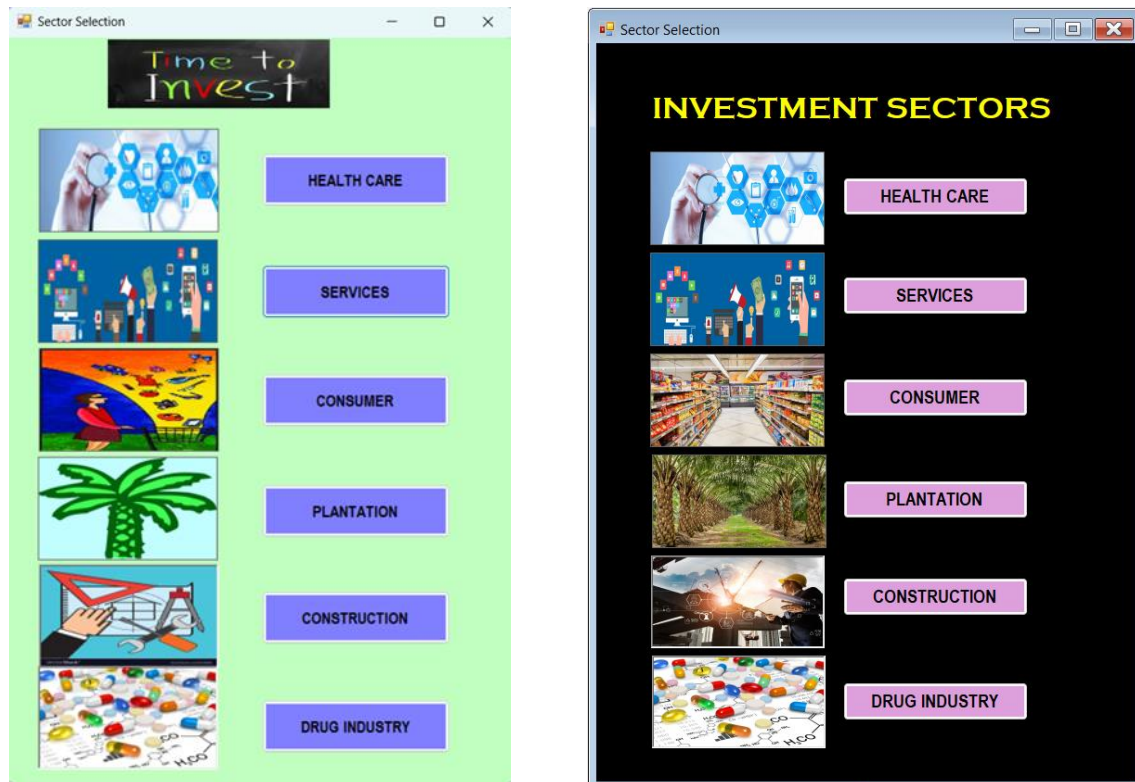


Figure 6: The main screen of the user interface of the e-INVEST system

Once the investor / user has made the sector selection, the menu interface will be displayed as can be seen in Figure 7. Among the options from the menu that can be selected are View Existing Companies, Rank Companies In System, Rank Selected Companies, Add New Data, Search / Delete Data, Sector and Exit. Each button if it is being clicked, will navigate to another interface that allows the investor / user to perform some other functions. Anyway, for this paper, the main focus is the function of ranking the companies in the system. For explanation purposes, the Healthcare sector is chosen and the ranking results generated by the systems will be presented in the next section.

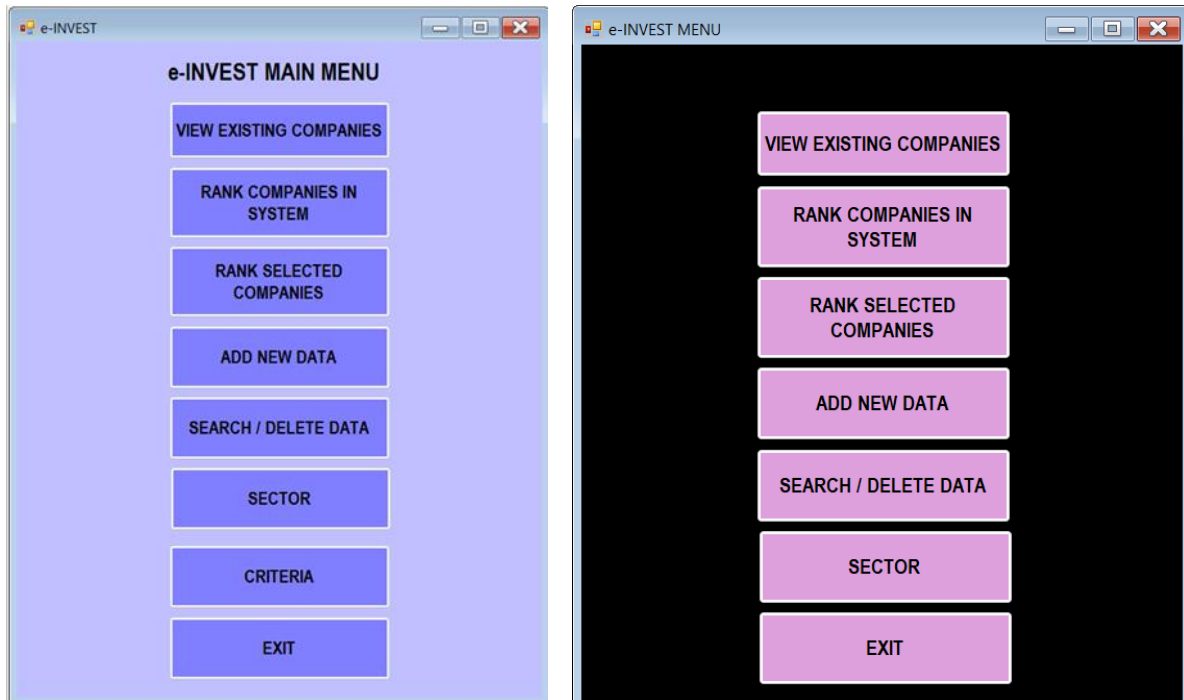


Figure 7: The main screen of the user interface of the e-INVEST system

3.1.4. *Pseudocodes.* The pseudocodes for both Fuzzy Logic and TOPIS approaches used to evaluate the financial performance of the companies are presented in this section.

i) Fuzzy Logic

The Fuzzy Logic approach based on the model proposed by Tavakkoli (2010) and was adopted by some previous studies (Fahami et al., 2015; Baranes et al., 2021; Morozko et al., 2022, Pislaru et al., 2019; Ünvan et al., 2022) has been employed in this study. Three types of criteria or financial ratios, the ROE, CR and DR have been used in the computation. Below, the pseudocodes for this approach are presented.

Begin

Retrieve the value for ROE, CurrentRatio and DebtRatio

Initialize MuCR, MuDR, MuROE, PositiveMuCR, min1 and min2, Finalmin to zero value

If ROE ≥ 0 and ROE < 0.7 then

Set MuROE = $1.42 * ROE$

Else If ROE ≥ 0.7 and ROE < 1 then

Set MuROE = 1

Else

Set MuROE = 0

End If

If CurrentRatio ≥ 0 and CurrentRatio < 1 then

Set MuCR = CurrentRatio

Else If CurrentRatio ≥ 1 and CurrentRatio < 2 then

Set MuCR = 1

```
Else If CurrentRatio >= 2 and CurrentRatio < 3 then
Set MuCR = (3 – CurrentRatio)
Else
Set MuCR = 0
End If
```

```
If MuCR < 0 then
Set PositiveMuCR = 1 + MuCR
Else
PositiveMuCR = MuCR
```

```
If DebtRatio >= 0 and DebtRatio < 0.5 then
Set MuDR = (2 * DebtRatio)
Else if DebtRatio >= 0.5 and DebtRatio < 2 then
Set MuDR = 2 * (2 * DebtRatio)
Else
Set MuDR = 0
End If
```

```
Set min1 = FindMin(MuROE and PositiveMuCR)
Set min2 = FindMin(min1 and MuDR)
Set FinalMin = min2
```

Rank the companies from the selected sector according to FinalMin in descending order
End

Note that the selected financial ratios for the selected companies in a particular sector are evaluated using some formulas with the objective of identifying the value of the final minimum which determines the ranking of the companies according to their financial performance.

ii) TOPSIS

The TOPSIS approach which was proposed by Hwang et al. (1981), and was adopted by many other researchers (Abd Rahim et al., 2020; Azhar et al., 2022; Chakraborty et al., 2023; Hoe et al., 2020; Lam et al., 2022; Sariyer et al., 2021; Ünvan, 2020) is utilized in this study. Seven types of criteria or financial ratios have been used in the computation to evaluate the financial performance of the companies in the sector selected. The pseudocodes for this approach are given below:

Begin

```
Retrieve the value for wCR, wDY, wPE, wGPM, wROE, wTDTA, wEPS
Initialize nCR, nDY, nPE, nGPM, nROE, nTDTA, nEPS, sumsqCR, sumsqDY, sumsqPE,
sumsqGPM, sumsqROE, sumsqTDTA, sumsqEPS to zero value
```

```
Find the total sumsqCR
Set the nCR = square root (sumsqCR)
```

Calculate the total sumsqDY
Set the $nDY = \text{square root}(\text{sumsqDY})$
Calculate the total sumsqPE
Set the $nPE = \text{square root}(\text{sumsqPE})$
Calculate the total sumsqGPM
Set the $nGPM = \text{square root}(\text{sumsqGPM})$
Calculate the total sumsqROE
Set the $nROE = \text{square root}(\text{sumsqROE})$
Calculate the total sumsqTDTA
Set the $nTDTA = \text{square root}(\text{sumsqTDTA})$
Calculate the total sumsqEPS
Set the $nEPS = \text{square root}(\text{sumsqEPS})$

Calculate a new value for CR by dividing it with nCR
Calculate a new value for DY by dividing it with nDY
Calculate a new value for PE by dividing it with nPE
Calculate a new value for GPM by dividing it with $nGPM$
Calculate a new value for ROE by dividing it with $nROE$
Calculate a new value for TDTA by dividing it with $nTDTA$
Calculate a new value for EPS by dividing it with $nEPS$

Calculate a new value for CR by multiplying it with wCR
Calculate a new value for DY by multiplying it with wDY
Calculate a new value for PE by multiplying it with wPE
Calculate a new value for GPM by multiplying it with $wGPM$
Calculate a new value for ROE by multiplying it with $wROE$
Calculate a new value for TDTA by multiplying it with $wTDTA$
Calculate a new value for EPS by multiplying it with $wEPS$

Calculate the maximum value of CR and set it as idealCR
Calculate the maximum value of DY and set it as idealDY
Calculate the maximum value of PE and set it as idealPE
Calculate the maximum value of GPM and set it as idealGPM
Calculate the maximum value of ROE and set it as idealROE
Calculate the maximum value of TDTA and set it as idealTDTA
Calculate the maximum value of EPS and set it as idealEPS

Calculate the minimum value of CR and set it as worstCR
Calculate the minimum value of DY and set it as worstDY
Calculate the minimum value of PE and set it as worstPE
Calculate the minimum value of GPM and set it as worstGPM
Calculate the minimum value of ROE and set it as worstROE
Calculate the minimum value of TDTA and set it as worstTDTA
Calculate the minimum value of EPS and set it as worstEPS

Calculate a new value for CR by subtracting idealCR from the latest CR
Calculate a new value for DY by subtracting idealDY from the latest DY

Calculate a new value for PE by subtracting idealPE from the latest PE
Calculate a new value for GPM by subtracting idealGPM from the latest GPM
Calculate a new value for ROE by subtracting idealROE from the latest ROE
Calculate a new value for TDTA by subtracting idealTDTA from the latest TDTA
Calculate a new value for EPS by subtracting idealEPS from the latest EPS
Calculate the distance from the positive ideal solution (d+) by square rooting sum of squares of all criteria

Calculate a new value for CR by subtracting worstCR from the latest CR
Calculate a new value for DY by subtracting worstDY from the latest DY
Calculate a new value for PE by subtracting worstPE from the latest PE
Calculate a new value for GPM by subtracting worstGPM from the latest GPM
Calculate a new value for ROE by subtracting worstROE from the latest ROE
Calculate a new value for TDTA by subtracting worstTDTA from the latest TDTA
Calculate a new value for EPS by subtracting worstEPS from the latest EPS
Calculate the distance from the negative ideal solution (d-) by square rooting sum of squares of all criteria

Calculate the value for C_i by dividing the total sum of d+ and d- from d+
Rank the companies from the selected sector according to C_i in descending order

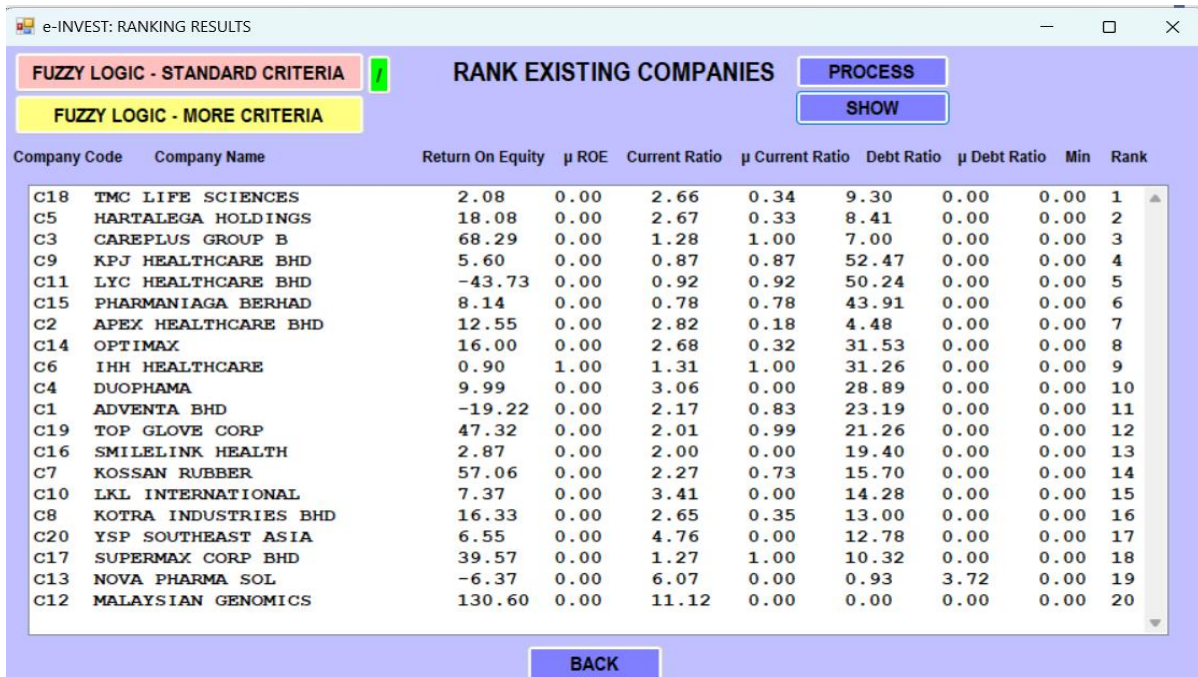
End

Some operations and computations were made on the seven financial ratios with the objective of finding the C_i , which determines the financial performance of the companies under the selected sector. Once the required values are obtained, the ranking of the companies will be done.

4. Results and Discussions

In this section, the results of the automated ranking process done by the developed system using both approaches will be presented and discussed.

Figure 8 is the screenshot of the ranking results of the companies in the Healthcare sector in Malaysia using the Fuzzy Logic approach. It is observed that based on the results, TMC Life Sciences, Hartalega Holdings, Careplus Group B, KPJ Healthcare Bhd and LYC Healthcare Bhd are the top 5 companies with regard to their financial performances, whereas Kotra Industries Bhd, YSP Southeast Asia, Supermax Corp Bhd, Nova Pharma Sol and Malaysian Geonomics are the bottom five companies.



e-INVEST: RANKING RESULTS

FUZZY LOGIC - STANDARD CRITERIA | RANK EXISTING COMPANIES | PROCESS


FUZZY LOGIC - MORE CRITERIA | SHOW

Company Code	Company Name	Return On Equity	μ ROE	Current Ratio	μ Current Ratio	Debt Ratio	μ Debt Ratio	Min	Rank
C18	TMC LIFE SCIENCES	2.08	0.00	2.66	0.34	9.30	0.00	0.00	1
C5	HARTALEGA HOLDINGS	18.08	0.00	2.67	0.33	8.41	0.00	0.00	2
C3	CAREPLUS GROUP B	68.29	0.00	1.28	1.00	7.00	0.00	0.00	3
C9	KPJ HEALTHCARE BHD	5.60	0.00	0.87	0.87	52.47	0.00	0.00	4
C11	LYC HEALTHCARE BHD	-43.73	0.00	0.92	0.92	50.24	0.00	0.00	5
C15	PHARMANIAGA BERHAD	8.14	0.00	0.78	0.78	43.91	0.00	0.00	6
C2	APEX HEALTHCARE BHD	12.55	0.00	2.82	0.18	4.48	0.00	0.00	7
C14	OPTIMAX	16.00	0.00	2.68	0.32	31.53	0.00	0.00	8
C6	IHH HEALTHCARE	0.90	1.00	1.31	1.00	31.26	0.00	0.00	9
C4	DUOPHAMA	9.99	0.00	3.06	0.00	28.89	0.00	0.00	10
C1	ADVENTA BHD	-19.22	0.00	2.17	0.83	23.19	0.00	0.00	11
C19	TOP GLOVE CORP	47.32	0.00	2.01	0.99	21.26	0.00	0.00	12
C16	SMILELINK HEALTH	2.87	0.00	2.00	0.00	19.40	0.00	0.00	13
C7	KOSSAN RUBBER	57.06	0.00	2.27	0.73	15.70	0.00	0.00	14
C10	LKL INTERNATIONAL	7.37	0.00	3.41	0.00	14.28	0.00	0.00	15
C8	KOTRA INDUSTRIES BHD	16.33	0.00	2.65	0.35	13.00	0.00	0.00	16
C20	YSP SOUTHEAST ASIA	6.55	0.00	4.76	0.00	12.78	0.00	0.00	17
C17	SUPERMAX CORP BHD	39.57	0.00	1.27	1.00	10.32	0.00	0.00	18
C13	NOVA PHARMA SOL	-6.37	0.00	6.07	0.00	0.93	3.72	0.00	19
C12	MALAYSIAN GENOMICS	130.60	0.00	11.12	0.00	0.00	0.00	0.00	20

BACK

Figure 8: The main screen of the user interface of the e-INVEST system

Meanwhile, Figure 9 is the screenshot of the ranking results of the companies in the Healthcare sector in Malaysia using the TOPSIS approach. It can be seen that IHH Healthcare, Top Glove Corp, Kossan Rubber, Malaysian Geonomics and Kotra Industries Bhd are the top 5 companies according to their financial performances. In terms of the bottom 5 companies with regard to the same aspect, Nova Pharma Sol, LKL International, TMC Life Sciences, LYC Healthcare Bhd and Adventa Bhd are the companies listed automatically by the system.



Company Code	Company Name	CR	DY	PE	Gross Profit Margin	ROE	Total Debt %Total Asset	EPS	CI	Ranking
C6	IHH HEALTHCARE	0.005	0.014	0.135	0.101	0.035	0.040	0.021	0.500	1
C19	TOP GLOVE CORP	0.011	0.093	0.011	0.104	0.072	0.027	0.062	0.500	2
C7	KOSSAN RUBBER	0.013	0.019	0.016	0.105	0.080	0.020	0.105	0.493	3
C12	MALAYSIAN GENOMICS	0.090	0.000	0.011	0.000	0.138	0.000	0.050	0.454	4
C8	KOTRA INDUSTRIES BHD	0.016	0.057	0.018	0.108	0.048	0.017	0.058	0.445	5
C3	CAREPLUS GROUP B	0.004	0.003	0.015	0.102	0.089	0.009	0.063	0.438	6
C20	YSP SOUTHEAST ASIA	0.035	0.058	0.011	0.104	0.040	0.016	0.049	0.430	7
C17	SUPERMAX CORP BHD	0.004	0.000	0.031	0.104	0.066	0.013	0.057	0.421	8
C4	DUOPHAMA	0.020	0.031	0.031	0.104	0.043	0.037	0.034	0.415	9
C15	PHARMANIAGA BERHAD	0.000	0.047	0.020	0.098	0.041	0.057	0.038	0.414	10
C5	HARTELEGA HOLDINGS	0.016	0.015	0.038	0.102	0.049	0.011	0.043	0.405	11
C9	KPJ HEALTHCARE BHD	0.001	0.023	0.030	0.104	0.039	0.068	0.021	0.405	12
C14	OPTIMAX	0.017	0.000	0.035	0.108	0.047	0.041	0.021	0.399	13
C2	APEX HEALTHCARE BHD	0.018	0.020	0.026	0.101	0.045	0.006	0.041	0.384	14
C16	SMILELINK HEALTH	0.011	0.011	0.038	0.105	0.037	0.025	0.017	0.374	15
C13	NOVA PHARMA SOL	0.046	0.015	0.030	0.104	0.030	0.001	0.015	0.372	16
C10	LKL INTERNATIONAL	0.023	0.000	0.028	0.103	0.040	0.018	0.018	0.363	17
C18	TMC LIFE SCIENCES	0.016	0.005	0.018	0.099	0.036	0.012	0.018	0.336	18
C11	LYC HEALTHCARE BHD	0.001	0.000	0.007	0.102	0.000	0.065	0.010	0.329	19
C1	ADVENTA BHD	0.012	0.000	0.000	0.096	0.019	0.030	0.000	0.297	20

Figure 9: The main screen of the user interface of the e-INVEST system

Based on the ranking results generated by both approaches, it is very obvious that the rankings of companies are not the same, in fact, there is no direct correlation between the two results generated. Scrutinizing the results further by observing Table 1, we identified that there are situations where there are two companies that were given a good ranking (Top 5) in the Fuzzy Logic approach, were ranked in the bottom 5 for TOPSIS (TMC Life Sciences and LYC Healthcare Bhd) and vice versa where Malaysian Geonomics and Kotra Industries were ranked Top 5 by using the TOPSIS approach but were ranked Bottom 5 by using the Fuzzy Logic approach.

Table 1: Top 5 and Bottom 5 Rankings of Companies in the Healthcare Sector Using Fuzzy Logic and TOPSIS approaches

Fuzzy Logic	TOPSIS	Fuzzy Logic	TOPSIS
Top Five Ranking (1 to 5)	Top Five Ranking (1 to 5)	Bottom Five Ranking (16-20)	Bottom Five Ranking (16-20)
TMC Life Sciences	IHH Healthcare	Kotra Industries Bhd	Nova Pharma Sol
Hartalega Holdings	Top Glove Corp	YSP Southeast Asia	LKL International
Careplus Group B	Kossan Rubber	Supermax Corp Bhd	TMC Life Sciences
KPJ Healthcare Bhd	Malaysian Geonomics	Nova Pharma Sol	LYC Healthcare Bhd
LYC Healthcare Bhd	Kotra Industries Bhd	Malaysian Geonomics	Adventa Bhd

The main possible and logical factor contributing to the very contra outcome of the ranking results generated by the two approaches is mainly due to the type of criteria (financial ratios) and the number of criteria taken into consideration by both approaches. Recall that, Fuzzy Logic only employed three types of criteria which are the ROE, CR and DR. As opposed

to Fuzzy Logic, the TOPSIS employed more criteria, which is 7 criteria altogether, which are CR, DY, P/E, GPM, ROE, DR and EPS. The additional criteria introduced by the TOPSIS and the approach in TOPSIS provide a different view of the companies. Looking at the number of criteria and the steps involved in the TOPSIS method, it can be agreed that this method is more comprehensive as compared to the Fuzzy Logic approach. This can be related to the claim about TOPSIS which appears to be more reliable in terms of changes to alternatives and criteria (Junior et al., 2014).

With the objective to provide an indicative ranking to be used by investors, having ranked a company that has good positioning on one approach and one of the worst rank on the other will provide mixed signs to the investor thus complicating the decision-making process. There are also companies that are ranked in the top 5 in one approach and were ranked in the 25% to 75% range, the companies are Hartalega Holdings, Careplus Group B and KPJ Healthcare. Similar to that IHH Healthcare, Top Glove Corp and Kossan Rubber ranked among the Top 5 in TOPSIS we ranked in the 25% to 75% range. The difference can be attributed to the base of the approach or the data being evaluated of these two approaches as each algorithm has its own different concern in evaluating a business's financial performance. Thus, it is suggested that a mechanism to find the best solution between the two approaches is further proposed.

5. Conclusion

To conclude, this paper discusses the risks that any investor may face in making investments. Due to the numerous criteria or financial ratios that must be taken into account, it is exceedingly time-consuming for investors to manually review and analyze a company's financial performance. Additionally, the limitations of human reasoning when presented with a wide range of options, also complicate the investor's decision-making in determining the right company to make investments.

As such, this study has proposed an automated system to assist investors who intend to make investments by providing functions to evaluate the financial performance of certain companies under selected sectors. Two approaches have been proposed by the authors, 1) Fuzzy Logic and 2) TOPSIS methods. Automated systems employing these methods have been constructed successfully. Each system provides a few menus and functionalities, but the main focus of this study is the function to automatically evaluate the financial performances of selected companies based on some important financial ratios. The system gives the flexibility for the investors to choose among the criteria of performance evaluations to determine the ranking results. Investors are able to see the ranking of the companies concerning their financial performance. By using the developed systems, investors might also avoid being overloaded with complex, sometimes contradicting online advice. It should be mentioned here that not only investors can benefit from the developed systems, but students learning business courses can also benefit from it.

Based on the results obtained, there is no single way or approach to evaluate a business and to assess its current standings, thus we would suggest that an aggregate approach towards business evaluation is introduced to further provide a better representation of the businesses to the possible investors. Another approach is to consolidate the results and provide a more general classification or evaluation that will give a better understanding to the investors by providing the level of fulfillment towards criteria that is of concern to the investors.

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