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**EMPLOYING AI TO EVALUATE COMPANIES'
PERFORMANCE - AN APPROACH TO UTILIZE CHATGPT
FOR FINANCIAL RATIO ANALYSIS TO ASSIST MANAGERS
IN DECISION MAKING**

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I hereby declare that I have compiled the thesis independently and all works, important standpoints and data by other authors have been properly referenced and the same paper has not been previously presented for grading.

The document length is 13185 words from the introduction to the end of the conclusion.

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ABSTRACT

The necessity of possessing financial awareness by managers for the success of a business is axiomatic. Financial ratio analysis can be utilized by managers to evaluate the performance of a company. Despite their exceptional management skills, numerous managers' breadth of knowledge in financial evaluation is finite. Considering the ever-growing confrontation of businesses with rapid change, managers need to ask experts for ratio analysis to be able to evaluate a company. But having experts to do the analysis is time consuming and costly.

In this study the accuracy and efficiency of ChatGPT as an AI-based language model for financial ratio analysis has been examined as an alternative way to make businesspeople, specifically managers able to do the ratio analysis by themselves. Testing 50 companies' financial statements for financial ratio analysis by ChatGPT showed 92% accuracy in profitability, liquidity, solvency, and operating ratios' analysis. However, there is still room for improvement in the accuracy of ratios' calculations, which were found to be 79% accurate.

In addition, a survey was conducted. Respondents, including experts and non-experts in financial ratio analysis tested ChatGPT by themselves or reviewed a sample ChatGPT's analysis, provided in the survey. The analysis of the survey revealed that respondents' perceptions of the benefits of ChatGPT in financial ratio analysis emphasize the potential for quick and efficient data sorting, save time, and increase productivity. However, they suggested that AI-based solutions such as ChatGPT should be viewed as a support to human judgment, not as a replacement. Therefore, managers can consider ChatGPT as an aid for primary evaluation of a company which can help them in decision making.

Keywords:

Artificial intelligence, Ratio analysis, Performance evaluation, Decision making

INTRODUCTION

Currently, financial ratios are widely used to assess the performance of companies (Chen & Shimerda, 1981). Managers utilize ratio analysis to examine their own firms, as well as those of their new partners and competitors, in order to make the best decision possible. Ratio analysis is also used by investors to gain a general understanding of the financial performance of the firm in which they intend to invest (Ndum, 2022). Furthermore, auditors and credit analysts utilize ratio analysis to evaluate a company's creditworthiness and compose credit reports for their management (Krulicky & Horak, 2021). On a basic level, everyone in business can benefit from an overview of the performance evaluation of a company with whom he or she will cooperate (Coakley & Brown, 1993).

As a credit analyst, the author has been asked to analyze the financial statement of a company as a new partner or for investment several times a month. Financial ratio analysis is usually done manually by analysts because it includes qualitative and quantitative factors to go through. The evaluation process of a company needs a detailed and exhaustive evaluation of a company's financial and operational performance, as well as its competitive positioning and growth possibilities. It demands a comprehensive grasp of financial and business analytical tools and techniques, as well as industry and market expertise (Babalola & Abiola, 2013). Managers typically request analysts to generate financial ratios analysis that is the most important part of companies' evaluation process and represent the results. These results are kind of streamlined evaluation of companys' performance that can assist managers in making decisions, financial plannings, mitigating risks, investments decisions, changing or continuing company's current strategy based on actual financial outcomes.

This study investigates a new AI-based language model (ChatGPT) that created by the artificial intelligence research firm (Open AI) as a large language model. It is trained on a massive quantity of text data from the internet and can give information and assistance on a variety of topics by understanding natural language and generating human-like replies to a variety of inquiries and

prompts. It uses deep learning algorithms to assess and comprehend inputs in natural language and provide relevant answers (George & George, 2023).

As a language model, ChatGPT is trained on a vast corpus of literature and can construct language similar to that of humans based on the input it gets (George & George, 2023). This implies that it is also efficient to respond quickly to questions about financial ratios and their computations, but it is crucial to note that ChatGPT is not a specialist financial analysis tool and does not possess the same degree of experience and knowledge as a qualified financial analyst. This is why its accuracy and efficiency are being investigated in this study as the object of this research.

Research problem for this study is defined as calculating financial ratios requires the collection and analysis of financial data from a range of sources, including financial statements, annual reports, and other financial data sources. This procedure can be time-consuming and complicated, especially for businesses that must examine a huge quantity of financial data. In addition, evaluating financial measures effectively requires a comprehensive grasp of financial analysis and accounting concepts, as well as the company's industry and market (Babalola & Abiola, 2013). This knowledge may not be easily available inside an organization, especially for smaller companies and the ones that their managers have limited knowledge in finance. As a result, many businesses may need to employ financial analysts or accountants to assist them in calculating and interpreting financial ratios. Employing specialists may be expensive for firms, especially smaller enterprises with limited financial means (Kunnathuvalappil Hariharan, 2018). In addition, the time and resources necessary to undertake a full financial analysis may divert focus and resources from other crucial company operations.

Introducing a new AI-based language model (ChatGPT) that is able to do analysis both qualitatively and quantitatively can make this process semi-automated and offer an innovative method to both experts for saving time and non-experts to have a primary evaluation of their considered company by themselves.

The aim of this study is to examine the accuracy and efficiency of ChatGPT in financial ratio analysis for evaluating the performance of firms in order to help business people specifically managers in decision making. This examination has been done from the perspective of a questionnaire's respondents as test evaluators and author-performed two accuracy tests. The findings will provide answers to the following study's questions.

Research question

How efficient are AI-based language models like ChatGPT in evaluating companies' performance?

Research subquestions:

How accurate is ChatGPT in financial ratio analysis?

How large language models like ChatGPT can improve Financial ratio analysis?

How ChatGPT's performance evaluation of a company can assist managers in decision making?

In order to achieve the research objective and answer the research question, a survey (Appendix 10) was conducted to gain insights into the efficiency of ChatGPT in ratio analysis from the perspective of 115 survey respondents. In addition, to evaluate the accuracy of ChatGPT analysis, the author has conducted an accuracy test on the findings of 50 companies' ratio analyses by the most accurate prompt done by ChatGPT. the most accurate prompt has been found in a separate experiment by testing 8 different prompts on 10 companies.

The following is an outline of this research structure:

Chapter literature review includes an overview and explanations of the basics of financial ratios, principles of using financial ratio analysis as a evaluation criteria. Pointing out the relevant previous studies around using AI in business, in addition to the mainstream concept of how financial ratio analysis can assist managers in decesion making.

Chapter methodology presents a detailed explanation around ChatGPT and the way it works. Presenting data collection method, variable's table (Table 4), their definitions and their connection to the survey questions and the other variable's table (Table 5) for testing 50 companies' financial statements as individual work to find how accurate are the calculations and analysis done by ChatGPT.

In chapter results the survey analysis findings has been given. The descriptive statistics of the survey participants are shown in (Tables 7 and 8). Moreover, there is a precise analysis of the independent T-test and correlation coefficient. In addition, the author's interpretation of the outcomes of two experimental tests is presented in a very straightforward manner. At the end of this chapter a management model that has been designed based on research findings is presented as a figure (figure 3).

Chapter discussion has presented the importance of the survey and experimental findings. Describes how these findings connect to prior and comparable studies conducted by other researchers. In addition, the practical implication of using ChatGPT for financial ratio analysis is discussed.

Chapter conclusion reveals a short recall of the purpose of this study, main results and how the research questions were answered. Furthermore, some limitations of using ChatGPT for financial ratio analysis have been highlighted. There are also some suggestions for future research in this field.

Utilizing AI-based tools such as ChatGPT in many industries such as business and finance is a relatively recent area of study and development. As a result, the number of academic articles published on this topic is limited, as is the rate of citation for these works. In new domains, it is normal for researchers to need time to undertake exhaustive studies and create a sound theoretical and empirical foundation. Nevertheless, despite the absence of well-established literature on this issue, there is considerable potential for AI-based language models such as ChatGPT to revolutionize several sectors, including finance and accounting, and greatly increase performance in a variety of tasks. Therefore, it is imperative that researchers continue to explore this area .

1. LITERATURE REVIEW

1.1. Definition of financial ratios

Financial ratios are numbers and percentages that demonstrate the relationship between two elements in a set of financial statements. These ratios are the most sophisticated analysis and interpretation tools for financial statements. Therefore, ratio analysis requires collecting data from financial statements in order to make better and efficient decisions (Nuhu, 2014).

There are several groups of financial ratios that serve as key determinants of a company's health (Agwor, 2014). Ratios can be categorized in a variety of ways, but the literature generally assesses businesses in the following categories: profitability, liquidity, solvency, and operational ratios (Özel & Oztemel, 2018). Each of these categories has a number of ratios that an expert or automated tool is able to calculate only if the company's annual report contains all of the formula's components. They are regarded as the key categories because they give a comprehensive perspective of the financial health of a business. They are used to evaluate a company's ability to make profits, regulate its short-term and long-term debt, and generate sales and profits efficiently. These four main groups of ratios including their related formulas are as follows:

1) Profitability ratios

Profitability ratios present an overview of the profitability of a firm compared to its sales, assets, and equity (Ndum, 2022). These ratios can offer an overview of a company's financial health and reveal if it is making sufficient earnings to pay its expenses and provide a return to its investors (Rashid, 2021). Following are four formulas related to profitability ratios:

$$\text{Gross Profit Margin Ratio (\%)} = \frac{\text{Net sales} - \text{Cost of goods sold}}{\text{Revenue}} \times 100 \quad (1)$$

$$\text{Net Profit Margin Ratio (\%)} = \frac{\text{Net Income}}{\text{Net Sales}} \times 100 \quad (2)$$

$$\text{Return on Equity (ROE) (\%)} = \frac{\text{Net Income}}{\text{Shareholders' Equity}} \times 100 \quad (3)$$

$$\text{Return on Assets (ROA) (\%)} = \frac{\text{Net Income}}{\text{Total Assets}} \times 100 \quad (4)$$

2) Liquidity ratios

Liquidity ratios describe the company's capability to fulfill its short-term financial obligations by using its present assets. These ratios can reveal if a company's cash and other liquid assets are sufficient to satisfy its short-term liabilities, such as accounts payable and short-term loans (Rashid, 2018). The below three formulas pertain to Liquidity ratios:

$$\text{Current Ratio (\%)} = \frac{\text{Current Assets}}{\text{Current Liabilities}} \times 100 \quad (5)$$

$$\text{Quick Ratio (\%)} = \frac{\text{Current Assets} - \text{Inventories}}{\text{Current Liabilities}} \times 100 \quad (6)$$

$$\text{Interest Coverage Ratio (\%)} = \frac{\text{EBIT}}{\text{Interest Expense}} \times 100 \quad (7)$$

where

EBIT – Earning before interest expense and tax

3) Solvency ratios

Solvency ratios consider the capacity of a corporation to satisfy its long-term financial commitments by using its assets. These ratios can give insight into a company's long-term financial health and its ability to repay long-term debt. The two formulas listed below apply to Solvency ratios:

$$\text{Debt to Equity Ratio (\%)} = \frac{\text{Total Liabilities}}{\text{Total Equity}} \times 100 \quad (8)$$

$$\text{Debt to Asset Ratio (\%)} = \frac{\text{Total Liabilities}}{\text{Total Assets}} \times 100 \quad (9)$$

4) Operating ratios

Operating ratios examine how well a corporation uses its resources to create sales and profits. These ratios can provide understanding into a company's operating performance and how well its costs and assets are being managed to create profits (Tracy, 2012). The three formulas listed here apply to Operating ratios:

$$\text{Operating Expense (\%)} = \frac{\text{Operating Expenses}}{\text{Net Sales}} \times 100 \quad (10)$$

$$\text{Operating Income Ratio(\%)} = \frac{\text{Operating Profit}}{\text{Net Sales}} \times 100 \quad (11)$$

$$\text{Asset Turnover(\%)} = \frac{\text{Net sales}}{\text{Total Assets}} \times 100 \quad (12)$$

This research focuses solely on four primary groups of financial ratios: profitability, liquidity, solvency, and operational ratios that can be derived from balance sheets and income statements data that can be found in annual reports of the companies on their websites.

1.2. Financial ratio analysis

Ratio analysis is a technique for doing financial analysis that highlights significant correlations between the components of financial statements (Ndum, 2022). Ratios are useful guidelines or shortcuts for assessing a company's financial state and operations and comparing its performance to that of earlier years or other companies. The ratio analysis's primary purpose is to indicate areas that warrant further investigation. Thus, Due to the challenges of condensed information in financial statements, the use of financial statements in decision-making is not always clear, they must be reviewed and analyzed by professionals to be understandable (Li et al., 2021).

1.3. Artificial intelligence

Artificial intelligence is the establishment of brain circuits capable of learning, planning, perceiving, and comprehending natural language (Pallathadka et al., 2021). Along with natural language processing, Artificial Intelligence may also be utilized to develop conversational trees that let consumers to interact and do certain tasks via chat or audio application (Ranjan et al., 2020). There are now a variety of AI-based technologies aimed to assist businesses streamline processes, improve decision-making, and increase consumer engagement.

1.3.1. Artificial intelligence in business and management

Multiple fields are significantly impacted by AI's influence on digital financial accessibility (Mhlanga, 2020). Fernandez (2019) has defined some examples of AI-based technologies that are commonly used in business as demonstrated bellow:

- a) Many firms utilize AI-powered chatbots to give customer service assist and answer in real-time to client enquiries.
- b) Forecasting analytics are tools for predictive analytics based on artificial intelligence. They are used to examine data and uncover patterns that may be utilized to forecast future trends and results.
- c) Financial institutions and other enterprises utilize AI-based fraud detection systems to detect and prevent financial fraud.
- d) Retail and manufacturing businesses employ AI-based image recognition systems to recognize and categorize photos of items and components.
- e) Natural language processing methods based on artificial intelligence are used to analyze and comprehend human language for usage in applications such as chatbots and voice assistants.

The above list of AI-based solutions demonstrates how well AI is increasing organizational productivity by facilitating and simplifying the handling of various activities.

1.3.2. ChatGPT as a new AI-based language model

ChatGPT is a novel AI language model meant to comprehend and produce human-like language based on the input it receives. It is not a specialist tool created for a particular business function, but rather a versatile tool that can be applied to a variety of jobs. ChatGPT is more versatile and adaptable than the AI-based solutions listed above, since it can be used in a number of scenarios and tailored to meet specific business requirements. For instance, it may aid both business experts and novices in evaluating a firm for a variety of purposes by importing the pertinent facts from the company's annual report and completing a basic ratio analysis without the need for sophisticated calculations and analyses that are usually done by analysts. ChatGPT has some competitive advantages like enabling all individuals, regardless of their background, to have an performance evaluation of their considered company (Yue et al., 2023). Research has indicated the prevalence of inadequate financial awareness among individuals and the consequent difficulties they confront navigating complicated financial and credit markets that demand well-informed decision making (Lusardi & Mitchell, 2014). Using artificial intelligence solutions to provide financial services may increase efficiency, minimize costs, improve quality, increase customer satisfaction, and expand financial inclusion (Fernandez, 2019).

1.4. Ratio analysis from the perspective of management theory

Analyzing financial statements is a crucial aspect of companies' valuation. Business analysis aims to enhance business decisions by examining facts on a company's financial situation, management, goals and strategies, and business environment (Babalola & Abiola, 2013). This section considers major ways that financial ratio analysis can help businesspeople in decision making.

Babalola & Abiola also explained that managers can use financial ratios analysis to evaluate companies' performance and compare it to industry standards or prior periods. This information may be utilized to determine which sections of the business are operating well and which require improvement. For instance, if a company's return on investment is lower than the industry average, management may propose investing in new innovations or reducing expenses in order to increase profitability. Furthermore, it can aid financial planning of a company by development of a firm's financial strategy and highlighting areas in which the company needs to enhance its financial performance. This information may be used to establish objectives and allocate resources to reach

those objectives. Financial ratios analysis can assist managers in identifying and mitigating possible financial risks, including liquidity issues and high debt levels. This information may be utilized to make informed lending, investing, and other financial decisions. Ratios can also assist management in identifying financial trends and patterns. For instance, if a company's profitability ratios have continuously declined over a number of quarters, management may need to analyze the underlying causes of this trend and take remedial action. Evaluation of a company can benefit potential investors in making investment decisions. Investors may use financial ratios to evaluate the risk and possible return of an investment and to compare the performance of several firms (Kernbichler, 2020). Ratio analysis can also facilitate the presentation of a company's financial health and performance to stakeholders including lenders, and regulators.

1.4.1. Performance evaluation of companies

Performance evaluation of a company is usually followed by following stakeholders and businesspeople:

- a) Managers, to identify the strengths and weaknesses of their own companies and use this information to gain a competitive advantage. Also, for considering mergers or acquisitions with other companies.
- b) Partner companies, for starting a new partnership or deciding about cutting off or continuing the current partnership.
- c) Suppliers, for assessing the risk associated with their partners or customers to ensure that they are not exposing themselves to unnecessary risks of not paying back for their services.
- d) Investors, for making informed investment decisions, managing risk, and holding companies accountable for their performance.
- e) Auditors, to perform their duties effectively and provide assurance to stakeholders that the financial statements are accurate and reliable.
- f) Credit analysts, for assessing their creditworthiness and credit risk, make informed credit decisions, manage their portfolio effectively, gain industry insights, and communicate with stakeholders.

The purpose of the evaluation is to assess the company's performance over a given period of time, typically a quarter or a year, and to identify areas of strength and weakness. Overall, performance

evaluation is a critical process for any company looking to improve its performance and stay competitive in today's rapidly changing business environment.

1.5. Associations between financial statements and administrative decisions

The major determinants of the performance of a company are the decisions made by the management as well as the process of reaching these decisions according to their financial and economic ramifications. Virag explained that financial reports generated in accordance with GAAP (Generally Accepted Accounting Principles) are often employed to evaluate the business effect of management decisions. These decisions are classified as investment, operational, and financial, and their total worth is represented on the Balance Sheet. The financial statements reveal the effect of previous and current decision making on the company's profits from regular operations, financial activities, and unusual occurrences. In addition, managers might utilize the Cash flow statement and statements of owners' equity to make informed decisions. Financial ratio analyses provide significance of all financial statements (Virag, 2004), (Figure 1).

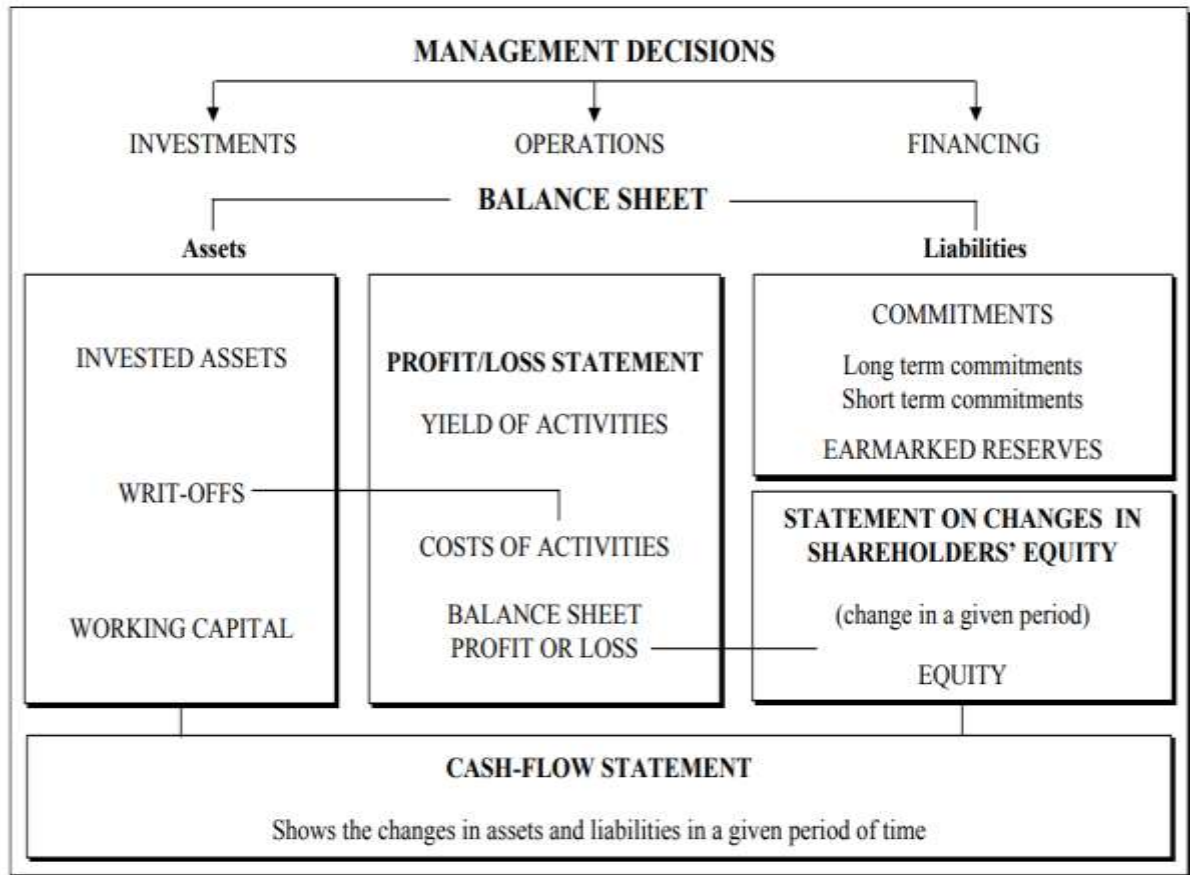


Figure 1. Relations between financial statements and management decisions
Source: (Virag, 2004)

Financial ratio analysis has long been a vital tool for assessing the performance of a company, but traditional techniques of analysis have limits and may not always be accurate (Šneidere, 2012). In recent years, researchers have investigated the possibility of employing AI-based technologies to enhance the accuracy, efficiency, and scalability of financial ratio analysis.

ChatGPT has been shown to be effective in different areas or applications, including natural language processing, question answering, and conversation production. For instance, Radford demonstrated that Chatbots can provide human-like replies to a variety of prompts and inquiries, making it a viable tool for conversation systems (Radford et al., 2019). Similarly, Brown proved that ChatGPT excels in a variety of natural language processing tasks, such as machine translation and summarization (Brown et al., 2020).

In addition to these basic uses of ChatGPT, past researches have also investigated the use of AI-based tools for analyzing financial ratios and assessing the performance of enterprises. Kim for instance, utilized machine learning approaches to forecast financial ratios and assess financial performance (Kim et al., 2020). while Deep learning algorithms were employed by Nurul Alam to assess financial information and forecast bankruptcy risk (Alam et al., 2021). These studies demonstrate the potential advantages of employing AI-based technologies for financial analysis, such as higher accuracy and scalability.

Fintech companies are increasingly employing AI applications for risk management and detection, risk measurement, fraud detection, and consumer protection, as well as in other prominent areas such as credit scoring, chatbots, capital optimization, market impact analysis, trade signaling, and 'reg tech' applications (Mhlanga, 2020). In today's digital age, businesses create large quantities of financial data that can be difficult to manage and analyze using conventional techniques. AI-based solutions such as ChatGPT have the ability to automate and simplify this procedure, allowing for a more precise and efficient analysis of financial data. The quantity of financial data continues to expand, the usage of AI-based technologies for financial ratio analysis is becoming increasingly significant (Li et al., 2021).

During the COVID-19 pandemic, however, financial analysts and investors face extra obstacles due to the unavailability of specialists who may be ill or confined, making it impossible to acquire timely advice for critical decision-making. As a result, established techniques of financial ratio analysis may not always be enough for determining an organization's financial health precisely. However, AI-based solutions may be an effective alternative in such circumstances. AI-based solutions may automate the financial ratio analysis process and decrease the need for human calculation and interpretation, which can be challenging without the assistance of professionals (Heo et al., 2020). This makes AI-base solutions significant for managers, investors, and non-financial experts, as it helps them to analyze their prospective firm independently in these difficult circumstances (Mertens, 2023).

ChatGPT uses a neural network built on transformers, and is able to handle vast quantities of financial data and create replies in normal language in response to human input based on Open AI. The potential advantages of employing ChatGPT for financial ratio analysis include increased precision, scalability, and efficiency for both business-finance specialists and non-experts. In the present economic context, managers, financial analysts, investors, and other stakeholders may find

the conclusions of this research relevant when analyzing the financial health of organizations. In addition, this research can pave the way for future investigations into the usage of AI-based technologies for financial analysis and evaluation.

The proposed approach in this study employs AI, notably the ChatGPT language model, to perform financial ratio analysis to determine the financial health of a firm. The ratios are generated using data from financial statements, such as the balance sheet and income statement, and are used to assess the liquidity, profitability, operating performance, and solvency of a firm. To execute the proposed model, the author first gets annual reports from publicly available sources and transforms the financial statements into text format. Following this, the most accurate prompt for the ChatGPT analysis model (Figure 2) are found through individual experiment described in the chapter methodology. These instructions are used to instruct the model how to interpret financial data and execute the relevant ratio calculation and analysis. The output of the model is then used to assess the financial health of the company.

The theory behind this technique is that by utilizing ChatGPT, the process of financial ratio analysis may be automated, saving managers' or investors' time and effort. In addition, by employing the ChatGPT model, the approach may be able to deliver a more precise and consistent analysis than traditional methods that rely on human judgment and interpretation. Overall, the suggested technique combines the concepts of financial ratio analysis with the capability of AI-based technology to provide a more efficient and accurate means of assessing a company's financial health.

2. RESEARCH METHODOLOGY

Financial ratio analysis is intended to aid in evaluating companies' performance and is employed as a tool for planning and management. Users of internal and external financial data who need to make decisions about investment and performance evaluation for starting or continuing their partnership with a new company or the current one, utilize financial ratios analysis. AI can ease this process for experts and nonexperts in business and finance to evaluate their considered company by themselves. ChatGPT is a new AI based tool which is used in this study for evaluating company's performance by financial ratio analysis. As it is a very new AI based program and has a vast number of abilities, so in first step an investigation was conducted on 10 companies from different industries in which their annual reports were downloaded from open sources to test if ChatGPT is able to calculate and analyze financial ratios.

Financial ratio analysis generally entails the following steps followed by analysts:

Step 1- Select the appropriate financial ratios.

Step 2- Gather the financial data required to calculate the ratios reported in the financial statements of the organization.

Step 3- Utilize basic mathematical formulas to determine the ratios.

Step 4- Analyze the outcomes

The ratio analysis results may then be used to acquire insight into the financial health, strengths, and weaknesses of the organization.

After testing ChatGPT for ratio analysis, this study confirms that ChatGPT is able to complete analyses steps. The sample of ChatGPT analysis can be found in (Appendix 11). As the answer was positive and ChatGPT is able to calculate and analyze financial ratios, measuring how much these analyses are accurate and how we can improve these results by making our input data more appropriate was the next step. To find the most appropriate form of input data into ChatGPT for receiving the most accurate results, an investigation has been done in technology and coding sources like GitHub and eight prompts were chosen for the test (Table 1).

As ChatGPT is currently able to understand everything just in text format, it is needed to convert the data into text format and add the appropriate punctuation that is known as prompt in computer language. For this purpose, a separate investigation has been done by the author on 10 companies' financial statements to test eight different prompts and find the most accurate one which can improve the result of analysis done by ChatGPT.

Another individual investigation has been done by the author for measuring the accuracy of ChatGPT formula calculation and result analyses, in which 50 Companies' annual reports have been randomly gathered from open sources and public data. For all of the companies, the financial statements (balance sheet and income statements) were extracted and converted into the text format. After designing the text format of financial statements with the most accurate prompt (found in previous step), the prepared data were inserted into ChatGPT's chat box one by one, and the ratio analyses generated by ChatGPT were saved. The saved results were compared to the manual calculation done by author to get the accuracy percentage of ChatGPT's ratio calculations and analyses (Table 12).

In the next step, to find the general efficiency of ChatGPT for evaluating companies' performance by financial ratio analysis, seven variables (Table 4) were defined as criteria for evaluating ChatGPT's efficiency. For each variable three to four questions were defined. In the next step, a survey was conducted to gain insights from the perspective of 115 experts and nonexperts in business and finance as survey's respondents. The respondents had a chance to examine the results of ChatGPT's analyses provided as a sample (Appendix 11) in the survey and also a chance for testing any financial statements of their own choice in ChatGPT. Afterwards, participants must respond to 22 questions (Appendix 10) defined based on seven variables that serve as efficiency's criteria.

2.1. Sample

There were $N = 115$ survey participants in this study. In ChatGPT accuracy experiment, sample size was $N = 50$ for companies being evaluated for accuracy of ChatGPT calculation and analysis, and in prompt experiment, sample size was $N = 10$ for companies being evaluated for determining the most effective prompt.

In this study the one of the data source from where the data is obtained was a questionnaire that was emailed to participants and shared on Facebook, LinkedIn, and Reddit. Owing to the nature of the communication channels, it is impracticable to quantify the number of invitations received by participants. In addition, 50 annual reports were acquired from open and public sources in order to extract their financial information for prompt and accuracy experiments.

The questionnaire asked participants three general questions about their personal information such as age, occupation, and years of professional experience, followed by twenty-two questions about their opinion of ChatGPT's efficiency after reviewing the sample analysis results provided in the survey or after testing ChatGPT ratio analysis on their own. The questions were designed based on the theoretical objectives of financial ratio analyses that evaluate the performance of companies. The efficiency of this evaluation using ChatGPT financial ratio analysis has been examined by participants and turned into questions in the questionnaire by using seven variables as efficiency criteria that are defined for this research for answering the research question.

2.1.1. Survey respondents

115 individuals participated in the survey and based on participant's demographic details; sample has been divided into six subsamples as follow: Age: (>30), (<=30); Profession: (Experts in financial ratio analysis, N=25), (non-experts in ratio analysis, N=90) and Professional experience(years): (>5), (<=5) years (Table 7).

2.1.2. Prompts under evaluation

Prompt engineering refers to the process of creating and optimizing natural language processing (NLP) for language models like ChatGPT. It entails developing a precise prompt that elicits the desired answer from the language model (Tenney et al., 2019). The purpose of prompt engineering is to delicate the language model's output for certain needs. This procedure frequently entails testing and modifying many prompt variants to identify the most effective one and enhance the efficiency of language models (Brown et al., 2020).

As research articles in the field of natural language processing contain examples of effective language model prompts, eight prompts (Table 1) were selected for this study from a variety of online resources that offer collections of ChatGPT prompts, like online forums where people

exchange prompts that they have discovered to be successful for a variety of activities, as well as testing with various prompts to see which prompt improves the ChatGPT's analysis.

The experiment began with testing eight generic prompts and was refined based on the study of ChatGPT's financial ratio analysis on ten companies, until the most effective prompt was identified. All ten firm's annual reports were collected from publicly available sources in order to test the ratio analysis on ten companies. The balance sheet and income statement were taken and converted into text format from each annual report. Each of those text format financial statements were designed by eight different prompts and tested in ChatGPT in different rounds. Four groups of financial ratios were created from the compiled results (profitability, liquidity solvency, operating). Each of the aforementioned groupings (Profitability ratios, Liquidity ratios, Solvency ratios and Operating ratios) was broken down into four section as follows: 1) Item recognition in financial statements 2) Formula recognition in financial statements 3) Ratio calculation accuracy 4) Qualitative interpretation of ratio analysis in text format.

2.1.3. Companies under evaluation

Excel's random number generator selected 50 companies from five industries (Energy, food, health, sport, technology) for the accuracy test of ChatGPT's ratio calculation and analysis. All 50 companies' annual reports were downloaded from open sources. Each annual report's balance sheet and income statement were extracted and converted into text format. After constructing the texts using the most accurate prompt, which was identified from previous experiment, the final commands were added, and the final texts were inserted into ChatGPT. The results of the calculations and analyses were compiled and divided into four categories (profitability ratios, liquidity ratios, solvency ratios, and operating ratios) in order to assess the accuracy. Each group was subdivided into four subgroups: 1) Item recognition in financial statements: To find out if ChatGPT is able to identify the criteria that are needed for each ratio formula, 2) Recognition of ratio's Formulas: Check to see if ChatGPT can figure out which ratios goes with which group of ratios. 3) Ratio calculation accuracy: Determine if ChatGPT can accurately calculate the ratio formula. 4) Qualitative interpretation of ratio analysis in text format: Performed to determine if ChatGPT is capable of analyzing calculation results on its own and providing a general, accurate evaluation of the companies under consideration.

2.2. Data collection

For data collection, this study utilized a questionnaire (Appendix 10) and two individual experimental tests. The first phase of the questionnaire consists of three questions regarding the demographics of the participants, including their age, job, and years of professional experience, this was for classify the responses based on these categories throughout the section analyzing the results. The second half of the questionnaire consists of sixteen questions for respondents who choose to answer based on ChatGPT financial ratio analysis provided as a sample (appendix 11). The final component of the questionnaire provides six questions for respondents interested in testing ChatGPT independently, utilizing the sample financial statements provided in the questionnaire as a second sample (appendix 12) or the financial statements of a firm of their choosing.

For the first experimental test related to determining the most accurate prompt, eight prompts were selected (Table 1) and tested on ten companies' annual reports to determine which one can improve the ChatGPT's analysis.

Table 1. Eight prompt derivatives were tested for finding the most accurate prompt

Prompts	Eight prompt derivatives were tested for finding the most accurate prompt
1	Financial statements in normal text format and without adding any syntax and ask ChatGPT simply to calculate and analyze financial ratios.
2	Financial statements in normal text format and without adding any syntax but the final command change to more specific as: I want you to act as a financial expert and calculate profitability ratios, liquidity ratios, solvency ratios, operation ratios and analyze the results of your calculations.
3	Adding quotation mark “ ” as a new prompt to the beginning and end of each part of balance sheet (assets, liabilities, equity) and income statement as a whole and add the previous professional command.
4	Adding # at the beginning of each parts (balance sheet, assets, liabilities, equity and income statement) and adding quotation marks “ ” to the beginning and ending of all these parts together and add this prompt: I want you to act as a financial expert and calculate “profitability ratios, liquidity ratios, solvency ratios, operation ratios”.
5	Adding # at the beginning of each parts (balance sheet, assets, liabilities, equity and income statement) and adding curly brackets { } to the beginning and ending of all these parts together and add this prompt:

Prompts	Eight prompt derivatives were tested for finding the most accurate prompt
	I want you to act as a financial expert and calculate “profitability ratios, liquidity ratios, solvency ratios, operation ratios.”
6	Adding # at the beginning of each parts (balance sheet, assets, liabilities, equity and income statement) and adding {[' ']} to the beginning and ending of all these parts together and add this prompt: I want you to act as a financial expert and calculate “profitability ratios, liquidity ratios, solvency ratios, operation ratios.”
7	Adding quotation marks “ “ at the beginning and ending of each title parts (assets, liabilities, equity) and adding [‘ ’] to the beginning and ending of all these parts items together and add this command: I want you to act as a financial expert and calculate “[profitability ratios, liquidity ratios, solvency ratios, operation ratios]” and “[analyze the results]”.
8	Adding # at the beginning of each parts (balance sheet, assets, liabilities, equity and income statement) and adding ‘ ’ to the beginning and ending of all items separately in each parts in addition to use {[]} to divide each parts from each other and add this command: I want you to act as a financial expert and calculate “profitability ratios, liquidity ratios, solvency ratios, operation ratios” and “analyze” the results of your calculations.

Source: author’s gathered information from technology and coding open sources like GitHub

For the second experimental test linked to evaluating the accuracy of ChatGPT’s calculations and analyses, 50 annual reports were downloaded from open resources and their financial statements (Balance sheets and Income statements) were extracted for the test. The following outcomes were measured in this experiment:

- 1) ChatGPT ratio calculation’s accuracy that is quantitative data.
- 2) ChatGPT recognition item in financial statements that is qualitative data.
- 3) ChatGPT recognized ratio formula that is qualitative data.
- 4) ChatGPT qualitative interpretation of ratio analysis that is qualitative data in text format.

To be able to compare all qualitative and quantitative data to each other and calculate the accuracy as a percentage, all results were categorised as one, zero and N/A in which, (one) considered as correct answer, (zero) considered as wrong answer and (N/A) considered for answers were ChatGPT was not able to calculate or analyze or did not recognize the items or formula at all. Calculation of the ratios by ChatGPT were compared to actual calculation of the ratios that was done by author based on standard ratio’s formulas (presented in chapter literature review). The deviation between two calculations were gathered in a separated table as Delta. Considering, the deviation of less than five percent as the correct answer (one) and the deviation more than five

percent considered as wrong answer(zero). ChatGPT’s qualitative interpretation of ratio analysis, on the other hand, has been compared to the standard acceptable range of ratios in each industry (Appendix 9) for all 50 companies.

2.3. Data format

Table 2. Data type and data format in this study

Types of data	Formats of data
Respondent’s assessment of ChatGPT’s efficiency	*Structured data in Likert scale 1...5
Respondent’s assessment of ChatGPT’s efficiency	Unstructured, free text answers from respondents for one open question, (question 22)
Author’s assessment of ChatGPT calculation and analysis’s accuracy	Structured, numerical data
Author’s assessment of most accurate prompt for improving ChatGPT analysis	Structured, numerical data

Source: author’s considerations

*Note: Answers provided by respondents in questionnaire have been measured by using Likert’s 5-point scale, where 1 – Strongly agree ... 5 – Strongly disagree.

2.4. Financial ratio analysis procedure by employing ChatGPT

Annual reports are documents that publicly quoted firms are obligated to publish at the end of each fiscal year in order to tell shareholders and other interested parties about the company's financial and operational performance over the prior year. Financial statements such as the balance sheet, income statement, and cash flow statement, corporate governance information, management report, Auditor’s report, notes, and other information about a company's performance are frequently included in annual reports. Annual reports are normally distributed in PDF format on companies’ websites. Financial statements give essential information on a company's financial performance, and ratio analysis is a typical method for reading and analyzing financial statements. In order to use ChatGPT to run financial ratio analysis, the author has followed the method in figure 2.

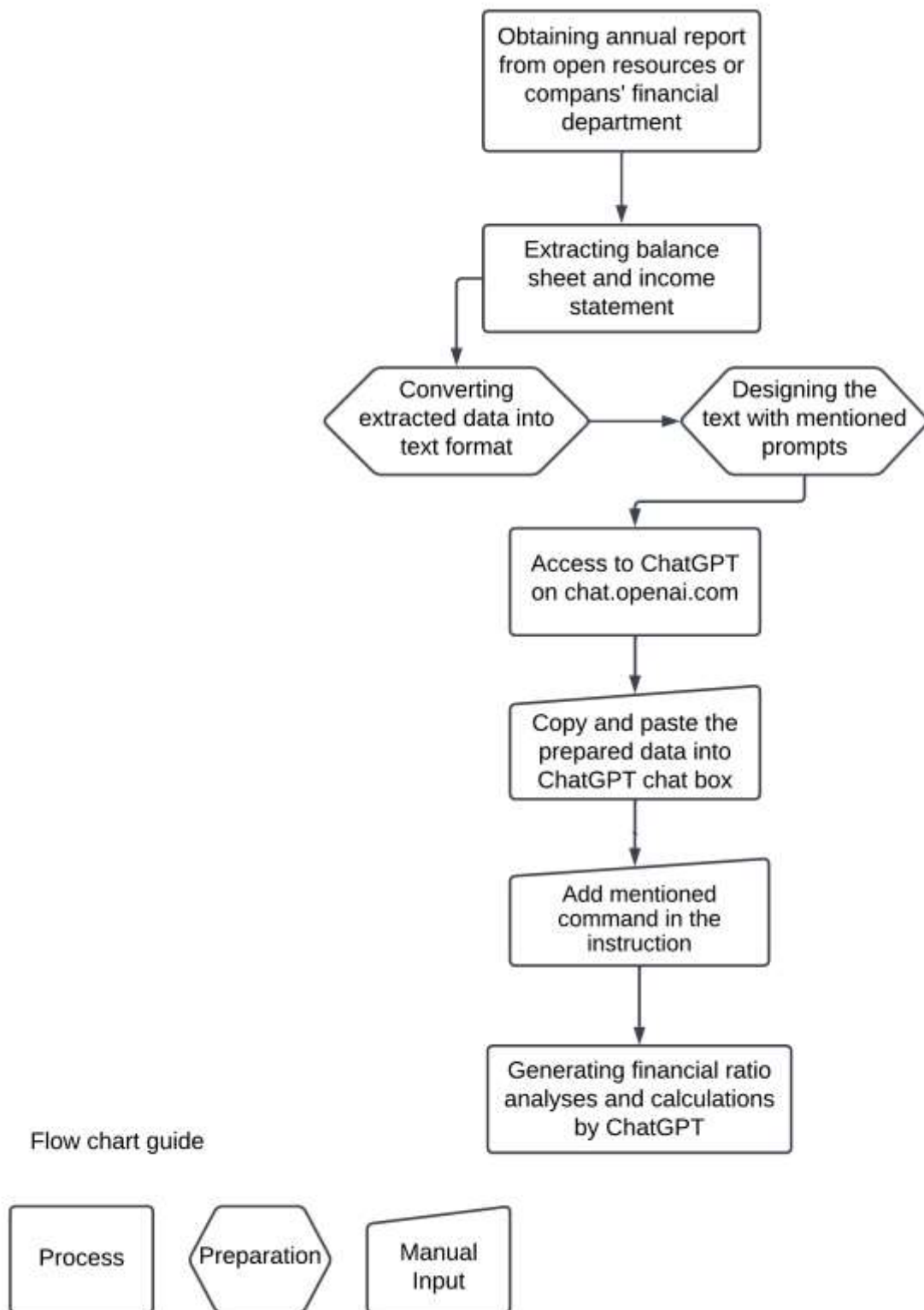


Figure 2. The procedure of the experiment to evaluate ChatGPT's accuracy in financial ratio analysis.

Source: Created by the author

In the first step of the procedure, it is necessary to download a company's annual report from open sources by searching and downloading the file, often a PDF document.

Next, the balance sheet and income statement, which are often displayed in two large tables in the annual report, must be extracted and converted into basic text format in a word file. This is due to the fact that ChatGPT can only interpret text format at this time.

To produce the most accurate results and make the content more comprehensible for ChatGPT, the text must be designed with the following punctuations, that is known as prompts in computer language. (# and {[" "]}) This prompt in the parenthesis is determined by prompt experiment as the most accurate one (Table 11).

Since the input data is ready to be copied and pasted into the ChatGPT chat box, it is time to access ChatGPT at <https://chat.openai.com/chat> and initiate a new conversation.

To create a new account on open AI, you must provide your email address and a phone number for email address confirmation.

Since access is available and the ChatGPT interface is visible, you may initiate a new chat and then copy and paste the prepared data into the ChatGPT chat box.

As chatGPT is an AI-based language model, it is required to request an action by appending the following command at the end of the first step's prepared data.

Command: (I want you to act as a financial expert and calculate “profitability ratios, liquidity ratios, solvency ratios, operation ratios” and “analyze” the results of your calculations).

Complete the process by pressing the (Enter) button or click (Send) button.

ChatGPT will calculate and analyze financial ratios and provide the results, which you should review.

The first section of the results includes the calculation of four sets of financial ratios required for evaluating a company as shown:

- 1) Profitability ratios including Return on assets (ROA), Return on equity (ROE), Gross profit margin and Net profit margin.
- 2) Liquidity ratios including Current ratio and the Quick ratio.
- 3) Solvency ratios including Debt-to-equity ratio, Debt-to-assets ratio, and Interest coverage ratio.
- 4) Operating ratios including Operating expense ratio, Operating income ratio and Asset turnover ratio.

The second section of the data provides text analysis of above ratios's calculations, which could give an investigator with a main appraisal of a company. Managers, investors, entrepreneurs,

auditors, analysts, etc. can acquire insight into the financial health and performance of a firm by evaluating these four kinds of financial ratio analyses. These ratios can be compared to industry standards or a company's historical data in order to evaluate long-term trends.

Table 3. A small part of input data into ChatGPT and output from ChatGPT

Input data into ChatGPT: Balance sheet and income statements of a sample company	Output data: ChatGPT calculation and analyses
<p>Balance sheet:</p> <p>#Assets {["Non-current assets#" "Property, plant and equipment 2,979.5" "Right-of-use assets 9.5" "Intangible assets 86.3" "Prepayments for non-current assets 45.9" "Deferred tax assets 1.9" "Derivative financial instruments 187.6" "Investments in associates 54.9" "Non-current receivables 1.1" "Total non-current assets 3,366.7] ["Current assets" "Inventories 114.1" "Greenhouse gas allowances and certificates of origin 208.6" "Trade and other receivables 336.6" "Derivative financial instruments 160.2" "Cash and cash equivalents 198.0" "Total current assets 1,017.5" "Total assets 4,384.2"]}</p>	<p>Profitability Ratios:</p> <p>Gross Profit Margin = (Revenue - Cost of Goods Sold) / Revenue = (1,313 - 888.9) / 1,313 = 32.3%</p> <p>Net Profit Margin = Net Profit / Revenue = 111.5 / 1,313 = 8.5%</p> <p>Return on Equity (ROE) = Net Income / Shareholders' Equity = 111.5 / 2,465.6 = 4.5%</p> <p>Return on Assets (ROA) = Net Income / Total Assets = 111.5 / 4,384.2 = 2.5%</p> <p>Analyses of the results:</p> <p>The Gross Profit Margin is 32.3%, which means that the company is able to generate a profit after accounting for the cost of goods sold.</p> <p>The Net Profit Margin of 8.5% indicates that the company is generating a decent profit from its operations after accounting for all expenses and taxes.</p> <p>The Return on Equity of 4.5% is relatively low, which could indicate that the company is not generating a high return on its shareholders' investments.</p> <p>The Return on Assets of 2.5% suggests that the company is generating a modest return on its total assets.</p>

Source: author's considerations

The above table (Table 3) is a small part of an example of the input data into ChatGPT chatbox and output data as ChatGPT calculation and analysis. The complete example can be found in (Appendix 11).

2.5. Variables

2.5.1. Variables designed for questionnaire

Seven variables were considered for the questionnaire in order to measure the efficiency of ChatGPT from various participant perspectives.

Table 4. Variables designed for questionnaire

Variable	No. of questions	Definition of the variable
1- Clear and understandable results	3	Examine the clarity of the sample calculations and analysis offered by ChatGPT in the questionnaire.
2-Useful output for stakeholders	3	Determine if the ratio analyses performed by ChatGPT are beneficial for analyzing the performance of a firm and accurately depict its financial health.
3-Assisting management in decision making	4	Determine if ChatGPT's ratio analyses can aid in management decision making, financial planning, detecting financial risks, and assessing investment possibilities.
4-Trustworthiness of the AI analysis	3	Determine if ChatGPT's ratio analyses are as accurate as human-made ratio analyses and other ratio calculators, and if managers can rely on them for decision making.
5-Improvement in financial ratio analysis as changed by AI	3	Examine if AI-based solutions can do the majority of human analytical tasks or automate and enhance financial ratio analysis.
6-Easy to use	3	Determine if ChatGPT is a user-friendly AI-based technology and if its prompts are simple to follow.
7-Understandable/transparent process	3	Check if ChatGPT gives a step-by-step analytical process breakdown.

Source: author's considerations

Each variable contains 3 to 4 questions (Appendix 10) to fulfil the goal of the research questions. The variables were designed in a way to reveal how efficient is ChatGPT analyses from the respondents' point of view.

2.5.2. Variables were measured through experimental work

The accuracy of ChatGPT's calculation and analysis in financial ratio analysis has been measured by using four variables.

Table 5. Four variables have been tested for measuring accuracy in calculation and analysis of financial ratios by ChatGPT

	Four variables for measuring accuracy in calculation and analysis of financial ratios by ChatGPT
1	ChatGPT recognition item in financial statements
2	ChatGPT recognized ratio formula
3	ChatGPT ratio calculation's accuracy
4	ChatGPT qualitative interpretation of ratio analysis in text format

Source: author's considerations

In the research methodology, the purpose and description of each of these four variables has been explained in depth.

2.6. Survey analysis

For this study, the data were collected through a questionnaire (Appendix 10). The number of participants was N=115(sample size). Seven variables (Table 4) were considered for answering the research question and subquestions and for each of them 3 to 4 questions were designed (there were 22 questions for this part)(Appendix 10). The answers provided by respondents for these 22 questions in the questionnaire have been measured by using Likert's 5-point scale, where 1 – Strongly agree ... 5 – Strongly disagree. To make the statistical analysis easier, the scale (1-5) reversed into (0-1) where zero was strongly disagree and 1 was strongly agree. Each of the three to four questions were grouped into one category under one specific variable and analyzed by averaging the value given by the respondent. The average values were used in statistical analysis then.

For the purpose of analyzing the survey findings the following statistical approaches are employed by using SPSS 29.0.

- (1) Descriptive statistics was applied to first three variables to determine if the data are normally distributed (Table 7).
- (2) An Independent T-test was performed on samples to test for variations in subgroup mean values (Table 8). In addition, the assumption of variance homogeneity was checked using Levene's F test, in which $p < 0.05$ indicating statistically significant.

(3) Significant relationships between variables have been identified using Pearson's correlation analysis (Table 10).

(4) All the answers for the open question (question 22), that was answered in free text format by respondents, gathered in a word file and a summary of the answers which included all points mentioned by respondents has been gathered, using qualitative analysis.

The Pearson correlation analysis measures the degree and direction of the linear relationship between two continuous variables. A negative number for the correlation coefficient (r) implies a negative association, whereas a positive value suggests a positive relationship. The greater the strength of the association, the closer the value is to -1 or $+1$. The associated p -value indicates the statistical significance of the observed relation (Table 6). A p -value less than 0.05 is considered statistically significant, suggesting that the observed correlation coefficient is unlikely to be attributable to random chance (Benesty et al., 2009).

Table 6. The Interpretation of the strength of the correlation coefficient (r) in Pearson correlation

r value	Interpretation
0.00 - 0.19	very weak or negligible correlation
0.20 - 0.39	weak correlation
0.40 - 0.59	moderate correlation
0.60 - 0.79	strong correlation
0.80 - 1.00	very strong correlation

Source: (Cohen et al., 2009)

Table 6 provides an interpretation of the strength of the Pearson correlation coefficient (r) as provided by Cohen and has been used in this study.

3. RESULTS

3.1. Survey results analysis

3.1.1. Descriptive statistic

This questionnaire survey was distributed through direct email to participants and sharing on Facebook, LinkedIn, and Reddit and a total of 115 responses were collected. (Table 7) presents basic descriptive statistics on the target groups of participants divided into related subgroups.

Table 7. Descriptive statistics categorized per groups and respondents' subgroups.

Group	Subgroup	No. of respondents	Min	Max	Average
Age	age<30	55	16	29	23.93
	age>=30	60	30	72	38.55
Total group	-	115	16	72	31.56
Professional experience	exp<5	58	0	4	1.64
	exp>=5	57	5	47	11.72
Total group	-	115	0	47	6.63
Job/Profession	Expert	25	-	-	-
	Non-expert	90	-	-	-
Total group		115	-	-	-

Source: author's calculations

Efficiency of ChatGPT for evaluating companies' performance was assessed by different groups of participants based on their age, job and professional tenure. They were also considered as two groups of experts (N=25) and non-experts (N=90) in financial ratio analysis, following their declared job title in the questionnaire.

Table 8. Assessed score (0-1) for employing ChatGPT to evaluate company’s performance as assessed by participants subgroups– Mean value of subgroups for each variable

		Subgroups					
		Age		Job/Profession		professional tenure	
	Variables	<30	>=30	Expert	Non-expert	<5	>=5
A	Clear and understandable results	0.26	0.24	0.25	0.25	0.31	0.19
B	Useful output for stakeholders	0.28	0.35	0.40	0.29	0.41	0.21
C	Assisting management in decision making	0.27	0.33	0.37	0.29	0.28	0.25
D	Trustworthiness of the AI analysis	0.30	0.38	0.41	0.32	0.33	0.27
E	Improvement in financial ratio analysis as changed by AI	0.29	0.34	0.36	0.30	0.31	0.25
F	Easy to use	0.32	0.29	0.34	0.30	0.26	0.26
G	Understandable/transparent process	0.29	0.25	0.26	0.28	0.28	0.25
H*	Total efficiency (all variables)	0.29	0.32	0.35	0.29	0.31	0.24

Source: author’s calculations

Note: (H*) Total efficiency is based on all questions making out all variables.

The description of the sample's mean values (Table 8) will be presented in the upcoming section, under Student T-test analysis.

3.1.2. Independent T-test – Description of mean values for each variable in Table 8

Analyzing (A) Clear and understandable results, provided by ChatGPT and presented as a sample for participants in survey. Independent samples t-test showed no statistical significance between different age groups of the participants as $t(113) = .08$, $p = .93$. Similar to different professions with very close mean value. However, in professional tenure with $t(24) = -1.50$, $p = .15$, people with work experience less than five years found the ChatGPT analysis more clear and understandable than people with more than five years’ experience. This can be because of different educational backgrounds, people with less than five years of work experience may have received more recent and updated education on financial analysis. Furthermore less experienced people may be more interested in following the results as the out put of ChatGPT results are very long.

Assessing the results for (B) Useful output (ChatGPT analysis) for stakeholders showed a large discrepancy in mean values of the age and professional tenure groups. The mean score in professional tenure group showed the less experienced people found ChatGPT outputs twice as useful for stakeholder as people with more than five-years experience. The reason can be young people are more interested in investing and may consider AI can ease decision making for them. The independent samples t-test for this group is also associated with a statistically significant difference as $t(24) = -2.42, p = .02$. A similar situation could be seen in Job group including experts and non-experts with $t(113) = -2.07, p = .04$. The mean score in Job group showed that experts considered ChatGPT's output more useful for stakeholder than non-expert people. This is because experts in financial ratio analysis are more aware of the advantages of these analyses for investors and managers in decision making.

(C) Assisting management in decision making was one of the most important variables in the questionnaire as it could directly answer one of the research questions. The mean value of this variable was reasonably similar across all groups and subgroups. However, experts from job groups and people older than 30 from age groups with higher mean score, found ChatGPT more helpful for managers in decision making. Experts definitely know financial ratios contain very valuable information that can help managers in decision making and people older than 30 may experience managerial positions by themselves and aware that when it comes to decision making, fast and available data can help to make better decisions and ChatGPT can provide this information very fast. The independent samples t-test also failed to find a significant difference for comparing different subsamples as follows: age group: $t(113) = 1.38, p = .17$, Job group: $t(113) = 1.61, p = .11$ and professional tenure group: $t(24) = -.42, p = .68$.

(D) Trustworthiness of the AI analysis was the other important variable that could answer second research questions. The analysis of the findings for this variable revealed that the mean values were rather close for all subgroups except for people with professional tenure of more than five. It indicates that diverse subgroups of participants viewed AI-based solutions such as ChatGPT with an appropriate level of reliability. But more experienced people may get used to the traditional ways of doing their jobs or they may fear of losing their jobs as being replaced with AI. The independent samples t-test suggests that the observed difference between the groups is not statistically significant as follows: age group: $t(113) = 1.70, p = .09$, Job group: $t(113) = 1.59, p = .12$ and professional tenure group: $t(24) = -.73, p = .47$.

Accessing the findings for (E)Improvement in financial ratio analysis as changed by AI revealed that participants from all groups acknowledge that AI-based technologies, such as ChatGPT, have enhanced the efficiency of financial ratio analysis. According to statistical studies, the mean value of the subgroups was quite similar but still higher for expert groups and lower for participants with more than five year experience. Experts may consider AI can reduce human errors in analyses and increase productivity, but more experienced people may not trust AI based tools for such important financial analysis or they may fear of being replaced with AI in their positions. In addition, the independent samples t-test did not show any significant differences between subgroups for this variable, since age group: $t(113) = 1.36, p = .18$, Job group: $t(113) = 1.10, p = .27$ and professional tenure group: $t(24) = -.73, p = .47$.

(F) Easy to use, designed for the participants who were interested in testing ChatGPT financial ratio analysis by using the provided sample in the survey or using the financial statements of their own chose to take the test. According to the survey findings, participants did not find ChatGPT very difficult to use, regardless of their job, age, or level of expertise in financial ratio analysis. Also both groups of more experienced and less experienced people in professional tenure group found ChatGPT level of easiness to use similar as their mean score was the same. The independent samples t-test also did not show significant difference in different groups as age group: $t(98) = .60, p = .55$, Job group: $t(98) = .82, p = .41$ and professional tenure group: $t(22) = .06, p = .96$.

(G) Understandable/transparent process was the other variable that was designed for participants who were eager to test ChatGPT financial ratio analysis by themselves. The independent samples t-test revealed no significant differences between the subgroups as follows: age group: $t(98) = -1.05, p = .30$, Job group: $t(98) = -.43, p = .67$ and professional tenure group: $t(22) = -.39, p = .70$. The mean values for this variable were very similar to each other and reveal all participants found ChatGPT financial ratio analysis process in the same level but not very transparent. This acknowledged that the technique of preparing financial statements as input data for testing ChatGPT was new, difficult to the participants that tested this procedure.

Total Efficiency of all variables based on survey (H), pointed out that the experts from job group with the highest mean score and participants with more than five-year experience with the lowest mean score. It revealed that experts in financial ratio analysis found ChatGPT more efficient AI based tool than other participants, which can ease the process of analyzing ratios and provide fast

and reliable results. They also consider ChatGPT as a tool that is easy to use and can support managers and stakeholders in making important decisions. On the other hand, ChatGPT's output was not very clear for more experienced participants. The mean scores from this group were all lower than other groups for all variables. It means that they did not confirm ChatGPT as an efficient tool for financial ratio analysis or assisting managers and stakeholders in decision making. But, the independent samples t-test revealed no significant differences between the subgroups' total score as follows: age group: $t(113) = 1$, $p = .32$, Job group: $t(113) = 1.46$, $p = .15$ and professional tenure group: $t(24) = -1.15$, $p = .26$.

It is noticeable that the total average mean score for participants with more than five years of experience was considerably lower than total average mean score from participants older than 30 years old (Table 8). On the other hand, the correlation between age groups and professional experience has been significant (Table 10). This could be justified according to the data derived from the descriptive statistics (Table 7). The age group constraints are 30 years as minimum and 72 years as maximum while the average is 38.55. This shows the abundance of respondents with ages nearer to 30 years old was relatively higher. Furthermore, the professional experience of the respondents with more than 5 years of experience fluctuates between 5 to 47 years whereas the average for this group was 11.72 years. This also reveals that the frequency of experience leans towards 5 years much more than 47 years and that the latter is considered to be outlined in the data. In brief, the relation between the two groups (participants with more than five years of experience and participants older than 30 years old) cannot be considered proportional and is not linear.

3.1.3. Correlation analysis

Pearson correlation analysis of survey results has been presented in (Table 10) to explain the efficiency of ChatGPT for evaluating the performance of companies.

Table 9. Correlations between variables that measured efficiency of ChatGPT for evaluating companies' performance, Including participants' Job, age, and professional tenure (N=115).

	AG	PE	CR	US	AM	TA	IR	EU	UP
AG	1								
PE	.859**	1							
CR	-0.046	-0.063	1						
US	0.032	0.04	.553**	1					
AM	0.024	0.043	.538**	.811**	1				
TA	0.015	0.003	.438**	.765**	.716**	1			
IR	0.056	0.054	.479**	.684**	.718**	.729**	1		
EU	-0.023	-0.008	.541**	.519**	.609**	.551**	.636**	1	
UP	-0.155	-0.12	.536**	.581**	.541**	.517**	.537**	.680**	1

Source: author's calculations

Notes:

1. (*) Correlation is significant at the 0.05 level; (**) Correlation is significant at the 0.01 level
2. Abbreviations: AG — age; PE — professional experience (years); CR — clear and understandable results; US — useful output for stakeholders; AM — assisting management in decision making; TA — trustworthiness of the AI analysis; IR — Improvement in financial ratio analysis as changed by AI; EU — easy to use; UP — understandable/transparent process.

The research has indicated the important elements that may be used to determine ChatGPT's efficiency in assessing the performance of companies. The Pearson correlation analysis revealed statistically significant correlations in (Table 10). For example there is a positive correlation between assisting management in decision making (AM) and trustworthiness of AI analysis (TA), indicating that participants who found the AI analysis trustworthy were also more likely to find it helpful in decision making, since reliable data is one of the most essential requirements for managers' decision making. Moreover, there's a significant correlation between assisting management in decision making (AM) and useful output for stakeholders (US) which point out both managers and stakeholders can benefit from ChatGPT financial ratio analysis in their decision making from participants' point of view.

The remaining correlation coefficients in the table that quantify the link between the efficiency factors and the characteristics of the individuals are statistically significant as follows.

There is a positive association between ease of use (EU) and understandable/transparent process (UP), indicating that participants who considered the process of testing ChatGPT for ratio analysis easier to use also thought the process to be more comprehensible and transparent. Furthermore There is a positive correlation between the trustworthiness of the AI analysis (TA) and the improvement in financial ratio analysis as changed by AI (IR), revealing that participants who find the AI analysis to be more trustworthy may also observe more significant improvements in financial ratio analysis, either in terms of time or cost savings or improvements in the results.

3.1.4. Analysis of answers to the open question – Qualitative analysis

Among the 22 questions pertaining to the main variables (Appendix 10), there was one open question as a subset of the last variable (Understandable/transparent process) for respondents who self-administered CatGPT. This question was answered by 16 of the 102 individuals who took the test. The next paragraph will detail the question and analysis of the respondent's replies.

Question: How AI- based tools like ChatGPT can improve financial ratio analysis?

Analysis of the responses

The responses indicated that employing artificial intelligence in financial ratio analysis can provide benefits such as fast and effective data sorting, efficient summarization of financial information, identification of patterns and trends, and enhanced accuracy and reliability of financial analysis. AI may also be used to automate data gathering and processing, saving time and increasing productivity. Nevertheless, respondents emphasized that AI should serve as an auxiliary tool for managers, not a replacement for human judgment. The requirement for human oversight is emphasized as a crucial component for ensuring the reliability and security of AI analysis, particularly with regard to investment choices. In addition, respondents underlined the importance of verifying input data and carefully interpreting results, as AI can still make mistakes when calculating and interpreting ratios. Lastly, there is consensus among responders that AI-based tools like ChatGPT show tremendous potential for financial analysis, but more real-world experiences are necessary to assess their efficiency in various industry sectors and to provide more targeted input to individual businesses. To sum up, respondents believed that AI can provide considerable improvements to financial ratio analysis, but it should be viewed as a support to human judgment rather than a replacement.

3.2. Analysis of the experimental works

3.2.1. Experiment 1 – Finding the most accurate prompt

Analysis of the results of experimenting eight different prompts on ten companys' financial statements, to find the most accurate prompt is presented in this section.

The following results are derived from four tables in (Appendixes 1 to 4) to show the most accurate prompt.

Table 10. Average accuracy for all ratios based on testing eight prompts

Average accuracy based on 8 prompts								
Ratios	prompt 1	prompt 2	prompt 3	prompt 4	prompt 5	prompt 6	prompt 7	prompt 8
Profitability ratios	91%	95%	90%	94%	90%	86%	92%	96%
Liquidity ratios	85%	86%	86%	89%	84%	87%	87%	83%
Solvency ratios	89%	85%	86%	90%	92%	89%	88%	98%
Operating ratios	82%	87%	83%	90%	93%	91%	93%	96%
Total average accuracy	87%	88%	86%	90%	90%	88%	90%	93%

Source: author's calculation based on figures in (Appendixes 1 to 4)

Examining each of the four sets of ratios using eight different prompts provided in (Table 11). Profitability ratios demonstrated a reasonably high degree of accuracy across all questions, with the lowest accuracy at 86 percent for prompt number six and the greatest accuracy at 96 percent for prompt number eight. While Liquidity ratios had a moderate amount of result accuracy throughout all eight evaluated prompts, below 90 percent, it was the only ratio to provide the lowest accuracy with 83 percent for prompt number eight. Solvency ratios, on the other hand, demonstrated greater than moderate accuracy, with 98 percent accuracy in response to prompt number eight. This was the greatest level of accuracy in response to prompt number eight compared to other ratios. For operating ratios, the general accuracy throughout all eight ratios was better than solvency ratios, but lower than profitability ratios. The lowest accurate result for operating ratios was released from prompt number one with 82 percent and the most accurate result was with testing prompt number eight with 96 percent similar to profitability ratios.

Based on total average accuracy figures presented in (Table 11) ratio's calculation and analysis by ChatGPT are more accurate when they were tested by prompt number eight with the total average accuracy of 93 percent. However prompt number three showed identical and the least accuracy of 86 percent and prompts number four, five and seven are in the second rank of accuracy with 90 percent.

3.2.2. Experiment 2 – Finding ChatGPT's accuracy in calculation and analysis

Analysis of the results of experimenting accuracy in calculation, Item and formulas recognition, and analysis of the results by ChatGPT on 50 companies from 5 industries presented in the (Appendix 5 to 8), Separately for all groups of ratios.

Table 11. Final accuracy results from four groups of ratios

Ratios	ChatGPT recognition item in financial statements	ChatGPT recognized ratio formula	ChatGPT ratio calculations' accuracy	ChatGPT qualitative interpretation of ratio analysis in text format	Total ChatGPT accuracy
Profitability ratios	99%	99%	77%	99%	94%
Liquidity ratios	98%	100%	71%	92%	90%
Solvency ratios	97%	100%	76%	93%	92%
Operating ratios	98%	99%	90%	84%	93%
Average accuracy	98%	100%	79%	92%	92%

Source: author's calculations based on figures in (Appendix 5 to 8)

The results of assessing the four sets of financial ratios of 50 companies using the most precise prompt (prompt number 8) are reported in (Table 12), showed that despite the fact that ChatGPT's average accuracy in financial ratios identification, calculations, and analysis is 92 percent, there is still room for improvement in the calculations of ratios, where accuracy is just 79 percent. The results indicated that the accuracy of ratios' calculations for profitability, liquidity, and solvency was less than 80 percent, however operating ratios' calculations where 90 percent correct. ChatGPT is also proven to be 100 percent accurate in identifying ratios' formulas across all four sets of ratios examined in this study.

3.3. Management model

The model depicted in (figure 3) could serve as a management model, which may possibly save time and money for managers, investors, and stakeholders with limited financial knowledge by enabling them to analyze their own firm, rivals, or new partners in less than 30 minutes. ChatGPT can be a valuable supplemental tool for them in the decision-making process since it is readily accessible and does not require the assistance of a specialist. The result analysis provided by ChatGPT can help businesspeople and managers measure a company's capacity to create profits through analyzing profitability ratios, evaluate an organization's capacity to satisfy its short-term financial debt through liquidity ratios, determine a company's capacity to satisfy its long-term debt by analyzing solvency ratios, and evaluate a company's efficiency in utilizing its resources to create revenue by assessing operating ratios. These evaluations can provide managers with an overview of a company's performance, and from there they can find the weaknesses and strengths of that company, improve financial planning, mitigate risks and make informed decisions. In addition, since ChatGPT is a language model, managers may ask it to elaborate on its analysis if they find the findings unclear. However, it is vital to check the veracity and trustworthiness of data, maybe by implementing accounting for AI errors and data quality checking, and not to depend only on AI-based solutions without the consultation of professionals.

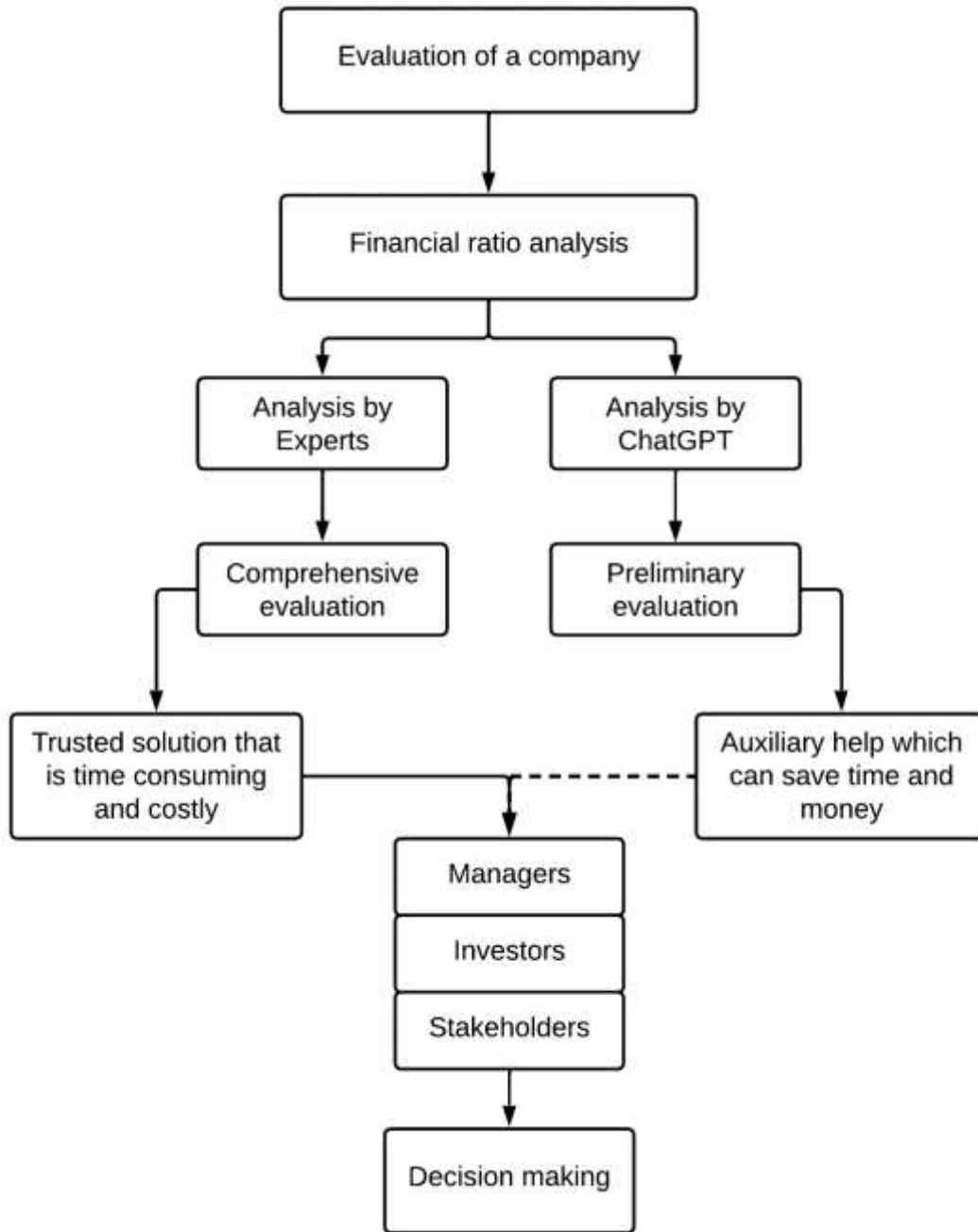


Figure 3. Management model
 Source: author's consideration

The model is also presenting ChatGPT as a solution that can serve experts as a time saving tool in the evaluation process and subsequently, reduce the time and expenses of such evaluations for businesses considering the less amount of time which experts need to spend on the process. Additional research and development may enhance the accuracy of ratios' calculation and make AI-based financial ratio analysis tools even more effective.

4. DISCUSSION

There are several previous studies around using AI-based technologies in business and finance, their advantages and limitations. Followings are some of the most related, previous studies which can highlight some similarities and differences to this study's findings:

As discussed in literature chapter before, ChatGPT is a language model that is based on a neural network architecture developed by OpenAI. Neural network, also known as artificial neural network (ANN), is a type of machine learning algorithm that is modeled after the structure and function of the human brain. ChatGPT utilizes artificial neural networks (ANNs) to perform financial ratio analysis (Medsker et al., 1993). A categorization is provided listing the financial analysis tasks in which ANN-based algorithms could assist managers in making decisions in the following areas: Project management and bidding strategy, risk rating of exchange-traded, credit authorization screening, financial and economic forecasting, income investments are all examples of applications of artificial intelligence (Medsker et al., 1993). Second research involved the development of two ANN systems, one with a regular feed-forward network and the other with special purpose architecture. The technology was verified using data gathered from Italian small enterprises. They demonstrate that with proper data analysis, data preparation, and adequate training, ANNs may be efficient at learning and evaluating a borrower's propensity to default (Angelini et al., 2008).

Ana Fernandez (2019) discusses the use of artificial intelligence (AI) applications in the financial sector. The study found that while these applications provide numerous benefits, there are also risks and limitations that must be managed to extract their full potential. The article suggests that it is important to distinguish between different types of activities for which these tools are used, and to assess the advantages and drawbacks of using AI technology on a case-by-case basis. One approach that is relatively common is to use AI-based tools together with traditional techniques, rather than solely relying on AI algorithms. By using AI as part of a process to reinforce and

validate decisions, potential biases and difficulties interpreting the underlying reasoning can be addressed.

In a separate study, a group of researchers concentrated on automating the present technique of financial ratio analysis in order to find the required system components. Their system could do the following sorts of analyses: (1) profitability, (2) liquidity, (3) turnover, (4) leverage and (5) historical performance. Based on these assessments, the system was able to generate a list of conclusions and suggestions similar to ChatGPT (Moynihan et al., 2006). In another study, Hsieh proposed a classification stating that the following potential corporate finance applications can be remarkably improved by the adaptation of ANN technology: financial evaluation, predicting behavior of investors, financial simulation, asset portfolio management and credit monitoring (Hsieh, 1993).

The above previous studies have investigated the potential benefits of using artificial intelligence-based technologies for financial ratio analysis. These studies share a similar focus on the potential benefits of using AI-based technologies for financial analysis, although differences may exist in the specific applications and methods used. In comparison to these studies, the present study's findings highlight the positive relationship between the trustworthiness of ChatGPT's analysis and its usefulness in decision-making, particularly in financial ratio analysis. Furthermore, this study's findings support the idea that AI-based technologies can serve as an auxiliary tool to reinforce and validate decisions, rather than a replacement for human judgment, which is in line with the approach suggested by Fernandez. Furthermore, the comparison between the findings of this study and previous research underscores the potential benefits of AI-based technologies for financial ratio analysis, while also highlighting the need for further research to evaluate their efficiency across various industry and contexts.

The practical implications of this research are favorable to businesses in several ways. By using software or existing technologies, companies can automate the extraction of financial statements from various sources, such as annual reports and financial databases. These technologies can also convert financial statements to text format and design them with accurate prompts, so making the procedure more effective and expedient. There are a variety of market-available technologies that can aid businesses in automating the process of obtaining financial statements and analyzing financial ratios. Xero is an illustration of such a tool that is a cloud-based accounting software, as

is Algo.ai which is an AI-powered financial analysis application that can extract and generate financial data for analysis.

Companies can integrate these tools into their existing financial reporting systems or employ cloud-based solutions with these capabilities to automate these processes. They can also investigate the use of artificial intelligence and machine learning techniques to enhance the process' accuracy and efficacy. There are many more tools and software that can automatically calculate and analyze financial ratios depending on the given data, similar to ChatGPT. However, these technologies are typically more expensive and complex than the simple data extraction techniques are outlined above. In addition, businesses may train their staff to utilize these tools effectively and to identify the limitations and possible biases of AI-based analysis. Despite the fact that ChatGPT might serve as a valuable beginning point for financial analysis, it should not be utilized in isolation. When making significant investments or business choices, it is usually suggested that organizations or individuals seek the opinion of financial professionals and examine other variables beyond financial ratios.

5. CONCLUSION

The evaluation of a company is an undeniable part of decision making by managers, investors, and stakeholders. On the other hand, financial ratio analysis is a fundamental and long-established method for analyzing a company's performance, but it requires financial expertise and analysts to do that, specially when there is a lack of financial knowledge in the management level. The procedure may be time-consuming and costly for firms and businesspeople when they ask experts for ratio analysis.

An alternative to have a preliminary, fast, and free evaluation of a company's performance is using a new language model introduced by Open AI company, ChatGPT. It is an AI-based language model that is able to communicate, calculate, analyze and e.g. Furthermore, ChatGPT may utilize natural language processing (NLP) to allow users to ask questions in plain language and get responses that are easy to understand and pertinent to the exact financial ratios being reviewed. This enables users to quickly and easily get insights into a company's financial performance without needing a solid understanding of financial analysis. Therefore, the purpose of this study is to examine the accuracy and efficiency of ChatGPT as an AI-based language model in financial ratio analysis for evaluating the performance of companies in order to help businesspeople specifically managers in decision making.

This examination was done by conducting a survey and author-performed two accuracy tests. The findings have provided answers to the research question regarding accuracy and efficiency of ChatGPT. The experiments revealed that ChatGPT had a 92 percent overall accuracy in detecting financial statement items and ratio formulas, calculating four sets of ratios, and assessing the results of its calculations in qualitative text style. This indicates that ChatGPT can be considered as an effective alternative way of financial ratio analysis, although there is potential for development in terms of ratio calculations precision as it was not as strong as it was in analyzing. Furthermore, survey respondents believed that ChatGPT may be a suitable alternative to expert

opinion in some instances, while it should not be depended upon without human judgment. The positive relationship between the trustworthiness of ChatGPT's analysis and its usefulness in decision making indicated that managers and evaluators may use ChatGPT's analysis as an auxiliary help. However, it is important to establish the reliability and trustworthiness of data to ensure effective decision making.

Regarding how AI-based technologies might enhance financial ratio analysis, respondents' perspectives on the advantages of AI in financial ratio analysis highlighted the possibility for rapid and efficient data sorting, enhanced productivity and dependability. This shows that AI-based solutions, such as ChatGPT, can assist in enhancing financial ratio analysis by delivering huge amount of data in shorter time. It is essential to highlight, however, that the output may not be helpful for all businesspeople, and further training and assistance may be required to guarantee that all users can comprehend and interpret the data. In general, the findings implied that AI-based solutions such as ChatGPT should be seen as a supplementary tool for primarily evaluation as shown in (figure 3) as a management model to ease the process of decision making.

While the findings of this study suggest the potential benefits of using ChatGPT for financial ratio analysis, there are also some limitations to consider. One limitation is that as a language model it relies heavily on the quality and quantity of data used for training, which can affect the accuracy and reliability of its analysis. Another limitation is that the ChatGPT may not always capture the full context and nuances of financial data, particularly when dealing with complex and dynamic financial scenarios. Moreover, financial ratio analysis is just one of many tools used in financial analysis, and the interpretation of financial ratios requires expertise and judgment that may not be readily available to ChatGPT. Therefore, while ChatGPT can provide a quick and convenient way to perform financial ratio analysis, it should not be relied upon as the sole basis for making important decisions or evaluating a company's financial performance.

Overall, by utilizing ChatGPT's ratio analysis, businesses can save time and money involved with engaging financial statements' analysts. This can help businesspeople make more informed and productive financial decisions. In addition, ChatGPT can offer a standardized and consistent method to ratio analysis, which can facilitate comparisons between companies or industries. This can simplify benchmarking and allow businesses to find areas for improvement. Additionally, ChatGPT facilitates the evaluation of a company's financial performance for non-specialist investors and individuals. This can help them make wiser investing selections.

While the experiments of financial ratio analysis, using ChatGPT in this study has provided valuable insights into the profitability, liquidity, solvency, and operating performance of the companies under study, there are still some areas for future research. One potential avenue for further exploration is the inclusion of cash flow statement in addition to the income statement and balance sheet. The cash flow statement gives a complete perspective of an organization's cash inflows and outflows and may assist spot possible liquidity difficulties or investment possibilities.

Furthermore, in this study, financial figures of one year of each company were used in experiment so, another area of future research could involve the use of multiple years of financial data to conduct growth and trend analyses. By examining a company's financial performance over a longer period of time, researchers could gain a better understanding of its overall trajectory and identify patterns of growth or decline. In addition, ChatGPT could be enhanced to provide more sophisticated analyses, such as predictive modeling, risk analysis, and scenario planning. These advanced capabilities could help investors and managers to better understand the impact of various financial and economic factors on a company's performance and make more informed investment decisions. Overall, there is a great deal of potential for future research to build upon this study's findings and explore many ways in which ChatGPT can be used to improve financial ratio analysis in evaluating companies' performance to ease decision-making process.

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APPENDICES

Appendix 1. ChatGPT ratio calculations' accuracy in all ratio groups examined by employing eight different prompts

ChatGPT ratio calculations' accuracy								
Ratios	prompt 1	prompt 2	prompt 3	prompt 4	prompt 5	prompt 6	prompt 7	prompt 8
Profitability	88%	90%	85%	90%	88%	88%	93%	93%
Liquidity	70%	73%	70%	73%	73%	70%	77%	67%
Solvency	80%	80%	70%	80%	90%	80%	80%	100%
Operating	80%	80%	77%	87%	97%	97%	93%	90%
Total average	79%	81%	75%	83%	87%	84%	86%	87%

Source: authors' calculations

Appendix 2. ChatGPT qualitative interpretation of ratio analysis in text format for all groups of ratios examined by employing eight different prompts

ChatGPT qualitative interpretation of ratio analysis in text format								
Ratios	prompt 1	prompt 2	prompt 3	prompt 4	prompt 5	prompt 6	prompt 7	prompt 8
Profitability	90%	90%	90%	93%	85%	80%	85%	95%
Liquidity	83%	90%	93%	93%	87%	100%	93%	93%
Solvency	90%	75%	90%	95%	90%	95%	85%	100%
Operating	77%	80%	80%	83%	80%	73%	87%	93%
Total average	85%	84%	88%	91%	85%	87%	88%	95%

Source: authors' calculations

Appendix 3 ChatGPT recognition item in financial statements for all groups of ratios examined by employing eight different prompts

ChatGPT recognition item in financial statements								
Ratios	prompt 1	prompt 2	prompt 3	prompt 4	prompt 5	prompt 6	prompt 7	prompt 8
Profitability	91%	99%	91%	94%	91%	91%	94%	96%
Liquidity	96%	86%	88%	94%	84%	86%	84%	80%
Solvency	87%	83%	83%	83%	87%	80%	87%	90%
Operating	85%	90%	85%	95%	98%	98%	95%	100%
Total average	90%	89%	87%	92%	90%	89%	90%	91%

Source: authors' calculations

Appendix 4. ChatGPT recognized ratio formula for all groups of ratios examined by employing eight different prompts

ChatGPT recognized ratio formula								
Ratios	prompt 1	prompt 2	prompt 3	prompt 4	prompt 5	prompt 6	prompt 7	prompt 8
Profitability	95%	100%	95%	98%	95%	85%	98%	100%
Liquidity	90%	93%	93%	93%	93%	93%	93%	93%
Solvency	100%	100%	100%	100%	100%	100%	100%	100%
Operating	87%	97%	90%	93%	97%	97%	97%	100%
Total average	93%	98%	95%	96%	96%	94%	97%	98%

Source: author's calculations

Appendix 5. Analysis of the results of Profitability ratios accuracy in calculation, Item and formula recognition, and qualitative interpretation of ratio analysis in text format by ChatGPT on 50 companies from five industries

ChatGPT recognition item in financial statements							
Net sales	COGs	Net income	Shareholders' equity	Total assets	total liabilities	EBIT	
100%	98%	96%	98%	100%	98%	100%	

ChatGPT recognized profitability ratio formula			
Gross profit margin	Net profit margin	Return on Equity	Return on assets
100%	100%	98%	98%

ChatGPT ratio calculations' accuracy			
Gross profit margin	Net profit margin	Return on Equity	Return on assets
94%	94%	82%	36%

ChatGPT qualitative interpretation of ratio analysis in text format			
Gross profit margin	Net profit margin	Return on equity (ROE)	Return in assets (ROA)
88%	96%	90%	92%

Total accuracy in Profitability ratios			
ChatGPT recognition item in financial statements	ChatGPT recognized ratio formula	ChatGPT ratio calculations' accuracy	ChatGPT qualitative interpretation of ratio analysis in text format
99%	99%	77%	92%

Source: authors' calculations

Appendix 6. Analysis of the results of Liquidity ratios accuracy in calculation, Item and formula recognition, and qualitative interpretation of ratio analysis in text format by ChatGPT on 50 companies from five industries

ChatGPT recognition item in financial statements				
Total Current Assets	Total Current liabilities	Inventory	EBIT	Interest expense
100%	98%	100%	98%	96%

ChatGPT recognized profitability ratio formula		
Current ratio	Quick ratio	Interest coverage ratio
100%	100%	100%

ChatGPT ratio calculations' accuracy		
Current ratio	Quick ratio	Interest coverage ratio
96%	44%	74%

ChatGPT qualitative interpretation of ratio analysis in text format		
Current ratio	Quick ratio	Interest coverage ratio
94%	90%	92%

Total accuracy in Profitability ratios			
ChatGPT recognition item in financial statements	ChatGPT recognized ratio formula	ChatGPT ratio calculations' accuracy	ChatGPT qualitative interpretation of ratio analysis in text format
98%	100%	71%	92%

Source: authors' calculations

Appendix 7. Analysis of the results of Solvency ratios accuracy in calculation, Item and formula recognition, and qualitative interpretation of ratio analysis in text format by ChatGPT on 50 companies from five industries

ChatGPT recognition item in financial statements			
Total assets	Total liabilities	Shareholder equity	
100%	92%	100%	

ChatGPT recognized profitability ratio formula	
Debt to Equity Ratio	Debt to Assets Ratio
100%	100%

ChatGPT ratio calculations' accuracy	
Debt to Equity Ratio	Debt to Assets Ratio
74%	78%

ChatGPT qualitative interpretation of ratio analysis in text format	
Debt to equity	Debt to assets
96%	90%

Total accuracy in Profitability ratios			
ChatGPT recognition item in financial statements	ChatGPT recognized ratio formula	ChatGPT ratio calculations' accuracy	ChatGPT qualitative interpretation of ratio analysis in text format
97%	100%	76%	93%

Source: authors' calculations

Appendix 8. Analysis of the results of Operating ratios accuracy in calculation, Item and formula recognition, and qualitative interpretation of ratio analysis in text format by ChatGPT on 50 companies from five industries

ChatGPT recognition item in financial statements			
Operating Expenses	Net Sales	Operating Income	Total Assets
100%	96%	94%	100%

ChatGPT recognized profitability ratio formula		
Operating Expense Ratio	Operating Income Ratio	Asset Turnover Ratio
98%	100%	100%

ChatGPT ratio calculations' accuracy		
Operating Expense Ratio	Operating Income Ratio	Asset Turnover Ratio
80%	96%	94%

ChatGPT qualitative interpretation of ratio analysis in text format		
Operating expenses ratio	Operating income ratio	Total asset turnover
76%	92%	84%

Total accuracy in Profitability ratios			
ChatGPT recognition item in financial statements	ChatGPT recognized ratio formula	ChatGPT ratio calculations' accuracy	ChatGPT qualitative interpretation of ratio analysis in text format
98%	99%	90%	84%

Source: authors' calculations

Appendix 9. *Industry standard ratios' range based on each industry tested in this study

Ratios	Energy industry	Food industry	Health industry	Sport industry	Technology industry
Gross profit margin	20-40%	30-70%	50-80%	50-70%	60-90%
Net profit margin	>5	>5	>10	>5	>10
Return on equity (ROE)	>20%	10-20%	15-30%	10-20%	20-40%
Return on assets (ROA)	>10%	5-10%	>15%	5-10%	10-20%
Current ratio	1.5-2.5	1.5-2.5	1.5-2.5	1.5-2.5	2-3
Quick ratio	1 - 1.5	0.5-1.5	1 - 1.5	0.5-1.5	1-1.5
Interest coverage ratio	>2	>2	>2	>2	>2
Debt to equity	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5	0.5-1.5
Debt to assets	0.3-0.7	0.3-0.7	0.3-0.7	0.3-0.7	0.3-0.7
Operating expenses ratio	60-75%	60-75%	70-80%	60-75%	50-70%
Operating income ratio	10-20%	5-20%	5-20%	15-25%	10-30%
Total asset turnover	0.5-1.5	1-3	0.5-1.5	1-3	0.5-1.5

Source: *Financial Ratio Analysis*, n.d.; *Financial Ratios*, n.d.

Note*, Industry standard range for each ratio refers to the typical range of values that a particular ratio takes in each industry. These ranges are derived by analyzing financial data of companies within a specific industry over a period, usually several years.

Appendix 10. Questionnaire

For data collection, this study utilized a survey which included three parts.

1-The first phase of the questionnaire consists of three mandatory questions regarding the demographics of the participants, including their age, job, and years of professional experience, in order to classify the responses based on these categories throughout the section analyzing the results.

2-The second half of the questionnaire consists of sixteen questions for respondents who preferred to answer the questions based on ChatGPT financial ratio analysis (Appendix 11) provided as a sample in the survey. Participants could leave the survey after completing this part.

3-The final part of the questionnaire provides six questions for respondents interested in testing ChatGPT independently, utilizing the sample financial statements (Appendix 12) provided in the questionnaire as a second sample or financial statements of a firm of their choosing. The instruction of how to prepare the financial statements and how to design the text format of financial statements with appropriate prompt and command was explained step by step for them in the survey.

The style of answering the questions was in Likert's 5-point scale, where 1 – Strongly agree to 5 – Strongly disagree.

The second group of participants were also asked to answer an open question as the final question.

Frist part of the questionnaire:
Participants' details Name..... Age..... Job/Profession: Professional experience (years):
Second part of the questionnaire Questions (1 – 16):
1. The financial ratios' results by ChatGPT are understandable. 2.Grouping ratios under related categories (profitability, liquidity, solvency, operating) by ChatGPT makes them more understandable.

3. The Text explanations of the results by ChatGPT are clear and understandable.
4. Investors could use ChatGPT ratio analyses to predict return on their investment.
5. ChatGPT's ratio analysis helps in evaluating the performance of a company.
6. ChatGPT's ratio analyses can represent the financial health of the company.
7. ChatGPT's ratio analysis is helpful to management in decision making.
8. ChatGPT's ratio analysis can help managers to evaluate investment opportunities.
9. ChatGPT's Financial ratio analysis can help managers in financial planning.
10. Managers can identify potential financial risks of their own companies by ChatGPT's ratio analysis.
11. Managers could trust ChatGPTs' ratio analyses for decision making.
12. ChatGPT's financial ratio analyses is as reliable as human made ratio analyses.
13. ChatGPT's financial ratio analyses is as reliable as other financial analysis tools.
14. AI based tools are able to carry out most human analytical jobs.
15. AI based tools like ChatGPT can overallly improve financial ratio analysis.
16. ChatGPT can automate the companies' financial performance evaluation.

Third part of the questionnaire Questions (17 – 22)

This instruction was provided in a questionnaire for participants who would like to test ChatGPT analysis by themselves.

It is possible to use your own or any company's Balance sheet and income statements of your own choice. But you would require the following steps.

- 1) converting all data from balance sheet and income statement into the text format.
- 2) use # and {' ' } through your text to get better results. (See table one)
- 3) Add the following command at the end of your data.

“Command”, (I want you to act as a financial expert and calculate “profitability ratios, liquidity ratios, solvency ratios, operation ratios” and “analyses” the results of your calculations).

For using CHATGPT, (if currently you do not have an account on CHATGPT, you need to go to this link <https://chat.openai.com/chat> and use your email address or Google/Microsoft account and an available phone number to confirm your email

17. ChatGPT is a user-friendly AI based tool for financial ratio analysis.

18. ChatGPT's interface is intuitive and easy to navigate.
19. It is easy to insert companies' financial statements into ChatGPT prompt.
20. ChatGPT's financial ratio analysis provides a step-by-step breakdown of the analysis process.
21. Financial ratio analysis by ChatGPT is faster than asking an expert to do that.
22. Open question: How can AI based tools improve financial ratio analysis?

22 questions pertaining to the seven main variables (A-G) for measuring ChatGPT efficiency

- A. Clear and understandable results for questions (1,2,3)
- B. Useful output for stakeholders for questions (4,5,6)
- C. Assisting management in decision making for questions (7,8,9,10)
- D. Trustworthiness of the AI analysis for questions (11,12,13)
- E. (AI shift) (Improvement in financial ratio analysis as changed by AI for questions (14,15,16)
- F. Easy to use for questions (17,18,19)
- G. Understandable/transparent process for questions (20,21,22)

Source: author's consideration

Appendix 11. The sample of calculations and analysis done by ChatGPT which were provided in the questionnaire

Calculation and Analyses provided by CHATGPT

Profitability Ratios:

$$\text{Gross Profit Margin} = (\text{Revenue} - \text{Cost of Goods Sold}) / \text{Revenue} = (1,313 - 888.9) / 1,313 = 32.3\%$$

$$\text{Net Profit Margin} = \text{Net Profit} / \text{Revenue} = 111.5 / 1,313 = 8.5\%$$

$$\text{Operating Profit Margin} = \text{Operating Profit} / \text{Revenue} = 145.5 / 1,313 = 11.1\%$$

$$\text{Return on Equity (ROE)} = \text{Net Income} / \text{Shareholders' Equity} = 111.5 / 2,465.6 = 4.5\%$$

$$\text{Return on Assets (ROA)} = \text{Net Income} / \text{Total Assets} = 111.5 / 4,384.2 = 2.5\%$$

Liquidity Ratios:

$$\text{Current Ratio} = \text{Current Assets} / \text{Current Liabilities} = 1,017.5 / 739.3 = 1.38$$

$$\text{Quick Ratio} = (\text{Current Assets} - \text{Inventories}) / \text{Current Liabilities} = (1,017.5 - 114.1) / 739.3 = 1.30$$

$$\text{Interest Coverage Ratio} = \text{Operating Profit} / \text{Interest Expenses} = 145.5 / 26.2 = 5.6$$

Solvency Ratios:

$$\text{Debt to Equity Ratio} = \text{Total Liabilities} / \text{Shareholders' Equity} = 1,918.6 / 2,465.6 = 0.78$$

$$\text{Debt to Assets Ratio} = \text{Total Liabilities} / \text{Total Assets} = 1,918.6 / 4,384.2 = 0.44$$

Operating Ratios:

$$\text{Operating Expense Ratio} = \text{Operating Expenses} / \text{Revenue} = (888.9 + 135.9 + 172.1 + 121.9) / 1,313 = 89.2\%$$

$$\text{Operating Income Ratio} = \text{Operating Profit} / \text{Net Sales} = 145.5 / 1,313 = 11.1\%$$

$$\text{EBITDA to Revenue Ratio} = \text{EBITDA} / \text{Revenue} = (145.5 + 172.1) / 1,313 = 22.7\%$$

$$\text{Asset Turnover Ratio} = \text{Revenue} / \text{Total Assets} = 1,313 / 4,384.2 = 0.30$$

Analyses of the results:**Profitability:**

- The Gross Profit Margin is 32.3%, which means that the company is able to generate a profit after accounting for the cost of goods sold.
- The Net Profit Margin of 8.5% indicates that the company is generating a decent profit from its operations after accounting for all expenses and taxes.
- The Operating Profit Margin of 11.1% shows that the company is able to generate a profit from its core operations.
- The Return on Equity of 4.5% is relatively low, which could indicate that the company is not generating a high return on its shareholders' investments.
- The Return on Assets of 2.5% suggests that the company is generating a modest return on its total assets.

Liquidity:

- The Current Ratio of 1.38 indicates that the company is able to pay off its short-term liabilities with its current assets, although the ratio is not particularly strong.
- The Quick Ratio of 1.30 is slightly lower than the Current Ratio, which means that the company may have some difficulty meeting its short-term obligations if its inventory cannot be sold quickly.
- The Interest Coverage Ratio of 5.6 indicates that the company is able to cover its interest expenses with its operating profit.

Solvency:

- The Debt-to-Equity Ratio indicates the degree of leverage or financial risk the company has. A ratio less than 1 indicates that the company has more equity than debt, which is generally considered favorable. In this case, the company has a Debt-to-Equity Ratio of 0.78, which means that the company has more debt than equity, suggesting that the company is highly leveraged.
- The Debt to Assets Ratio measures the percentage of total assets financed by debt. In this case, the company has a ratio of 0.44, indicating that 44% of its total assets are financed by debt. This suggests that the company is moderately leveraged.

Operating:

- The Operating Expense Ratio measures the proportion of revenue that is consumed by operating expenses. In this case, the company has an Operating Expense Ratio of 0.89, indicating that almost all of its revenue is consumed by operating expenses. This suggests that the company may need to reduce its operating expenses to improve profitability.

- The Operating Income Ratio measures the profitability of the company's operations. In this case, the company has an Operating Income Ratio of 0.11, indicating that it earns 11 cents in operating profit for every dollar of revenue generated.
- The EBITDA to Revenue Ratio is used to measure a company's ability to generate earnings from its operations. In this case, the company has a ratio of 0.35, indicating that for every dollar of revenue, it generates 35 cents in earnings before interest, taxes, depreciation, and amortization (EBITDA).
- The Asset Turnover Ratio measures the efficiency of a company's use of its assets to generate revenue. In this case, the company has an Asset Turnover Ratio of 0.30, indicating that for every dollar of assets, it generates 30 cents in revenue.

Source: Analysis by ChatGPT

Appendix 12. The samples of balance sheet and income statement of a company in text format provided in questionnaire

Balance sheet and income statement of a sample company in text format	
<p>#Balance sheet:</p> <p>#Assets</p> <p>{["Non-current assets"]</p> <p>“Property, plant and equipment 2,979.5”</p> <p>“Right-of-use assets 9.5”</p> <p>“Intangible assets 86.3”</p> <p>“Prepayments for non-current assets 45.9”</p> <p>“Deferred tax assets 1.9”</p> <p>“Derivative financial instruments 187.6”</p> <p>“Investments in associates 54.9”</p> <p>“Non-current receivables 1.1”</p> <p>“Total non-current assets 3,366.7]</p> <p>[“Current assets”</p> <p>“Inventories 114.1”</p> <p>“Greenhouse gas allowances and certificates of origin 208.6”</p> <p>“Trade and other receivables 336.6”</p> <p>“Derivative financial instruments 160.2”</p> <p>“Cash and cash equivalents 198.0”</p> <p>“Total current assets 1,017.5”</p> <p>“Total assets 4,384.2”]}}</p> <p>#EQUITY</p> <p>{[“Total equity and reserves attributable to equity holder of the Parent Company Share capital 746.6”</p>	<p>#Income statement:</p> <p>{[“Revenue 1,313.0”</p> <p>“Other operating income 162.3”</p> <p>“Change in inventories of finished goods and work-in-progress -11.0”</p> <p>“Raw materials and consumables used -888.9</p> <p>Payroll expenses -135.9”</p> <p>“Depreciation, amortization and impairment - 172.1”</p> <p>“Other operating expenses -121.9”</p> <p>“OPERATING PROFIT 145.5”</p> <p>“Finance income 0.6”</p> <p>“Finance costs -26.2”</p> <p>“Net finance costs -25.6”</p> <p>“Profit from associates under the equity method 2.0”</p> <p>“PROFIT BEFORE TAX 121.9”</p> <p>“Corporate income tax expense -10.4”</p> <p>“PROFIT FOR THE YEAR 111.5”]}}</p>

<p>“Share premium 259.8”</p> <p>“Statutory reserve capital 75.0”</p> <p>“Other reserves 219.8”</p> <p>“Retained earnings 1,017.6”</p> <p>“Total equity and reserves attributable to equity holder of the Parent Company 0”</p> <p>“Share capital 2,318.8”</p> <p>“Non-controlling interest 146.8”</p> <p>“Total equity 2,465.6”}]}</p> <p>#LIABILITIES</p> <p>{[“Non-current liabilities 0”</p> <p>“Borrowings 788.3”</p> <p>“Deferred tax liabilities 21.8”</p> <p>“Other payables 3.0”</p> <p>“Derivative financial instruments 37.8”</p> <p>“Contract liabilities and government grants 300.9”</p> <p>“Provisions 27.5”</p> <p>“Total non-current liabilities 1,179.3”]</p> <p>[“Current liabilities”</p> <p>“Borrowings 168.2”</p> <p>“Trade and other payables 255.5”</p> <p>“Derivative financial instruments 116.1”</p> <p>“Contract liabilities and government grants 0.7”</p> <p>“Provisions 198.8”</p> <p>“Total current liabilities 739.3”</p> <p>“Total liabilities 1,918.6”}]}</p> <p>{[“Total liabilities and equity 4,384.2”}]}</p>	<p>Appendix 12 continued</p>
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Source: author’s consideration as a sample from one of the annual reports

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Supervised by: Tarmo Koppel, PHD

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